Department of Energy
Albuquerque Operations
Los Alamos Area Office
Los Alamos, New Mexico 87544

11-15-91

2.99 Permit

CERTIFIED - RETURN RECEIPT REQUESTED

Mr. Myron O. Knudson, Director
Hazardous Waste Management Division
U. S. Environmental Protection Agency
1445 Ross Avenue, Suite 1200
Dallas, TX 75202-2733

Dear Mr. Knudson:

Enclosed are two copies of the annual update of the Installation Work Plan (IWP) for Environmental Restoration at the Los Alamos National Laboratory (LANL). Also enclosed is an electronic copy of the document text. These documents are submitted in accordance with the requirements of Tasks I and II of the "Special Conditions Pursuant to the 1984 Hazardous and Solid Waste Amendments to RCRA" as they apply to LANL.

Please be informed that for this and future deliverables, the authority for signing the certification required under 40 CFR 270.11 shall rest with Allen J. Tiedman (Associate Director for Operations) for LANL, and the Branch Chief, of the Environment, Safety and Health Branch for the Department of Energy, Los Alamos Area Office.

The plan has not been modified substantively since last year. Changes have been principally editorial and responses to the evolving structure of the program. Because of the resource constraints, the schedule shown in the Appendix S completes the Corrective Measures Study later than the 10 years in the permit schedule. We will be applying for a permit modification in the near future once the budget for this Fiscal Year becomes official. If you have any questions, please call Steve Slaten at FTS 855-5050.

Sincerely,

Karl J. Twombly, Chief
Environment, Safety and Health Branch

LESH:2SS-032

Enclosures

cc w/enclosures:
Tom Gunderson, EM-DO, MS K491
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15166

cc w/o enclosures:
Richard Sena, DOE/AL, MS A906
John Ahlquist, DOE/HQ

CERTIFICATION

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Document Titles:

Installation Work Plan for Environmental Restoration at Los Alamos National Laboratory, Revision 1, November 1991

Name: _____ Date 11-14-91

Allen J. Tiedman
Associate Director for Operations
Los Alamos National Laboratory

Name: _____ Date: 11/15/91

Karl J. Twombly, Chief
Environment, Safety, and Health Branch
Los Alamos Area Office - DOE

■ EXECUTIVE SUMMARY

In 1989, the US Department of Energy (DOE) created the DOE Office of Environmental Restoration and Waste Management (EM). The goal of the office is to implement the department's policy to ensure that its past, present, and future operations do not threaten human health and safety or the environment. The EM Office implements procedures to meet these goals through three associate directorates: Environmental Restoration (ER), Waste Operations, and Technology Development. The ER Program within EM is responsible for assessing, cleaning up, decontaminating, and decommissioning sites at DOE facilities and sites formerly used by DOE. This Installation Work Plan (IWP) describes how the DOE and the University of California (UC) will conduct the department's ER Program at Los Alamos National Laboratory (Laboratory).

The Laboratory and the neighboring residential areas of Los Alamos and White Rock are located in Los Alamos County, north central New Mexico, approximately 60 mi north-northeast of Albuquerque and 25 mi northwest of Santa Fe. The 43-mi^2 Laboratory site and the communities adjacent to it are situated on the Pajarito Plateau. The ephemeral and intermittent streams that drain the plateau have created numerous narrow finger-like mesas. Mesa tops range in elevation from approximately 7,800 ft on the flank of the Jemez Mountains to about 6,200 ft at their eastern termination above the Rio Grande Valley. The eastern margin of the plateau stands 300 to 900 ft above the Rio Grande.

Since its inception in 1943, the Laboratory's primary mission has been nuclear weapons research and development. The Laboratory is administered by UC for DOE. Primary programs include weapons development, magnetic and inertial fusion, nuclear fission, nuclear safeguards and security, and laser isotope separation. Basic research in the areas of physics, chemistry, and engineering, supports the weapons programs. Research on peaceful uses of nuclear energy includes space applications, power reactor programs, radiobiology, and medicine. Major research programs in elementary particle physics are carried out at the Laboratory's linear proton accelerator. Other programs include applied photochemistry, astrophysics, earth sciences, lasers, computer sciences, energy resources (including solar and geothermal), biomedical and environmental research, and nuclear waste management research.

Since the early 1970s, the Laboratory has operated an environmental surveillance program that routinely samples air, water, soil, and foodstuffs throughout the Los Alamos area to determine levels of contamination. The data collected in this program are published annually for distribution to the public and to local, state, and federal agencies. These data indicate that Laboratory operations do not currently threaten human health or the environment. The ER Program at the Laboratory augments the environmental

surveillance program by identifying potential future threats to human health and the environment and by mitigating them through efficient corrective actions that comply with applicable environmental regulations. Corrective actions include such measures as source containment to prevent contaminant migration, controls on future land use, and excavation and treatment of the source to remove hazards to health and the environment.

Two primary laws govern ER activities at the Laboratory: the Comprehensive Environmental Response, Compensation, and Liability Act [CERCLA (Superfund)] and the Resource Conservation and Recovery Act (RCRA). The hazardous waste provisions of RCRA govern the day-to-day operations of hazardous waste management, storage, and disposal (TSD) facilities. The law established a permitting system and set standards for all hazardous-waste-producing operations at a TSD facility. Under this law, the Laboratory qualifies as a treatment and storage facility and must have a permit to operate. In 1984, Congress amended RCRA by passing the Hazardous and Solid Waste Amendments (HWSA). Section 3004(u) (of RCRA as amended by HSWA) mandates that permits for TSD facilities include provisions for corrective action to mitigate releases from facilities currently in operation and to clean up contamination in areas designated as solid waste management units (SWMUs).

Congress conceived and passed CERCLA to clean up the nation's most hazardous abandoned waste sites. Under CERCLA, the EPA ranks abandoned facilities that have hazardous waste sites according to their potential threat to human health and environment. The high-scoring sites are listed on the National Priorities List (NPL) and are cleaned up in accordance with CERCLA regulations. When EPA ranked the Laboratory, the agency determined that current environmental conditions do not pose an imminent threat to human health. Hence, the Laboratory is not listed on the NPL. DOE/UC's RCRA permit includes a section called the HSWA Module, which prescribes a specific corrective action program for the Laboratory. Because the Laboratory has not been listed on the NPL, the HSWA Module provides the primary guidance for the Laboratory's ER Program. However, the program must also meet the substantive requirements for CERCLA, as well as those of other environmental statutes.

This IWP has been prepared in accordance with the HSWA Module of the Laboratory's RCRA permit and with proposed correction action requirements for incorporation in EPA's standards for hazardous waste. EPA proposed Subpart S of 40 CFR 264 in July 1990 to implement the cleanup program mandated in Section 3004(u) of RCRA. This IWP describes how each of the following corrective action steps will be implemented at the Laboratory.

- The RCRA facility investigation (RFI)—The goal of this step is to identify the nature and extent of contamination at source points and in environmental pathways that could lead to exposure of human and environmental receptors. This step will be implemented by characterizing the extent of contamination in the detail necessary to determine what corrective measures, if any, need to be taken. The Laboratory will focus effort on answering only those questions relevant to deciding further actions.

- Corrective measures study (CMS)—If characterization indicates that corrective measures may be needed, this study will evaluate alternatives that might be reasonably implemented. Corrective measures will be evaluated based on their projected efficacy in reducing risks to human and environmental health and safety in a cost-effective manner.

- Corrective measures implementation (CMI)—This step implements the chosen remedy, verifies its effectiveness, and establishes ongoing control and monitoring requirements.

The IWP includes

- a program management plan that describes the organization and management of the Laboratory's ER Program, including projected schedules and costs;

- a quality program plan that defines the overall program to ensure a technically defensible and valid program;

- a health and safety program plan that describes measures to ensure health and safety during implementation of the Laboratory's ER Program;

- a records management program plan that describes the mechanisms to be used to track information and data throughout the ER Program:

- a community relations program plan that describes how the Laboratory will provide information to and receive recommendations from the public throughout the life of the ER Program;

- a proposal to integrate RCRA closure and corrective action requirements; and

- a strategy for the conduct of interim remedial measures.

The HSWA Module provides a schedule for addressing 603 SWMUs that the EPA has selected from those identified by DOE/UC. The schedule

requires that all 603 SWMUs be addressed in RFI work plans by May 23, 1994, and that the CMS reports be complete by May 23, 2000. DOE/UC has aggregated all SWMUs into operable units to be taken through the corrective action process. Thus, the permit schedule for work plan completion will be met by submitting one RFI work plan for each of the 24 operable units (24 work plans by May 23, 1994).

Current risks from known SWMUs are low; hence, no operable unit or set of SWMUs has a priority for action over others based on health or environmental concerns. The order in which operable units will be addressed is therefore designed to meet the requirements of the HSWA Module. However, DOE/UC proposes to extend the RFI process by an amount that will delay completion of the CMS report to the year 2002. This extension of the schedule is necessary because the HSWA Module included only a subset of the SWMUs that the ER Program must address to meet all applicable environmental regulations (not just those of RCRA). In addition, the extended schedule allows the spread of effort over a period compatible with the availability of national resources, including funding.

The HSWA Module of the RCRA permit defines the principal requirements with which DOE/UC must comply in implementing the ER Program at the Laboratory. However, RCRA does not address several issues of concern at Los Alamos. For example, source material, by-product, and special nuclear material are exempt from the RCRA definition of solid waste and are not subject to the provisions of the HSWA Module. DOE/UC recognize that these radioactive constituents are of major concern and cannot be separated from concerns about hazardous wastes. Thus, DOE/UC's ER Program addresses radioactive as well as other hazardous substances not regulated by RCRA. This approach is intended to implement a technically comprehensive program that covers potential liabilities associated with other environmental laws, such as CERCLA. However, it is understood that language in this IWP pertaining to subjects outside the scope of RCRA is not enforceable under the RCRA permit.

In accordance with the provisions of the HSWA Module, this plan will be revised annually to update the status of the ER Program at the Laboratory, future plans, and near- and long-term schedules, as well as to accommodate the DOE appropriation process.

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ABBREVIATIONS AND ACRONYMS USED IN THE ENVIRONMENTAL RESTORATION PROGRAM

ADM	Action description memorandum
ADS	Activity data sheet
AEC	US Atomic Energy Commission
AIRFA	American Indian Religious Freedom Act
ALARA	As low as reasonably achievable
AOC	Area of concern
AQCA	Air Quality Control Act
ARAR	Applicable or relevant and appropriate
ASME	American Society of Mechanical Engineers
A–E	Architect-engineer
BAT	Best available technology
BRMD	Budget and Resource Management Division
CA	Corrective activities
CAA	Clean Air Act
CAMU	Corrective action management unit
CARD	Citizens Against Radioactive Dumping
CCNS	Concerned Citizens for Nuclear Safety
CEARP	Comprehensive Environmental Assessment and Response Program
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CGI	Combustible gas indicator
CLS	Chemical and Laser Sciences (Division)
CMI	Corrective measures implementation
CMS	Corrective measures study
CPM	Construction project manager
CRM	Communications and Records Management (Division)
CRP	Community Relations Plan
CSCSC	Cost and schedule control systems criteria
CWA	Clean Water Act
CY	Calendar Year
DEAR	Department of Energy acquisition regulation
D&D	Decontamination and decommissioning
DOE	US Department of Energy
DOE/AL	US Department of Energy Albuquerque Operations Office
DOE/HQ	US Department of Energy Headquarters
DOE/LAAO	US Department of Energy Los Alamos Area Office
DOT	Department of Transportation
DQO	Data quality objectives
EA	Environmental assessment
EES	Earth and Environmental Sciences (Division)
EIS	Environmental impact statement
EOC	Emergency Operations Center

EM	Environmental management
EPCRA	Emergency Planning and Community Right-to-Know Act
EPA	US Environmental Protection Agency
ER	Environmental restoration
ERA	Environmental Research Applications
ERDA	US Energy Research and Development Administration
ERPG	Emergency response planning guideline
ESA	Endangered Species Act
ES&H	Environment, safety, and health
ESAAB	Energy Systems Acquisition Advisory Board
FAR	Federal acquisition regulation
FQCPO	Facility Quality Control Project Office
FIMAD	Facility for Information Management, Analysis, and Display
FS	Feasibility study
FSAR	Final safety analysis report
FUSRAP	Formerly Utilized Sites Remedial Action Program
FY	Fiscal year
GC/MS	Gas chromatograph/mass spectrometer
GDMS	Glow discharge mass spectrometry
GIS	Geographical Information System
GM	Geiger-Mueller
GWPA	Ground Water Protection Act
H&S	Health and Safety
HCIA	Hazardous Chemicals Information Act
HSE	Health, Safety, and Environment (Division)
HSWA	Hazardous and Solid Waste Amendments
HWA	Hazardous Waste Act
ICP-ES	Inductively coupled plasma emission spectroscopy
IGMP	Installation Generic Monitoring Plan
INAA	Instrumental neutron activation analysis
INC	Isotope and Nuclear Chemistry (Division)
IRM	Interim remedial measure
IS	Information Services (Division)
IWP	Installation work plan
LANL	Los Alamos National Laboratory
LAMPF	Los Alamos Meson Physics Facility
LASL	Los Alamos Scientific Laboratory (LANL before 1979)
LDR	Land disposal restriction
LEL	Lower explosive limit
LERC	Laboratory Environmental Revision Committee
LIBS	Laser-induced breakdown spectroscopy
MCL	Maximum contaminant level
MCS	Management control system
MDA	Material disposal area
MDL	Minimum detection limit

MSA	Major systems acquisition
MSHA	Mine Safety and Health Administration
M&O	Management and operations
NCGIA	National Center for Geographic Information and Analysis
NEPA	National Environmental Policy Act
NERP	National Environmental Research Park
NESHAP	National Emission Standards for Hazardous Air Pollutants
NFA	No further action
NIOSH	National Institute of Occupational Health and Safety
NIST	National Institute of Standards and Technology
NMEID	New Mexico Environmental Improvement Division
NMODC	New Mexico Oil Conservation District
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
OCD	Oil Conservation Division
OSCG	On-scene control group
OSR	Occupational safety requirements
OS&H	Occupational safety and health
OSHA	Occupational Safety and Health Administration
OTD	Office of Technology Development
OU	Operable unit
OVA	Organic vapor analyzer
PA/SI	Preliminary assessment/site investigation
PC	Personal computer
PCB	Polychlorinated biphenyl
PCE	Per-chlorethane
PCM	Project Control Manager
PCO	Project Control Office
PEIS	Programmatic environmental impact statement
PL	Project leader
PM	Program Manager (ER)
PMP	Program Management Plan
PSAR	Preliminary safety analysis report
QA	Quality assurance
QAPjP	Quality assurance project plan
QAR	Quality assurance representative
QC	Quality control
QP	Quality administrative procedure
QPP	Quality Program Plan
QPPL	Quality Program Project Leader
RA	Remedial action
R&D	Research and development
RD	Remedial design
RFA	RCRA facility assessment
RCRA	Resource Conservation and Recovery Act

RDDT&E	Research, development, demonstration, testing, and evaluation
RFI	RCRA facility investigation
RI	Remedial investigation
RM	Records management
ROD	Record of decision
RPA	Radiation Protection Act
RPF	Records-Processing Facility
SA	Safety assessment
SARA	Superfund Amendment Reauthorization Act
SART	Site assessment and remediation technology
SDWA	Safe Drinking Water Act
SEN	Secretary of Energy notice
SOP	Standard operating procedure
SPCC	Spill prevention control and countermeasures
SSP	Site-specific plan
SWA	Solid Waste Act
SWAT	Solid Waste Assessment Team
SWCS	Sanitary wastewater consolidation system
SWDA	Solid Waste Disposal Act
SWMU	Solid waste management unit
TA	Technical area
TAL	Target analyte list
TEC	Total estimated cost
TLD	Thermoluninescent dosimeter
TLV	Threshold limit value
TPC	Total program cost
TRU	Transuranic (waste)
TSD	Treatment, storage, disposal
TSCA	Toxic Substances Control Act
UC	University of California
USC	United States Code
USGS	US Geological Survey
UST	Underground storage tanks
WBS	Work Breakdown Structure
WIN	Waste Information Network
WIPP	Waste Isolation Pilot Plant
WM	Waste management
WQA	Water Quality Act
XRF	X-ray fluorescence

■ 1.0 INTRODUCTION

In 1989, the US Department of Energy (DOE) created the Office of Environmental Restoration and Waste Management (EM). The goal of the office is to implement the department's policy to ensure that its past, present, and future operations do not threaten human or environmental health and safety (DOE 1990). The EM Office implements procedures to meet these goals through three associate directorates: Environmental Restoration (ER), Waste Operations, and Technology Development. The ER Program in EM is responsible for assessing, cleaning up, decontaminating, and decommissioning sites at DOE facilities and sites formerly used by DOE. The Installation Work Plan (IWP) describes how the DOE and the University of California (UC) will conduct the department's ER Program at Los Alamos National Laboratory (the Laboratory).

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Congress conceived and passed CERCLA to clean up the nation's most hazardous abandoned waste sites. Under CERCLA, the US Environmental Protection Agency (EPA) ranks abandoned facilities that have hazardous

waste sites according to their potential threat to human health and the environment. The high-scoring sites are listed on the National Priorities List (NPL) and are cleaned up in accordance with CERCLA regulations. When EPA ranked the Laboratory, the agency determined that current environmental conditions do not pose an imminent threat to human health. Hence, the Laboratory is not listed on the NPL. DOE/UC's RCRA permit includes a section called the HSWA Module, which prescribes a specific corrective action program for the Laboratory. Because the Laboratory has not been listed on the NPL, the HSWA Module provides the primary guidance for the Laboratory's ER Program. However, the program must also meet the requirements of CERCLA, as well as other environmental statutes.

The HSWA Module specifies a three-step corrective action process (Figure 1-1):

- The RCRA facility investigation (RFI)—The goal of this step is to identify the extent of contamination at source points and environmental pathways for the exposure of potential human and environmental receptors. This step will be implemented by characterizing the extent of contamination in the detail necessary to determine what corrective measures, if any, need to be taken. This approach will focus effort on answering only those questions relevant to deciding further actions in a cost-effective manner.

- Corrective measures study (CMS)—If characterization indicates that corrective measures may be needed, this study will evaluate alternatives that might be reasonably implemented. These measures will be evaluated based on their projected efficacy in reducing risks to human and environmental health and safety in a cost-effective manner.

- Corrective measures implementation (CMI)—This step implements the chosen remedy, verifies its effectiveness, and establishes ongoing control and monitoring requirements.

This IWP has been prepared in accordance with the HWSA Module and with proposed Subpart S, Corrective Action for Solid Waste Management Units, of 40 CFR 264 (EPA 1990) in the regulations promulgated by EPA to implement HSWA. EPA proposed Subpart S in July 1990 to implement the cleanup program mandated in Section 3004(u) of RCRA. This IWP describes how each of the three corrective action steps described above will be implemented at the Laboratory. DOE/UC proposes to use the operable unit approach defined in CERCLA for organizing and managing the various SWMUs. Operable units are aggregates of SWMUs that will be addressed together. The details for each step required under the corrective action process will be presented individually for each operable unit.

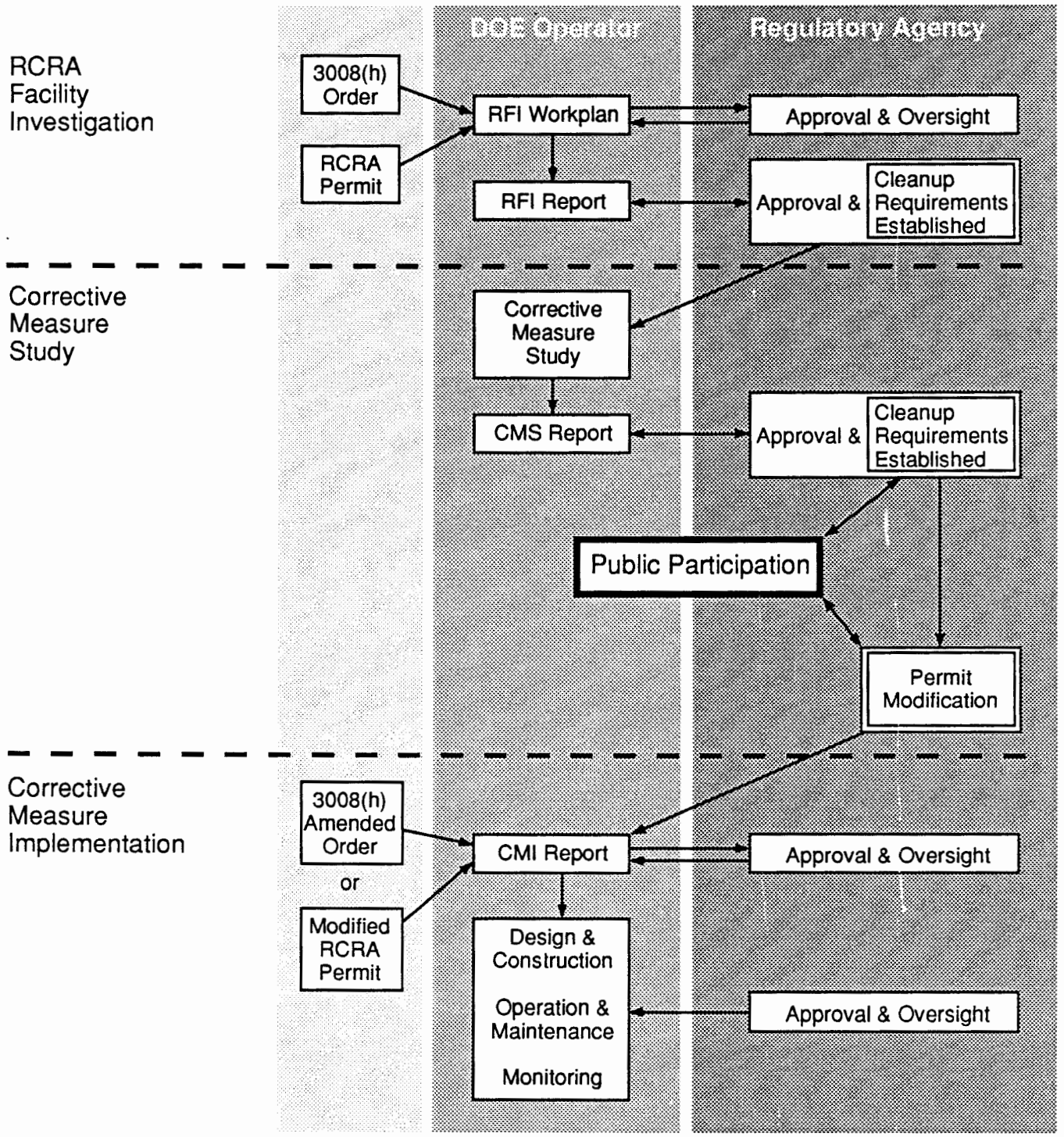

Figure 1-1. Resource Conservation and Recovery Act corrective action process.

The HSWA Module provides a schedule for addressing 603 SWMUs that the EPA has selected from those identified by DOE/UC. The schedule requires that all 603 SWMUs be addressed in RFI work plans by May 23, 1994, and that CMSs be complete by May 23, 2000. The work plan requirement will be met by completing work plans for 24 operable units at the Laboratory. These work plans will describe how the general approach of the IWP will be applied to each operable unit. Current risks from known SWMUs are low; hence, no operable unit or set of SWMUs has a priority for action over others based on health or environmental concerns. The order in which operable units will be addressed is therefore designed to meet the requirements of the HSWA Model. However, DOE/UC propose to extend the RFI schedule so that the CMS process is not complete until May 23, 2002. This is necessary because of the increased number of SWMUs identified at the Laboratory, and this will allow the spread of effort over a period that is compatible with the availability of national resources, including funding.

Major components of this IWP that address the requirements of the HSWA module are

- a facilities description, which includes a description of current environmental conditions at Laboratory sites (Section 2);

- a description of the ER Program at the Laboratory, including an overview of DOE's ER Program and how it will be implemented and a general discussion of the technical approach (Section 3);

- a program management plan (PMP) that describes the organization and management of the Laboratory's ER Program, including projected schedules and costs (Annex I);

- a quality program plan (QPP) that defines the overall program to ensure a technically defensible and valid program (Annex II);

- a health and safety (H&S) program plan that describes measures to ensure H&S during implementation of the Laboratory's ER Program (Annex III);

- a records management program (RMP) plan that describes the mechanisms to be used to track information and data throughout the ER Program (Annex IV);

- a community relations program (RMP) plan that describes how the Laboratory will provide information to and receive recommendations from the public throughout the life of the ER Program (Annex V);

- a proposal to integrate RCRA closure and corrective action requirements (Section 3.11); and

- a strategy for the conduct of interim remedial measures (Section 3.12).

The HSWA Module of the RCRA permit defines the principal requirements with which DOE/UC must comply in implementing the ER Program at the Laboratory. However, RCRA does not address several issues of concern at Los Alamos. For example, source material, by-product, and special nuclear material are exempt from the RCRA definition of solid waste and are not subject to the provisions of the HSWA Module. DOE/UC recognize that these radioactive constituents are of major concern and cannot be separated from concerns about hazardous wastes. Thus, DOE/UC's ER Program addresses radioactive as well as other hazardous substances not regulated by RCRA. This approach is intended to maintain a technically comprehensive program that covers potential liabilities associated with other environmental laws, such as CERCLA. However, it is understood that language in this IWP pertaining to subjects outside the scope of RCRA is not enforceable under the permit.

In accordance with the provisions of the HSWA Module, this plan will be revised annually to update the status of the ER Program at the Laboratory, future plans, and near- and long-term schedules as well as to accommodate the DOE appropriation process.

■ REFERENCES

DOE (US Department of Energy) June 1990. "Environmental Restoration and Waste Management Five-Year Plan, Fiscal Years 1992–1996," DOE/S-0078P, Washington, DC.

EPA (Environmental Protection Agency) July 27, 1990. "Corrective Action for Solid Waste Management Units (SWMUs) at Hazardous Waste Management Facilities," proposed rule, Title 40, Parts 264, 265, 270, and 271, Federal Register, Vol. 55, p. 30798.

■ INSTALLATION DESCRIPTION

2.1 GEOGRAPHIC SETTING

Los Alamos National Laboratory the (Laboratory) and the neighboring residential areas of Los Alamos and White Rock are located in Los Alamos County, north central New Mexico, approximately 60 mi north-northeast of Albuquerque and 25 mi northwest of Santa Fe (Figure 2-1). The 43-mi^2 Laboratory site and the communities adjacent to it are situated on the Pajarito Plateau, which consists of a series of fingerlike mesas separated by deep canyons containing ephemeral and perennial streams oriented east to west. Mesa tops range in elevation from approximately 7,800 ft on the flank of the Jemez Mountains to about 6,200 ft at their eastern termination above the Rio Grande Valley. The eastern margin of the plateau stands 300 to 900 ft above the Rio Grande (DOE 1979). The Department of Energy (DOE) controls the area within the Laboratory's boundaries and has the option to completely restrict access.

2.2 MISSION OF LOS ALAMOS NATIONAL LABORATORY

The Laboratory is administered by the University of California (UC) for the DOE. Since its inception in 1943, the Laboratory's primary mission has been nuclear weapons research and development. The Laboratory's primary programs include weapons development, magnetic and inertial fusion, nuclear fission, nuclear safeguards and security, and laser isotope separation. In the areas of physics, chemistry, and engineering, there is also basic research that supports the weapons programs. Research on peaceful uses of nuclear energy includes space applications, power reactor programs, radiobiology, and medicine. Major research programs in elementary particle physics are carried out at the Laboratory's linear proton accelerator. Other programs include applied photochemistry, astrophysics, earth sciences, lasers, computer sciences, energy resources (including solar and geothermal), biomedical and environmental research, and nuclear waste management research. Appendix A summarizes activities at the Laboratory's 32 active technical areas (TAs) shown in Figure 2-2.

In August 1977, the Laboratory site was dedicated as a National Environmental Research Park (NERP). The ultimate goal of programs associated with this research facility is to encourage environmental research that will contribute understanding of how people can best live in balance with nature while enjoying the benefits of technology. Park resources are available to individuals and organizations outside of the Laboratory to facilitate self-supported research on these subjects.

A final environmental impact statement that assesses potential cumulative environmental impacts associated with current, known future, and continuing activities at the Laboratory was completed in 1979 (DOE 1979). The

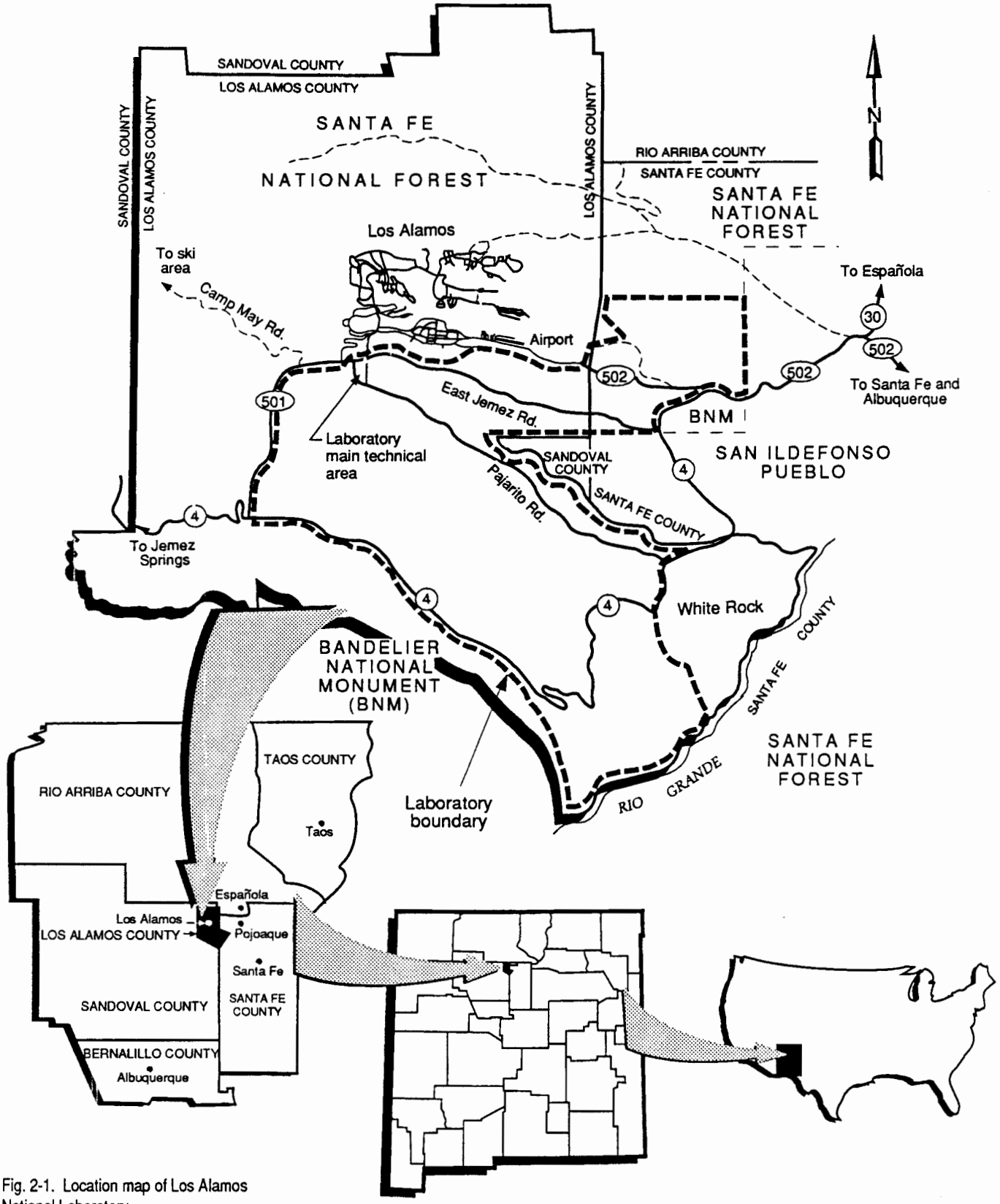

Fig. 2-1. Location map of Los Alamos National Laboratory.

report provides environmental information for decisions regarding continuing activities at the Laboratory, as well as more detailed information on the environment of the Los Alamos area. This information has been updated annually by the Laboratory's environmental surveillance report.

2.3 HISTORY OF LOS ALAMOS NATIONAL LABORATORY

The US Army Manhattan Engineer District, which was established in 1942, quickly progressed to a point where a remote site for experimental work was needed. The Army decided to locate weapons research, called "Project Y," at the Los Alamos Ranch School for Boys, which consisted of a group of some 50 log buildings on a 790-acre site northwest of Santa Fe, New Mexico. In 1942, the Undersecretary of War directed acquisition of the site, which ultimately included the Ranch School property, another 3,120 acres in homesteads and grazing lands, and 45,666 acres of public land supervised by the US Forest Service.

In 1943, this land became known as the Los Alamos Site, later Los Alamos Scientific Laboratory (LASL). Its initial mission was to develop the world's first nuclear fission weapon, a project that lasted for the duration of World War II. From its inception, the Laboratory has been operated by UC.

Laboratory activities were established in wooden buildings south of the original Ranch School buildings in what is now downtown Los Alamos. Additional Laboratory buildings were constructed; army-style barracks, temporary and prefabricated, provided housing.

With the end of World War II and the growth of international competition, a national policy of maintaining pre-eminence in the field of atomic energy was established. Congress chose to sustain the Los Alamos site; the Atomic Energy Commission (AEC) received control of the Laboratory from the Army and renewed the operating contract with UC. Thereafter, a major construction program was started south of Los Alamos Canyon. During subsequent years, the Laboratory continued to expand at a steady rate, first under the AEC and later under the Energy Research and Development Administration (ERDA). In the 1960s, lots in the townsite area were sold to private individuals. Since 1978, the Laboratory has operated under the control of the DOE, and is currently officially known as Los Alamos National Laboratory.

2.4 WASTE MANAGEMENT PRACTICES

Activities at the Laboratory have generated and will continue to generate three types of hazardous wastes: (1) wastes from processing operations, (2) wastes from research and development (R&D) activities, and (3) high-

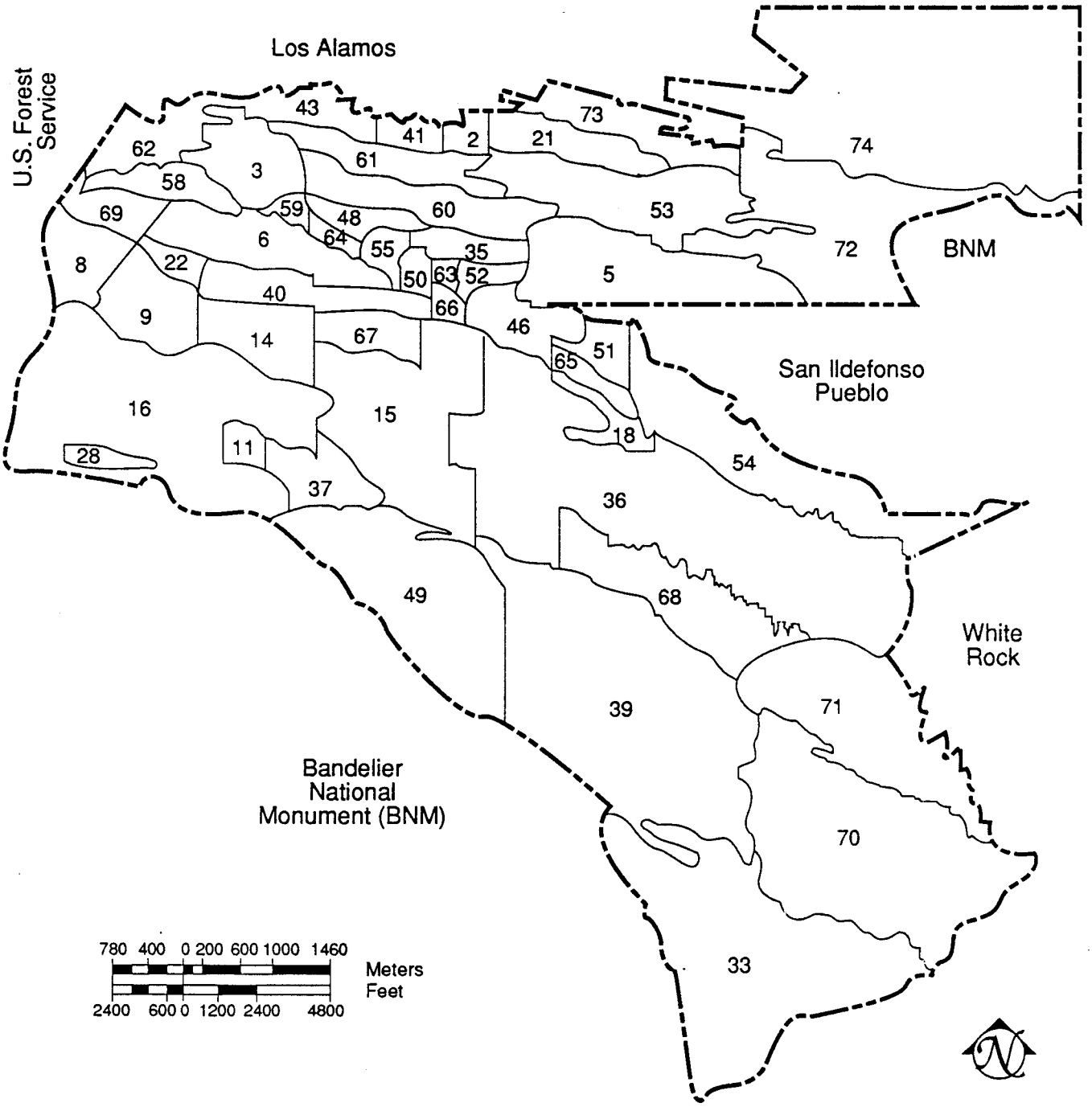

Fig. 2-2. Technical areas on Laboratory site.

explosive waste. These three main groups of hazardous wastes are generated from stream processing, isotope separation, shop manufacturing, basic and applied chemistry R&D programs, explosives testing and manufacture, chemically contaminated equipment, radioactive material processing, and from a mixture of these processes. Table 2-1 lists the hazardous wastes generated at Los Alamos identified by generation process. Typically, wastes from processing operations consist of significant volumes of material that contain a very limited number of contaminants, and the composition and concentration of contaminants in a given process waste are generally uniform unless the process is modified. Typically, R&D wastes usually have smaller volumes of a number of different laboratory reagents, chemicals, solvents, and other general laboratory wastes. Waste species from R&D activities continually vary, depending on the nature of the Laboratory's rapidly changing R&D efforts. High-explosive waste consists of a fairly constant and narrow assemblage of chemicals in varying concentrations.

Since 1972, the Waste Management Group (HSE-7) has produced waste management site plans annually Appendix B. These plans identify and describe the areas and processes that generate significant radioactive and hazardous wastes. Treatment facilities, material disposal areas (MDAs), and storage facilities are also described, as are the volumes of waste treated during the year and the alpha activity of radioactive waste and discharge effluent. The plans also describe decontamination and decommissioning (D&D) and future waste management plans and budgets. HSE-7 is accountable for the operation of all waste management facilities, except those related to high-explosive wastes. Activities at HSE-7 include treatment of radioactive liquid and solid wastes; packaging, transport, and treatment of hazardous chemical wastes; and operation of radioactive and hazardous chemical waste disposal and storage sites. HSE-7 also handles mixed wastes (defined as low-level radioactive wastes that also meet the definition of hazardous chemical waste in 40 CFR 261 (EPA 1989), transuranic wastes (TRU), and by-product materials that are excluded from the definition of mixed wastes. Existing information from this radioactive waste management program will be used to assist in cleaning up MDAs that fall under the ER Program.

Radioactive waste management facilities include liquid and solid waste treatment plans and associated effluent control systems (filtration units and monitoring equipment), waste storage and disposal locations, and airborne contamination release points. Most of the Laboratory's radioactive and hazardous liquid wastes are treated at TA-50. Radioactive liquid wastes are also currently treated in Building 257 at TA-21. The use of this plant is diminishing as generating operations are phased out of the TA-21 buildings. Some liquid radioactive wastes are generated at the Los Alamos

TABLE 2-1 HAZARDOUS WASTES AT LOS ALAMOS IDENTIFIED BY GENERATION PROCESS AND WASTE CHARACTERIZATION.

Process or Operation Generating Hazardous Wastes	Wastes Generated	Approximate Annual Volume (lb)	Hazard Code	EPA Hazardous Waste Number*
Basic and Applied Chemistry R&D Program				
Chemistry and Metallurgy Research Building Radiochemistry Laboratory Health Research Laboratory	Numerous chemical wastes	Organic 50,000 Inorganic 40,000	Varies	Many
Electrochemistry Processing				
Materials Technology Group	Cyanide and chromate plating solutions	2,000	Toxic, reactive	F007, F009
Printed Circuit Board Shop	Acid/base copper etching/plating solutions	40,000	Corrosive	D002
Isotope Separation				
Isotope and Structural Chemistry Group	Concentrated nitric and sulfuric acid	80,000	Corrosive	D001, D002
Shops (Mechanical Fabrication Division				
	Lithium hydride, lithium metal	3,500	Reactive	D003
	Halogenated solvents	<1,000	Toxic	F001, F002
	Nonhalogenated solvents	<1,000	Ignitable	F003
Explosives				
Dynamics Testing and Design Engineering	High explosives, potential for barium	50,000	Ignitable, reactive	D001, D003, D005, and K044
	Contaminated burn pad sand	10,000	EP toxic	D005
Chemically Contaminated Equipment				
LANL Facilities	Empty drums, tanks, cylinders, etc.	12,000	Varies	Many

*40 CFR Part 261, Identification and Listing of Hazardous Wastes (EPA 1989).

Meson Physics Facility (LAMPF) accelerator and are held in lagoons at TA-53. The Laboratory is currently using one solid waste disposal site, Area G in TA-54, for disposal of radioactive solid waste. Mixed wastes are currently stored at Area L in TA-54, a hazardous waste storage and treatment site.

Liquid waste treatment processes at TA-21 and TA-50 typically produce a solid waste with a few radioactive residuals in the liquid and gaseous effluents. Liquid effluents are treated to comply with the radioactive release limits specified in DOE Order 5400.5 (DOE 1990) before discharge into Mortandad Canyon north of TA-50 and DP Canyon north of Building 257 (TA-21). Gaseous effluents at each generation site are managed in compliance with radioactive release limits before release to the atmosphere in accordance with DOE Order 5400.5. These effluents are also monitored continuously, using particulate- and/or gas-monitoring methods. Solid radioactive wastes are packaged at the generation site for shipment to Area G in TA-54. All low-level wastes are buried in pits or shafts. Chemical wastes are shipped from generation sites to Area L in TA-54 for packaging, storage, and treatment.

The DOE has required, since 1971, that TRU solid wastes be segregated from low-level wastes and that they be specially packaged, handled, and stored retrievably. TRU solid wastes at Los Alamos include essentially the same materials as low-level waste but contain contamination in excess of specified levels. Through FY82, this level was 10 nanocuries of alpha activity per gram (nCi/g) of waste. After 1982, the regulated level for TRU wastes was enhanced to 100 nCi/g. Originally, TRU wastes were stored in a cement mix, which was poured into asphalt-lined corrugated metal pipes. Since 1982, TRU wastes have been stored in drums and crates on asphalt pads. These containers are stacked 12 to 16 ft high. Their tops and sides are covered with plywood, and the entire area is enclosed by 0.5-mm nylon-reinforced vinyl sheeting and covered with 3 to 6 ft of tuff. TRU material will be transported to the Waste Isolation Pilot Plant (WIPP) site in southern New Mexico when it opens. All waste shipped to the WIPP site will meet WIPP waste acceptance criteria.

In May 1985, the DOE/UC an application with the New Mexico Environmental Improvement Division (NMEID) and Environmental Protection Agency (EPA) for a permit to operate the Laboratory under the provisions of the Resource Conservation and Recovery Act (RCRA). The NMEID granted the permit for current waste operations in November 1989. Under this permit the following facilities may operate:

- TA-50 — batch treatment system and waste container storage system.
- TA-50 — chemical waste incineration

- TA-54, Material Disposal Area L— waste transfer, treatment, packaging, and storage facilities.

Thermal treatment facilities for burning on detonating high explosives, explosives contaminated materials, and active materials are operating under interim status at TAs-14, -15, -16, -36, and -39.

Additional chemical waste facilities include the polychlorinated biphenyl (PCB) storage building at TA-21-61 and the Pan Am motor oil storage tanks at TA-0, TA-54 (Area J), and TA-16 (Area P). Earlier submittals of the RCRA permit application included the Area L landfill; however, because the Laboratory could not comply with RCRA requirements for groundwater monitoring and double-lined leachate collection facilities, the landfill operation was withdrawn from the permit application. All landfill burial operations at Area L ceased in November 1985, and a closure plan for these facilities has been prepared and submitted.

2.5 OVERVIEW OF THE ENVIRONMENTAL SETTING

2.5.1 Land Use Patterns

Most Laboratory and community developments are confined to mesa tops. Large tracts of land north, west, and south of the Laboratory site are managed by the Santa Fe National Forest, Bureau of Land Management, Bandelier National Monument, General Services Administration, and Los Alamos County (Figure 2-3). The San Ildefonso Pueblo borders Los Alamos County to the east.

Laboratory land is used for building sites, experimental areas, waste disposal locations, roads, and utility rights-of-way. However, these uses account for only a small part of the land. Most of the land controlled by the Laboratory serves as a buffer zone for Laboratory facilities, providing security and safety, and is a reserve for future construction. The Laboratory's long-range site development plan (LANL 1990a) ensures adequate planning for the best possible future uses of available Laboratory lands.

The public is allowed limited access to certain areas of the Laboratory reservation. An area north of Ancho Canyon between the Rio Grande and State Route 4 is open to hikers, boaters, and hunters, but woodcutting and vehicles are prohibited. Portions of Mortandad and Pueblo canyons are also open to the public. An archaeological site (the Otowi tract), northwest of State Road 502 near the White Rock Y, is open to the public, subject to restrictions imposed by regulations to protect cultural resources.

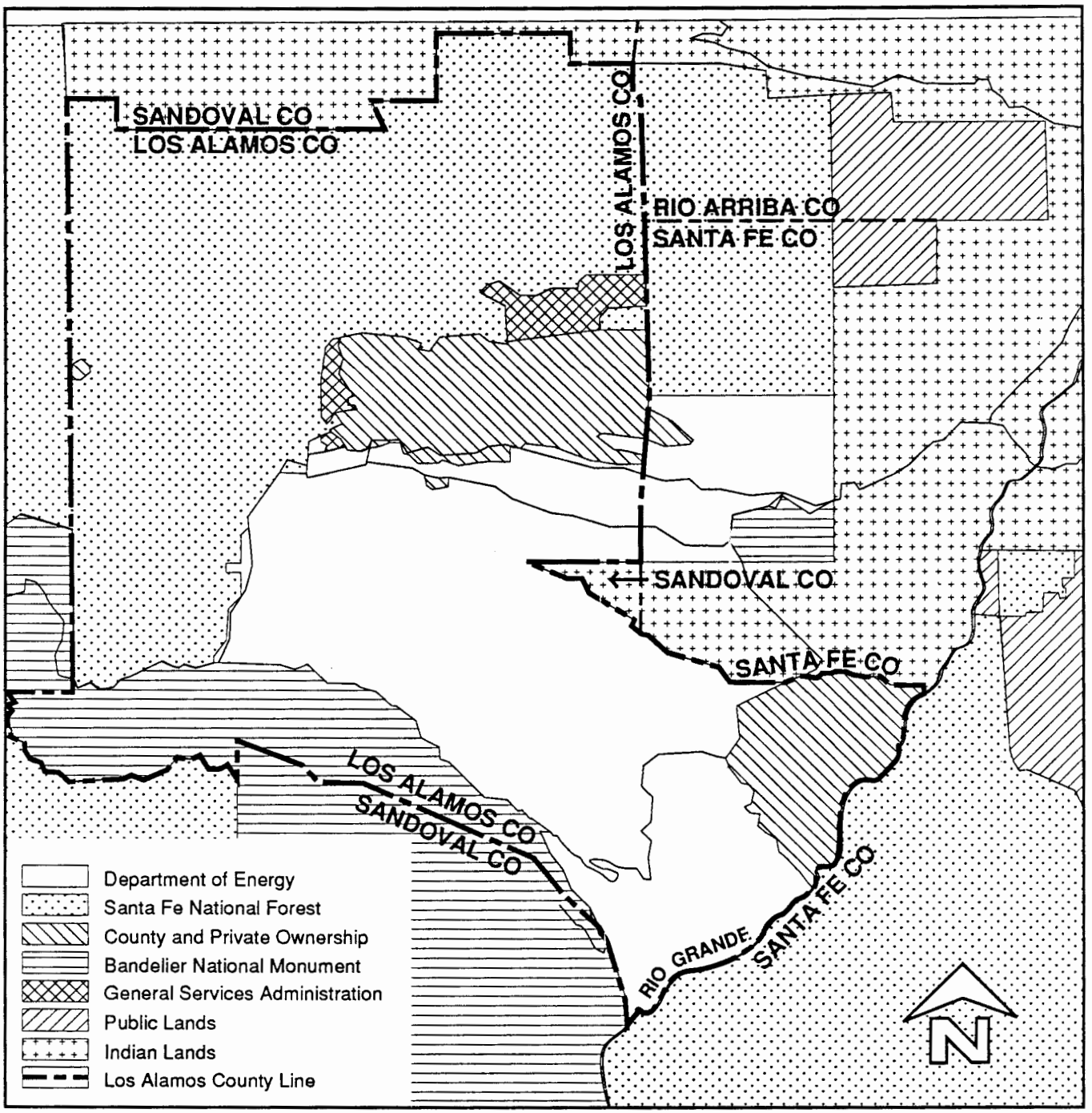

Fig. 2-3. Land ownership in the Los Alamos area.

2.5.2 Ecology

Understanding of the structural and functional relationships among Los Alamos ecosystems is limited, partly because of the wide diversity of ecosystems. This diversity has been created by the pronounced 4,920-ft elevation gradient that extends from the Rio Grande on the east to the Jemez Mountains 12 mi to the west. Many canyons, with abrupt changes in

surface slope, parallel this gradient. The pronounced east-west canyon and mesa orientations, with concomitant differences in soils, moisture, and solar radiation, produce an interlocking finger effect among ecological life zones, resulting in many transitional overlaps of plant and animal communities within small areas. Information and maps of wetlands and flood plains at Los Alamos are contained in Appendixes C and D. Section 2.6 provides a detailed overview of the hydrogeological environment at Los Alamos.

2.5.2.1 Flora

Six major vegetative complexes or community types are found in Los Alamos County. A piñon pine and juniper forest surrounds most of the Laboratory. Within the confines of the Laboratory's border, the predominant community types are ponderosa pine woodland (6,900 to 7,500 ft in the western third of the reservation), piñon-juniper (6,200 to 6,900 ft in the central third), and juniper grassland (5,600–6,200 ft in the eastern third). Most of the environmental surveillance, waste operations, and R&D activities affect physical, chemical, and biological components of the piñon-juniper woodland.

Less is known about ecosystems other than the piñon-juniper woodland. Hakonson et al. (1973) provided a general description of the Laboratory and environs. Almost 350 plant species have been identified, and species lists have been prepared (DOE 1979). Special studies have described the past and current status of the flora of the complex (Foxx and Tierney 1980, 1984, 1985). Past and present uses of the Laboratory and adjacent lands have resulted in structural changes in plant communities. Laboratory uses have had, and will continue to have, important consequences for local ecosystems. There have been few construction and waste disposal activities in the flood plains of canyons in and near the Laboratory. Natural wetland areas occur in some canyons, and more extensive wetlands have developed as a result of effluent outfalls.

The grama grass cactus, which is proposed for inclusion on the federal endangered species list, has been found on the dry mesa tops of Los Alamos County at elevations of about 6,000 to 6,400 ft. However, it has not been found on Laboratory property. Penalties exist for transporting plants protected under the 1985 New Mexico Rule No. NRD:85-3. Among the species protected under this rule, nine have been documented in the vicinity of Los Alamos County. To date, none has been found on Laboratory property.

2.5.2.2 Fauna

Before the Laboratory was established, farming on the mesas by Native Americans and European settlers created disturbed areas that are now in various stages of succession. These areas afford suitable feeding locations for herbivores, especially deer and elk, and adjacent timbered canyon slopes provide cover for these species. Sheer canyon walls at lower elevations serve as important nesting habitats for birds of prey. Generally, larger mammals, reptiles, and invertebrates are most sensitive to variations in elevations and are confined to smaller ranges.

Information on the fauna within the Laboratory complex is largely qualitative. Species lists have been compiled from observational data and published data (DOE 1979), but the occurrence of some species has not been verified. Only one limited fauna survey has been conducted on Laboratory grounds (Miera et al. 1977). Special studies are currently under way to provide a more comprehensive survey of the vertebrate fauna.

Based on published reports and ongoing surveys, one federally listed endangered animal species, the peregrine falcon, is known to inhabit Los Alamos County. A peregrine aerie exists in Pueblo Canyon. The nesting peregrines from this aerie, as well as raptors, hunt on Laboratory lands; however, no critical habitats have been defined. The Jemez Mountain salamander has been found in the moist upper reaches (above 8,000 ft) of the canyons that dissect the plateau—usually at an elevation higher than that of the Laboratory. In 1985, one specimen was collected and recorded as having been found on Laboratory property. This species is currently listed as endangered by the state and is being considered for the federal list as an endangered or threatened species.

2.5.3 Climate

Bowen (1990) has compiled and interpreted climatological data for the Los Alamos area, and this information is summarized below.

Los Alamos has a semiarid, temperate mountain climate. Forty percent of the 18-in. annual precipitation normally occurs from thundershowers during July and August. Winter precipitation falls primarily as snow, with accumulations of about 51 in. annually.

Summers are generally sunny, with moderate, warm days and cool nights. Maximum daily temperatures are usually below 90°F. Brief afternoon and evening thundershowers are common, especially in July and August. High altitude, light winds, clear skies, and dry atmosphere allow night temperatures to drop to the 50s (°F) after even the warmest day.

Winter temperatures typically range from about 15°F to 25°F during the night and from 30°F to 50°F during the day. Occasionally, temperatures drop to 0°F or below. Many winter days are clear with light winds, allowing strong sunshine to make conditions comfortable even when air temperatures are cold. Snowstorms with accumulations exceeding 4 in. are common in Los Alamos, and some of these storms are associated with strong winds, frigid air, and dangerous wind chills, especially in the mountains.

The climate during 1961 through 1988 had slightly cooler temperatures and higher precipitation than those recorded from 1911 through 1988 (entire record). The only significant difference between the period between 1961 and 1988 and the entire record period is the large amount of snowfall.

Because of complex terrain, surface winds in Los Alamos often vary greatly with time of day and location. With light winds and clear skies, a distinct daily wind cycle often exists: a light southeasterly to southerly upslope wind during the day and a light westerly to northwesterly drainage wind during the night. However, several miles to the east toward the edge of Pajarito Plateau near the Rio Grande Valley, a different daily wind cycle is common: a moderate southwesterly up-valley wind during the day and either a light northwesterly to northerly drainage wind or moderate southwesterly wind at night. On the whole, the predominant winds are southerly to northwesterly over western Los Alamos County and southwesterly and northeasterly toward the Rio Grande Valley.

Historically, no tornadoes have been reported to have touched down in Los Alamos County. Strong dust devils can produce winds up to 75 mph at isolated spots in the county, especially at lower elevations. Strong winds with gusts exceeding 60 mph are common during the spring.

Lightning is common over the Pajarito Plateau. Fifty-eight thunderstorm days occur during an average year, mostly during the summer. Lightning protection is an important design factor for most facilities at the Laboratory. Hail damage can also occur. Hailstones with diameters up to 0.25 in. are common; 0.5-in.-diameter hailstones are infrequent.

The irregular terrain at Los Alamos affects the atmospheric turbulence and dispersion, sometimes favorably and sometimes unfavorably. Enhanced dispersion promotes greater dilution of contaminants released into the atmosphere. The complex terrain and forests create an aerodynamically rough surface, forcing increased horizontal and vertical dispersion. Dispersion generally decreases at lower elevations, where the terrain becomes smoother and less vegetated. The frequent clear skies and light, large-scale winds cause good vertical daytime dispersion, especially during the warm season. Strong daytime heating during the summer can force vertical

mixing up to 3,000 to 6,000 ft above ground level, but the effectiveness of the generally light winds in diluting contaminants horizontally is limited.

Clear skies and light winds have a negative effect on nighttime dispersion, causing strong, shallow surface inversions to form. These inversions can severely restrict near-surface vertical and horizontal dispersion. Inversions are especially strong during the winter. Drainage winds can fill lower areas with cold air, thereby creating deeper inversions, which are common toward the Rio Grande valley on clear nights with light winds. Canyons can also limit dispersion by channeling air flow. Strong, large-scale inversions during the winter can limit vertical mixing to under 3,000 ft above ground level.

Dispersion is generally greatest during the spring, when winds are strongest. However, deep vertical mixing is greatest during the summer. Low-level dispersion is generally low during summer and autumn, when winds are light. Even though low-level winter dispersion is generally greater, intense surface inversions can cause least-dispersive conditions during the night and early morning.

During the winter, the frequencies of atmospheric dispersive capability (sampled at TA-59) are 52% unstable (Stability Classes A through C), 21% neutral (Class D), and 27% stable (Classes E and F). The frequencies are 44%, 22%, and 34%, respectively, during the summer. These stability category frequencies are based on measured vertical wind variations. Stability generally increases (the winds become less dispersive) toward the valley.

2.5.4 Population Distribution

Los Alamos County had an estimated 1989 population of approximately 19,300 (based on the 1980 census adjusted for 1989). Two residential areas (Los Alamos and White Rock) and their related commercial areas exist in the county (Figure 2-1). The Los Alamos townsite (the original area of development that now includes residential areas known as Eastern Area, Western Area, North Community, Barranca Mesa, and North Mesa) has an estimated population of 12,100. The White Rock area (including the residential areas of White Rock, La Senda, and Pajarito Acres) has about 7,200 residents. About one-third of the people employed in Los Alamos commute from other counties. Population estimates for 1989 place about 208,000 persons within a 50-mi radius of Los Alamos (Table 2-2).

TABLE 2-2 ESTIMATED 1989 POPULATION WITHIN 50 MILES OF LOS ALAMOS NATIONAL LABORATORY[A]

Distance from TA-53 (km)[b]									
Direction	**1–2**	**2–4**	**4–8**	**8–15**	**15–20**	**20–30**	**30–40**	**40–60**	**60–80**
N	1	0	0	0	0	0	1,090	0	352
NNE	0	0	0	541	0	518	1,660	1,720	211
NE	1	0	0	0	303	14,700	966	1,080	3,650
ENE	0	0	0	1,860	1,500	2,610	2,610	1,140	2,140
E	0	0	80	24	534	1,100	668	0	1,390
ESE	0	0	0	0	0	281	22,230	1,040	1,450
SE	0	0	7,190	0	0	0	51,400	2,350	8
SSE	0	0	0	0	0	0	409	4,180	91
S	0	0	0	50	0	315	607	6,680	0
SSW	0	0	0	20	0	808	199	8,150	33,110
SW	0	0	0	0	0	0	311	4,110	0
WSW	0	0	0	0	0	311	309	2,520	204
W	0	0	0	0	0	0	0	162	131
WNW	0	1,530	6,950	0	0	0	0	0	3,050
NW	0	557	1,830	0	0	0	0	1,380	0
NNW	0	615	616	0	0	0	0	61	60

[a]Total population within 50 mi of Los Alamos is 208,000.
[b]This distribution represents the resident, non-work-force population with respect to the Los Alamos Meson Physics Facility's stack (LAMPF, TA-53).

2.6 GEOLOGIC AND HYDROLOGIC SETTING

This overview of the hydrogeologic environment at the Laboratory and in the northern New Mexico region is intended to describe the major geologic, hydrologic, and hydrogeologic features and their conceptual interrelationships. It addresses the regional and installation-wide geologic setting and hydrologic characteristics that affect surface water and groundwater occurrence and movement and their interactions as they relate to the potential for contaminant transport. This overview is intended as a guide to the significant literature in these areas rather than as a technical summary. The sources cited here and additional literature on the hydrology and geology of the Los Alamos region may be found in an annotated bibliography of geologic, hydrogeologic, and environmental studies related to SWMUs at the Laboratory LANL 1990. This bibliography was submitted to EPA in September 1990, and it and the literature it describes are available for review in the ER Program's public reading room located at 2111 Trinity Drive, Building 2, Room 10, in Los Alamos.

2.6.1 Hydrogeological Setting

The Laboratory is located on the flanks of the Jemez Mountains, a ring of volcanic and volcaniclastic rocks around a caldera (a collapse structure) (Figure 2-4). Volcanic ash flow and ash fall deposits from the most recent eruption, approximately 1 million years ago, encircle the Jemez Mountains and form a gently dipping plateau on the eastern side, the Pajarito Plateau (Crowe et al.1978). The Pajarito Plateau has been dissected into numerous, finger-like mesas separated by deep, east-southeast-trending canyons. It is terminated on its eastern margin by the Rio Grande, the master stream of the region. The Laboratory is located on the Pajarito Plateau (Figure 2-4).

Surface waters at the Laboratory occur primarily as ephemeral streams. Springs on the flanks of the Jemez Mountains supply base flow into the upper reaches of some canyons, but the amount is insufficient to maintain surface flows across the Laboratory site because it is depleted by evaporation, transpiration, and infiltration. Runoff from heavy thunderstorms or heavy snowmelt reaches the Rio Grande several times a year in some drainages. Effluents from sanitary sewage, industrial waste treatment plants, and cooling-tower blowdown are released to some canyons along the western edge of the plateau at rates sufficient to maintain surface flows for more than a mile.

Groundwater occurs in three modes in the Los Alamos area: (1) water in shallow alluvium in canyons, (2) as perched water (water in a saturated zone that is separated from the main aquifer by a less permeable layer and a large zone of unsaturated rock), and (3) the main aquifer of the Los Alamos area.

Perennial and ephemeral streamflows in canyons of the Pajarito Plateau have deposited alluvium that ranges in thickness from 3 ft to as much as 100 ft. The alluvium is quite permeable, in contrast to the underlying volcanic tuff and sediments. Ephemeral runoff in the canyons infiltrates the alluvium until downward movement is impeded by the less permeable tuff and sediments, resulting in a shallow alluvial groundwater body. Depletion by evapotranspiration and movement into the underlying volcanics limits the aerial and vertical extent of the alluvial water (Purtymun 1977 et al.).

Perched water occurs in conglomerates and basalts beneath the alluvium in a limited area about 120 ft deep in the midreach of Pueblo Canyon and in a second area about 150 to 200 ft beneath the surface near the confluence of lower Pueblo and Los Alamos canyons. The only discharge of perched water is from this second area, at Basalt Spring in Los Alamos Canyon.

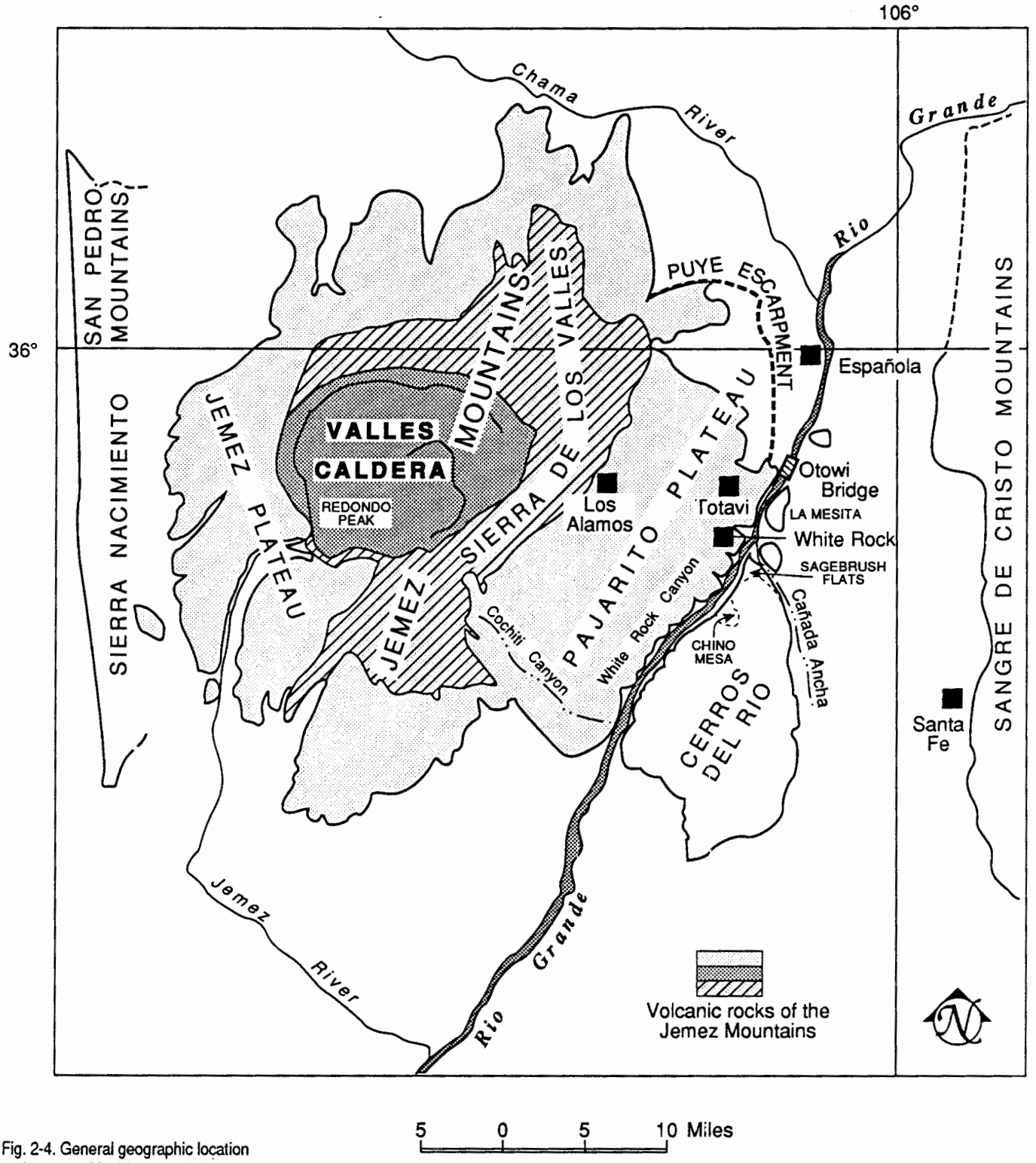

Fig. 2-4. General geographic location and topographical features in the vicinity of Los Alamos.

The main aquifer of the Los Alamos area is the only aquifer in the area capable of serving as a municipal water supply. The surface of the aquifer declines eastward from the Jemez Mountains to the Rio Grande. Depth to the aquifer decreases from 1,300 ft along the western margin of the plateau to about 600 ft at the eastern margin. The main aquifer is isolated from alluvial and perched waters by about 350 to 620 ft of unsaturated volcanic tuff and sediments. Thus, there is little potential for recharge from alluvial or perched water to the main aquifer.

Water in the main aquifer is under water table conditions in the western and central part of the plateau and under artesian conditions in the eastern part and along the Rio Grande (Purtymun 1974b). Major recharge to the main aquifer is from the intermontane basin of the Valles Caldera in the Jemez Mountains west of the Laboratory (Figure 2-4). The water table in the caldera is near the land surface. The caldera's underlying saturated zone and volcanic sediments are highly permeable and recharge the aquifer. The Rio Grande is the groundwater discharge area; springs fed by the main aquifer discharge an estimated 4,300 to 5,500 acre-ft of water annually into White Rock Canyon between Otowi Bridge at State Road 502 and the mouth of Rito de Frijoles.

2.6.2 Geology

2.6.2.1 Historical Geology

The Laboratory is located in the Rio Grande Depression, which began forming approximately 21 million years ago as a result of faulting. This depression, or rift, is a complex system of north-south-trending basins that have formed by downfaulting of large blocks of the earth's crust (Dransfield and Gardner 1985). In the Los Alamos area, the depression is about 35 mi wide and encompasses the Española Valley, the Pajarito Plateau, and the Jemez Mountains. The Sangre de Cristo Mountains border the depression on the east side, and the Sierra Nacimientos borders it on the west (Figure 2-4) (LASL 1977).

The Jemez Mountains volcanic pile in north central New Mexico lies over the western fault margin of the Rio Grande Depression. The mountains consist of volcanic rocks erupted from many vents during the last 10 million years, culminating in two major pyroclastic eruptions that deposited more than 145 mi^3 of ash and pumice as an apron around the mountains. This layer of ash and pumice, called the Bandelier Tuff, has a maximum thickness of 1,000 ft and forms the Pajarito and Jemez plateaus on the eastern and western flanks of the mountains, respectively (Figure 2-4). The Laboratory is located on the Pajarito Plateau, which has been dissected by

deeply incised canyons into a series of east- to southeast-trending narrow mesas (Appendix C) (Burton 1982).

In the interior of the Rio Grande Depression is a suite of sediments and volcanic rocks called the Santa Fe Group in which basalt is locally interbedded with beds of sands, clays, and gravel. These sediments outcrop between the Sangre de Cristo Mountains and the Pajarito Plateau (Figure 2-4). Most of these sediments are derived from rocks bordering the depression on the east. The total thickness of this deposit is unknown (Griggs 1964).

2.6.2.2 General Stratigraphy

The Pajarito Plateau is capped by the Bandelier Tuff of Pleistocene age and is composed of pumice, slightly welded to welded ash, tuff breccia, and crystal fragment tuff. Over most of the plateau, the Bandelier Tuff rests on the Santa Fe Group of Miocene-, Pliocene-, and Pleistocene-age sediments (Figure 2-5). The lower part of the Santa Fe, known as the Tesuque Formation, consists of sand, silt, clay, and some interbedded gravel. The Tesuque Formation is overlain by the Puye Formation. The Puye Formation has a lower member, known as the Totavi Lentil, which is a deposit of sand, pebbles, and boulders of quartzite, granite, and volcanic rocks. The upper member of the Puye Formation is called the Fanglomerate Member and is composed of silts, sands, and pebble-to-boulder breccia of volcanic rocks.

On the eastern part of the plateau, the Totavi Lentil is overlain by thick flows of basalts, known as the basaltic rocks of Chino Mesa. On the western part of the plateau, the Puye Formation interfingers with the volcanic rocks of the Tschicoma Formation of Miocene and Pliocene age of the Sierra de Los Valles (Baltz et al. 1963).

2.6.2.3 Soils

The soils in Los Alamos County are a sandy, clayey loam. The thickness of the soils on mesa tops varies from several feet thick near the center to zero at the mesa edge. Within the canyons are alluvial deposits of clay, silt, sand, and rock fragments, varying in thickness from nearly zero to as much as 100 ft.

A soil survey of Los Alamos County was conducted and a survey map was developed in which 61 soil mapping units were identified (Nyhan et al. 1978). The soils of the area are classified according to soil properties such as color, texture, size distribution, pH, and hydrologic properties.

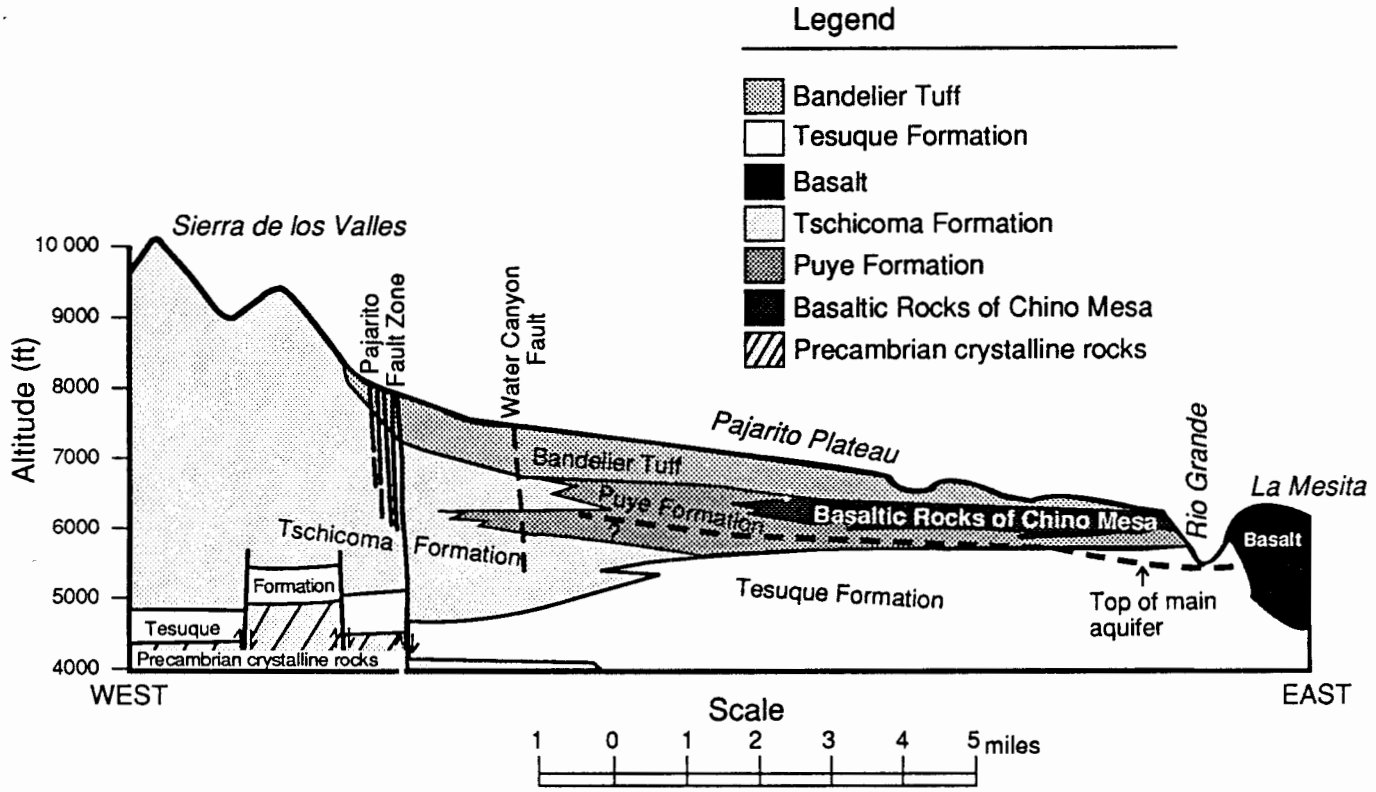

Fig. 2-5. Geologic cross section of Los Alamos area.

2.6.2.4 Faulting and Seismicity

The western boundary of the Laboratory lies along the main leg of the Pajarito Fault System, which is a major structural element of the Rio Grande Rift. Near Los Alamos, the Pajarito Fault consists of the Pajarito Fault zone and the related Guaje Mountain and Rendija Canyon faults (Wachs et al. 1988). Most of these faults show evidence of Quaternary movement through displacement of the upper Bandelier Tuff.

Numerous small to moderate earthquakes have occurred in the general area within the past 100 years. The largest was the Cerrillos earthquake of 1918, which appears to have been of a magnitude of 5 to 6 on the Richter scale. Several earthquakes of magnitudes of 3 to 4 have occurred in the area since 1950 (DOE 1979). An estimate of future earthquake activity based on extrapolation of seismic data suggests that an earthquake of magnitude 4.5 to 5 could occur within 65 mi of Los Alamos once per 100 years (House and Cash 1988), while other investigators estimate a magnitude of as high as 6.5 to 7.8 (Gardner and House 1987).

2.6.2.5 Volcanic Activity

Volcanism climaxed in the Jemez Mountains in mid-Pleistocene time, and the latest eruption occurred 42,000 years ago (Burton 1982). Vestiges of volcanic activity continue today, as evidenced by solfataric and hot spring activity both in and outside the Valles Caldera (DOE 1979). Geological data on the volume of the magma chamber, heat flow, solidification rates, and in geothermal gradients may be interpreted to indicate that magma still occurs in the magma reservoir and that the eruptive center is still geologically active although in a state of dormancy (Dames and Moore 1972). The rate of volcanism in the Jemez Mountains during the last 10 million years has been estimated to be $1 \times 10^{-8}/mi^2/yr$ (Burton 1982).

2.6.3. Geohydrology of Mesa Tops and Vadose Zone

2.6.3.1 General Conditions

2.6.3.1.1 Hydrogeologic Properties of Tuff

Investigations conducted since the 1950s indicate that the Bandelier Tuff, on which most Laboratory facilities have been constructed, does not bear water, except in very shallow and localized locations. The low moisture content and extensive thickness of unsaturated rock generally minimize the possibility of fluid movement downward through the Bandelier Tuff to the main aquifer.

The Bandelier Tuff is 260 to 1,050 ft thick and is composed of two members: the lower member, the 1.4-million-year-old Otowi Member, is a massive to poorly bedded, nonwelded pumiceous tuff breccia of ash flow origin, which is as much as 260 ft thick. The upper member, the 1.1-million-year-old Tshirege, is a succession of nonwelded to welded ash flows as much as 330 ft thick. The Tshirege forms alternating vertical cliffs and steep slopes caused by differential induration of the ash flows, which has produced units of varying hardness. The basal units of both members are ash falls (DOE 1979). The tuff is exposed along canyon walls and is covered by a thin mantle of soil on the surface of the mesas.

The degree of welding (the fusing of glass shards during the cooling of an ash flow) influences the physical and hydrologic characteristics of the individual ash-flow tuff units. The porosities of the tuff range from 30 to 60% by volume, generally decreasing with increasing levels of welding (Purtymun and Koopman 1965). The pores in the tuff are not all interconnected; however, in general, the nonwelded tuff has greater permeability. Hydraulic conductivities of saturated tuff measured by Weir and Purtymun (1962) range from 0.01 ft/day for a welded tuff to as much as 6.6 ft/day in a

nonwelded tuff. The natural moisture content of the tuff that forms the mesas is low, generally less than 5% by volume.

The surface of the tuff becomes "case hardened" and forms a rind as it is exposed to the weather. This rind forms a protective surface that resists erosion by wind and water. Exposed ash falls (pumice), however, weather readily and leave a pitted surface on some units.

Joints, formed by cooling of the ash flows, commonly divide the tuff into irregular blocks. Joint frequency decreases with a decrease in the degree of welding (fewer joints are found in the nonwelded tuff than are found in welded tuff). The predominant joint sets are vertical or nearly vertical. Joints range from closed to open as much as several centimeters; they may be filled with caliche near the surface, grading downward to clay (usually montmorillonite), and may be open at depths greater than 30 ft.

2.6.3.1.2 Movement of Fluids Through Tuff

Precipitation, if it occurs persistently and in large amounts, may pass through the soil cover and reach the Bandelier Tuff. Because potential evapotranspiration exceeds precipitation at the Pajarito Plateau, most of the percolating water is evaporated long before it reaches the tuff (or buried waste). The bottom of the soil horizon, which consists of a pronounced clay, is generally less than 3 ft deep. The clay horizon effectively restricts any further downward movement of water into the underlying Bandelier Tuff (Abeele et al. 1981, Weir and Purtymun 1962). Where the soil cover has been removed or disturbed, water moves almost vertically into the tuff (Abrahams et al. 1961).

Periodic moisture readings of the tuff indicate that at depths exceeding 33 ft the tuff rarely exceeds 10% saturation (Abeele et al. 1981). At such low moisture content, only unsaturated and vapor flow can occur. Interconnected joints and fractures could provide paths for rapid water movement at saturation; however, at shallow depths, they are commonly filled with fine-grained weathering products (e.g., montmorillonite clay) that strongly inhibit moisture movement.

The degree of unsaturation increases with greater depths in the tuff. Water under these conditions moves mostly by the slow process of capillarity, which greatly minimizes the possibility of downward migration of fluids to the main aquifer. There can also be movement of water or volatile organics in the vapor phase that may be relatively rapid along open pathways in the fractures and joints. This phenomenon is of particular concern because of possible migration of contaminants, such as tritium or volatile organic solvents, that travel in the gaseous phase.

2.6.3.2 Middle Mesa

From 1945 through 1967, liquid radioactive wastes at TA-21, DP West, were discharged into a series of four seepage beds excavated in porous tuff underlying Material Disposal Area T (MDA-T). Nyhan et al. (1984) provide details: MDA-T is located on Middle Mesa between Los Alamos and DP canyons (Appendix C). About 98% of the estimated 10 Ci of plutonium discharged to absorption beds was added between 1945 and 1952 (H-Division 1974, Rogers 1977). Since 1945, several studies have been conducted to determine the vertical distribution of radionuclides beneath the adsorption beds at Area T. Nyhan et al. (1984) discuss and summarize the findings of earlier studies. The results of selected studies are briefly discussed here.

In 1953, the United States Geological Survey (USGS) drilled five 10- to 20-ft-deep holes in and around the adsorption beds. Analysis of the holes indicated that vertical migration of plutonium had occurred within 20 ft of the surface of the adsorption beds. Initial laboratory studies of the interaction of radionuclides in the liquid wastes with local soils and geologic materials were performed. Cores of Bandelier Tuff that had been exposed to waste solutions of plutonium retained essentially all of the radionuclides in the top few millimeters of the core (Christenson et al. 1958).

In 1959, the Laboratory initiated a field study to determine the distribution of plutonium previously discharged into an adsorption bed at MDA-T (Christenson and Thomas 1962). This study indicated that plutonium had penetrated as far as 28 ft along fissures in the tuff.

In 1960 and 1961, researchers added 67 ft of water and wastewater to Adsorption Bed 1 in an attempt to change the distribution of plutonium beneath the bed from that shown in the 1953 and 1959 studies (Christenson and Thomas 1962, Abrahams 1963a). This work concluded that water apparently moves through open joints. After 17 years of migration of the slug of water added to Adsorption Bed 1, plutonium and ^{241}Am were detected to sampling depths of 100 ft; however, these contaminants were only found at depths of 21 to 45 ft in an adjacent adsorption bed that had not received water in 1960 and 1961 (Nyhan et al. 1983a). The results of a comprehensive field study by Nyhan et al. (1984) indicate that the vertical distributions of radionuclides and water are related to the occurrences of fractures and to variations in the geologic properties of the tuff units in each profile, as well as to the amount of water received.

2.6.3.3 Mortandad Mesa

2.6.3.3.1 Pit Infiltration Studies

In 1956, a test pit 2 ft in diameter by 1 ft deep was constructed on the mesa top between Mortandad and Pajarito canyons (Appendix C) to evaluate the infiltration properties of soil and tuff materials under ponded conditions (Abrahams et al. 1961). The pit penetrated only the upper portion of the 6-ft-thick soil cover. Water was introduced into the pit, and a constant water level was maintained at 0.75 ft for 99 days. Soil moisture measurements showed that, although the surficial soils became saturated (38% by volume), the moisture content in the underlying tuff remained very low (4% by volume) 97 days after the test.

Although the quantity of water used during the study was equivalent to almost 50 years of precipitation on the Pajarito Plateau, the moisture content of the tuff below 8 ft was unchanged. The fact that water did not penetrate the dense transition zone between the soil and tuff during the study or during the following year indicates that the soil cover impedes vertical movement into the underlying tuff (Abrahams 1963b).

2.6.3.3.2 Injection Well Studies

The USGS and UC began a study in 1964 to determine the hydrologic characteristics of the unsaturated Bandelier Tuff at TA-50 through the use of injection wells. Two injection wells and seven neutron moisture probe observation wells were completed to depths of between 60 and 295 ft in the Tshirege Member. (Water was injected at rates up to 16 gal./min for periods up to 89 days, and the movement of moisture from the injection zone into the adjacent tuff was monitored for periods approaching 1 year after the tests had ended (Purtymun et al. 1989).

In the longest of the tests, 335,000 gal of water was injected over a period of 89 days. When injection ceased, a limited zone of saturation developed adjacent to the injection horizon. Gradually, however, the saturated zone dissipated as capillary forces redistributed the moisture in the unsaturated tuff until no further movement occurred. The downward movement of moisture was nearly arrested at a depth of about 210 ft.

Interpretation of the test results led the authors to conclude that the hydrologic characteristics of the unsaturated tuff can cause retention or arrest the movement of water-soluble contaminants originating from liquid or solid wastes stored in the tuff. A sufficient and nearly continuous water supply would have to be available before water-soluble contaminants could be rapidly mobilized to completely penetrate the unsaturated tuff.

2.6.3.3.3 Area C Studies

Five neutron moisture probe access holes were drilled in 1978, and moisture conditions were monitored for 16 months (Abeele et al. 1981). Moisture contents below 100 ft averaged 6 to 10% by volume and showed no significant net gradient.

2.6.3.4 Mesita del Buey

During the last 20 years, numerous subsurface investigations have been performed on Mesita del Buey between Pajarito Canyon and Cañada del Buey (Appendix C). These studies have been conducted to ensure that the mesita terrain can safely contain hazardous and radioactive wastes, specifically at MDAs G and L.

2.6.3.4.1 Hydrology and Geology Study

The stratigraphy of Mesita del Buey is typical of the remainder of the Pajarito Plateau. The mesa is covered by a clay-like soil and is underlain by a series of ash falls of rhyolite tuffs from 240 to 590 ft thick (Purtymun and Kennedy 1971). The tuffs are above the main aquifer of the Los Alamos area, which lies at depths of approximately 950 and 850 ft below Areas G and L, respectively, and has an average saturated thickness of 1,470 ft (Purtymun 1984). Purtymun and Kennedy (1971) provide detailed descriptions of the various ash flow and ash fall layers at the mesita. Three of the boreholes on the mesa are of sufficient depth to penetrate formations underlying the Bandelier Tuff.

The hydrologic characteristics and conditions of the soil, tuff, and material used to cover the wastes indicate no recharge to the stream-connected aquifer in the canyon south of the mesa or to the main aquifer through the soil, buried wastes, or tuff at Mesita del Buey (Purtymun and Kennedy 1971).

2.6.3.4.2 Fracture Orientation Patterns

The most prevalent structural features in the rocks of Mesita del Buey are the fractures or joints in the volcanic rocks caused by shrinkage during cooling. Purtymun and Kennedy (1971) describe the suite of joint patterns found on the mesa. They conclude that the heterogeneous characteristics of the tuff (varying temperatures and moisture content of the ash, etc.) are the cause of the multiple fracture patterns in the tuff.

Investigations of the subsurface at Areas G and L have also provided descriptions of jointing in the tuff. Purtymun et al. (1978) drilled a number

of horizontal core holes beneath a waste disposal pit at Area G (Section 2.6.3.6.6). The borings encountered near-vertical joints at frequencies ranging from about 3 to 6 ft in recovered core. Most of the joints were filled or plated with brown clay. Many of the drillholes sunk by Bendix Field Engineering Corp. (1986) encountered similar conditions, in which the fractures were partially or completely filled with caliche, brown clay, or limonitic material.

2.6.3.4.3 Moisture Studies

Abrahams et al. (1961) studied moisture relationships of the Bandelier Tuff on Mesita del Buey during the late 1950s and 1960s. He measured the physical properties (density, porosity, etc.) and hydrologic properties (permeabilities, moisture tension curves, etc.) of tuff samples and conducted field experiments to investigate infiltration under high-moisture conditions. Data were also collected on the natural moisture conditions in the tuff that showed values of 5 to 10% by volume below a depth of a few meters.

Purtymun and Kennedy (1971) showed variable amounts of precipitation infiltrate and percolate through the tuff or soil. Where the soil has not been disturbed, little if any water from precipitation has infiltrated the underlying tuff. Where the soil has been disturbed, as in the waste disposal areas, the moisture content of the tuff indicates a much higher degree of infiltration than it does in the undisturbed tuff. Tests of precipitation infiltration in the disturbed tuff that composes the pit overburden show that moisture from a single storm may reach depths nearing 6.5 ft but that, in subsequent weeks, it is returned to the atmosphere by evaporation.

Abeele (1978) used a neutron moisture probe to monitor the moisture content of fill material overlying waste disposal pits and solid tuff in the shaft disposal field. In the fill material, the data show significant seasonal fluctuations in moisture content to a depth of 13 ft and a downward moisture flux below that depth. In the solid tuff, the data also show seasonal fluctuations in moisture content in the upper 13 ft but no significant changes below that depth.

2.6.3.4.4 Tritium Migration Studies

Migration of tritium from wastes deposited at Area G was detected as early as 1970. One study showed that the tritium concentration in the tuff around an unlined shaft (Number 13, Area G) increased to a maximum between depths of 10 and 30 ft and then decreased again with depth (Purtymun 1973). The pattern of tritium concentrations in the subsurface indicated that migration is influenced by the presence of open joints in the tuff, which

provides a pathway for migration of tritiated water in the vapor phase. Additional studies (Abeele et al. 1981) indicate that tritium also migrates from asphalt-lined shafts into adjacent soils. In both studies, tritium activity decreases logarithmically with distance from the shaft.

2.6.3.4.5 Horizontal Hole Study

Purtyman et al. (1978) collected samples for radiochemical analysis along horizontal core holes beneath Pit 3 in Area G. A drill pad was constructed in a small canyon east of the pit, and five horizontal holes were cored under the pit. The analytical results from samples obtained beneath the pit were then compared statistically with the analytical results from samples obtained beside the pit.

The results showed conclusively that the man-made radionuclides known to be present in the pit were not present at concentrations above the minimum detection limits in the samples collected beneath the pit. There were no statistically significant differences in gross alpha or gross beta radiation or in individual radionuclide concentrations between the sampling locations.

2.6.3.4.6 Vadose Zone Studies

In 1985, detailed vadose zone characterization studies were undertaken in Areas G and L to permit quantitative analysis of moisture movement and chemical characterization of the Bandelier Tuff (International Technology Corporation 1987). The investigators used a two-tiered approach to quantify moisture movement in the tuff: (1) measurements of rock characteristics and hydraulic head to calculate seepage velocity and rates of moisture flux and (2) measurement of moisture content of the tuff following precipitation events to determine changes in moisture content with depth.

Eighteen 100- to about 135-ft-deep boreholes were drilled into the Bandelier Tuff from the top of Mesita del Buey, and approximately 1,700 ft of core were obtained. Selected core samples were analyzed for numerous parameters, and hydrologic testing and geophysical logging were performed in the boreholes. Selected boreholes were completed for pore gas sampling, neutron moisture probe monitoring, and psychrometer installation. In addition, holes were drilled in the adjacent canyons to determine whether an alluvial aquifer was present under Mesita del Buey.

The combination of very low moisture content in the tuff, empirical determination that moisture from precipitation does not infiltrate below a depth of 10 to 22 ft, and very low calculated flux rates suggests that aqueous transport of contaminants through Bandelier Tuff is not a viable mechanism for contaminant migration at Areas G and L (Bendix Field Engineering

Corporation 1986). Calculated maximum downward flux rates for Areas G and L were 0.25 ft/yr and 0.49 ft/yr, respectively.

2.6.3.4.7 Organic Plume Migration Studies

In 1985 and 1986, seven test locations were selected for core and pore gas analyses of the Bandelier Tuff at Mesita del Buey. One background hole was selected at the western end of the mesa. Of the remaining six test holes, two were located at Area G and four at Area L.
The results indicate that volatile organic waste constituents have migrated from land disposal units at Areas G and L (Devaurs 1985, Devaurs and Bell 1986). Volatile organic vapors have been detected at depths up to 100 ft. The highest pore gas concentrations of volatile organic compounds have been detected in the test holes nearest organic disposal shafts at Area L. The most likely transport mechanism of organics is vapor phase migration rather than aqueous transport. Metal contamination from the land disposal units at Areas G and L was detected in only two samples from shallow depths (20 ft or less) at Area L (Devaurs 1985).

2.6.3.5 Area P

The monitoring described below is currently being conducted in support of interim status closure and postclosure care plans at the landfill in Area P, TA-16. These data are presently being summarized in a final report. Other investigations, including an area geological characterization (Brown et al. 1988) and a water balance study (Nyhan 1989a), summarize historical site conditions.

The vadose-zone-monitoring system, consisting of eight separate wells clustered in four well nests, was installed in and below the Area P landfill during the fall of 1988. Each well nest consists of either a single or dual completion pressure-vacuum lysimeter borehole and an adjacent neutron moisture probe access well. The four lysimeter boreholes contain a total of seven independent lysimeters located at varying depths in and below the landfill, while the neutron access wells penetrate the underlying native Bandelier Tuff to a maximum depth of 30 ft.

Soil and tuff core samples collected during these installations have been analyzed for landfill-related contamination. In addition, four of the seven lysimeters have yielded small volumes of water at routine sampling intervals over a 1-year period; all of these lysimeters are adjacent to the landfill. The three remaining lysimeters that did not yield water are all located below the landfill/tuff contact. Monthly measurements of neutron moisture taken at the access well have shown a consistently stable moisture distribution in four landfill access wells and five perimeter access wells. However,

volumetric moisture contents typically vary between individual wells and over depth. Detailed analyses of these vadose-zone-monitoring data will assist in evaluating current site conditions and will be summarized in a final report.

2.6.3.6 Frijoles Mesa

2.6.3.6.1 Hydrogeologic Study

In 1959 and 1960, before the Laboratory began hydronuclear experiments involving radioactive and high-explosive materials at TA-49, the USGS performed a detailed geologic and hydrologic investigation of Frijoles Mesa between Ancho and Water canyons (Appendix C). The USGS investigations were conducted in large (3- or 6-ft-) diameter test holes at depth ranging from 30 to 120 ft below ground surface. The hydrogeologic investigation of the mesa consisted of geologic mapping, performing subsurface geologic studies, interpreting geophysical logs of holes, conducting pumping tests, and making water level and soil moisture measurements in boreholes.

The fundamental conclusion of the study was that "recharge to the ground water from Frijoles Mesa is very small or nonexistent; thus no contaminants in solution are likely to be carried to the ground water beneath TA-49" (Weir and Purtymun 1962). Data from three deep test wells indicated that the top for the main acquifer near the center of the experimental areas was at a depth of about 1,170 ft. Geologic examination revealed no perched water is present. The absence of perched water and moisture in test holes indicates that water rarely inflitrates the mesa surface to depths greater than the thickness of the soil (Weir and Purtymun 1962).

Groundwater quality has been monitored routinely since the time the experiments were initiated (Appendix C). The measurements confirm that there has been no contamination of groundwater (Purtymun and Stoker, 1987).

2.6.3.6.2 Hole Examinations

As a part of its investigation, the USGS collected rock samples and sent them to USGS laboratories for petrographic description, chemical and x-ray analysis, and measurement of physical properties. Rock samples have been stored in archives for future study, and large- (3- and 6-ft-) diameter test holes have been photographed for future reference.

2.6.3.6.3 Moisture Movement Studies

To measure moisture, the USGS drilled 23 access holes ranging from 10 to 49 ft deep from the surface of the mesa. Soil thickness was measured and mapped. The holes were logged with a neutron probe to determine the moisture content of the soil and tuff near the mesa surface. The studies indicated little if any movement of precipitation into the tuff underlying the soil cover (Abrahams et al. 1961). The natural moisture content of the tuff ranges from less than 4% to about 8% by volume, indicating that movement of water could occur only by diffusion in the vapor phase. Wier and Purtymun (1962) concluded that the soil cover "...forms an almost perfect seal over the mesa surface and the near-surface joints."

2.6.3.6.4 Special Monitoring

In 1961, in cooperation with the USGS, the Laboratory undertook a program of environmental surveillance of TA-49, and the Laboratory has continued the program exclusively since 1970. This surveillance includes analyzing sediment and surface runoff, measuring water levels, and sampling the water in the main aquifer via wells and springs. Measurements confirm that there has been no contamination of groundwater. Minor plutonium contamination of the surface soil dating from the time of hydronuclear experiments has been detected in small surface drainages near the experiment area (Purtymun and Stoker 1987).

In 1975, routine monitoring at the site detected the presence of about 50 ft of water in the bottom of Core Hole 2, located adjacent to hydronuclear Test Hole 2-M. Analysis of water samples from the core hole showed the presence of plutonium, indicating that water had moved plutonium from the experimental hole into the core hole.

Concern relating to the presence of water in the core resulted in a special hydrologic investigation in 1980 to locate the source of the water to determine whether it resulted from infiltration through a broken asphalt surface above Test Hole 2-M or whether water was moving into the tuff beneath the experiment area on a larger scale. Plutonium and moisture contents were evaluated in test borings, and it was determined that the water in the core hole came through the asphalt surface cover (Purtymun and Stoker 1987). The hole was bailed dry in 1980 and remained dry through 1986, the time of the last inspection.

2.6.4. Geohydrology of Canyon Surface Waters and Alluvial Aquifers

2.6.4.1 General Conditions

In the Los Alamos area, surface water occurs primarily as ephemeral streams. There are no perennial streams within Laboratory boundaries. Springs on the flanks of the Jemez Mountains supply base flow in the upper reaches of some of the canyons that extend through Laboratory lands; perennial flow occurs in the upper reaches of Cañon del Valle and Los Alamos, Pajarito, and Water canyons (Appendix C) (Purtymun 1975). The amount of discharge is insufficient to maintain surface flow across the Laboratory site before depletion by evaporation, transpiration, and infiltration. Surface flow can occur for more than a mile as the result of releases from industrial waste treatment plants, sanitary sewage, and cooling tower blowdown. These effluents do not leave the boundary of the Laboratory. Several times a year, runoff from heavy thundershowers or heavy snowmelt in Los Alamos, Pueblo, Pajarito, and Water canyons reaches the Rio Grande.

All the canyons on the Pajarito Plateau contain alluvium that is quite permeable, ranging in thickness from 3 to 100 ft. Only canyons that originate in the Sierra de Los Valles (Figure 2-4) or that receive significant quantities of industrial effluent have alluvial aquifers. These criteria are met in lower Pueblo, Los Alamos, Mortandad, and Pajarito canyons (Appendix C). Water infiltrates through the alluvium until the downward movement is impeded by the less permeable tuff and sediments. Depletion by evapotranspiration and movement into the underlying volcanics limits the horizontal and vertical extent of the alluvial aquifers (Purtymun et al. 1977).

2.6.4.2 Bayo Canyon

Bayo Canyon originates on the Pajarito Plateau and is tributary to the lower reach of Los Alamos Canyon (Appendix C). It has a drainage area of 33.8 mi^2 and an average slope of 0.03. The canyon cuts into the Bandelier Tuff, the Puye Formation, and the Tesuque Formation. The flow in the canyon is ephemeral, and most of the runoff is caused by heavy summer thundershowers. The runoff generally lasts no longer than several hours (Purtymun 1975, 1979). There are no gaging stations in this canyon.
In 1961, three test holes were drilled in Bayo Canyon to determine whether water occurred in the alluvium or in the tuff at the Puye Formation contact. The test holes indicated no water in the channel alluvium or perched in the tuff. Three test holes were drilled in 1973, and 12 test holes were drilled in 1974; all were dry. These results indicate that the movement of contaminants by groundwater in Bayo Canyon is very unlikely (LASL 1979).

2.6.4.3 Pueblo Canyon

Pueblo Canyon originates on the flanks of the Sierra de Los Valles and has cut a deep canyon into the Pajarito Plateau (Appendix C). It drains 8.6 mi^2.

2.6.4.3.1 Surface Water and Sediments

Release of treated sewage effluent from the Bayo treatment plant causes perennial streamflow in the lower reaches of Pueblo Canyon. Runoff from winter snowmelt and summer thunderstorms adds to the volume of flow. From 1951 through 1963, industrial effluents from the Laboratory treatment plant at TA-45 were released into Acid Canyon, a tributary to Pueblo Canyon. A former sewage treatment plant released effluents into the middle reach of the canyon from 1947 through 1966. Measurements of flow in Pueblo Canyon and a history of effluent discharge are provided by Weir et al. (1963), Abrahams (1966), Abrahams and Purtymun (1966), Purtymun (1975), and LANL (1981). Sediment discharges are reported by Purtymun et al. (1990). Runoff events have redistributed sediments from Pueblo Canyon into lower Los Alamos Canyon, and this transport is likely to continue. No major flooding events have occurred in Pueblo Canyon during the last 40 years.

Current streamflow in Pueblo Canyon consists primarily of sewage effluent; therefore, the chemical quality of the surface water is determined by this source (Weir et al. 1963, Abrahams 1966, Abrahams and Purtymun 1966, Purtymun 1975, ESG 1976–1989). From 1943 through 1951, untreated effluent containing radionuclides—mainly plutonium, uranium, tritium—and fission products was released into Acid Canyon. Treated radioactive wastes were released into Pueblo Canyon from the treatment plant at TA-45 between 1951 and 1964. The quality of surface water has been reported since monitoring began in 1945 (Weir et al. 1963, Abrahams 1966, Abrahams and Purtymun 1966, Purtymun 1975, LANL 1981, ESG 1971–1989).

Concentrations of radionuclides in surface water and sediment decreased as the treatment plants became operational. Radionuclide concentrations in the canyon also generally decrease downstream from the effluent outfalls because sediments in the stream channels adsorb the radionuclides and the sediments disperse (Weir et al. 1963, Abrahams 1966, Abrahams and Purtymun 1966, Purtymun 1975, LANL1981, Nyhan et al. 1980). Most of the radioactively contaminated sediments lie in lower Pueblo Canyon. Dose calculations indicate that the dose received from the sediments would slightly exceed the dose received from background levels (LANL 1981).

From 1949 to 1967, the USGS studied the effects of the release of industrial effluents on the environment and geohydrology (Weir et al. 1963, Abrahams 1966, Abrahams and Purtymun 1966, Purtymun 1966a, 1966b, and 1966c, Purtymun and Enyart 1966, Purtymun and Kunkler 1967, Purtymun and Kunkler 1969, LANL 1981). Environmental data gathered subsequently by the Laboratory are summarized in a series of reports issued from 1967 through the present (ESG 1971–1989). Chemical and radiochemical analyses show that drinking water standards for chemical and radiochemical constituents are exceeded; however, this water is not used for municipal, agricultural, or industrial supply.

An extensive field-monitoring and sampling program to evaluate the radiological conditions in Acid and Pueblo canyons was conducted during 1976 and 1977 as part of the Formerly Utilized Sites Remedial Action Program (FUSRAP) sponsored by the DOE. This study reviewed historical records and used new sampling methods to obtain data. It considered potential radiation exposure under current and future conditions and maximum doses (LANL 1981). Residual radioactivity was found on sediments, although the indicated dose to the public was found to be small (LANL 1981).

A number of investigators have studied distribution of radionuclides in channel sediments and radionuclide transport in snowmelt runoff (Purtymun et al. 1990). The USGS has conducted seepage runs for discharge measurements (Abrahams and Purtymun 1966). Purtymun et al. (1988b) sampled surface and groundwaters for organics from pesticides and other sources. Snowmelt runoff was found to carry plutonium primarily in the sediment fraction. Concentrations of plutonium were low. Volatile organics, base neutral acid, and cyanide were detected in a few instances. No semivolatile organics, pesticides, herbicides, or PCBs were detected.

2.6.4.3.2 Alluvial Aquifer

The streamflow in Pueblo Canyon recharges a shallow body of groundwater in the alluvium. As the water in the alluvium moves downgradient, water is lost to evapotranspiration and through recharge into two shallow perched water bodies in the Puye Formation and the basaltic rocks of the Chino Mesa Formation (Purtymun 1975).

From 1954 to 1965, the USGS installed 14 shallow wells and collected samples. (Weir et al., 1963, Abrahams and Purtymun 1966, Purtymun 1966a, 1966b, 1966c, Purtymun and Enyart 1966, Purtymun and Kunkler 1967). Storm runoff destroyed most of the wells. In 1965, alluvial aquifer sampling was discontinued because of the great chemical and radiochemical similarity of surface and groundwater. This sampling was resumed in

1990 to study inorganic and organic compounds, heavy metals, and pesticides that were not investigated earlier.

Special studies of the alluvial aquifer consist of reconnaissance sampling for organics, pesticides, and herbicides (Purtymun et al. 1988b). The studies were performed through sampling of the surface water.

2.6.4.4 Los Alamos Canyon

2.6.4.4.1 Surface Water and Sediments

The Los Alamos Canyon drains a 10.6-mi^2 area that extends from the divide on the Sierra de Los Valles down to the Rio Grande near Otowi Bridge (Appendix C). Its major tributaries are Pueblo Canyon near the eastern edge of the plateau and DP Canyon near the center of the plateau. Perennial surface flow occurs in the upper reaches and is partially impounded by Los Alamos Reservoir. Surface flow in the middle and lower reaches is intermittent. Some cooling tower and sewage effluents are released from TA-2 and TA-41. During the summer, stormwater runoff occasionally reaches the Rio Grande. Some yearly snowmelt runoff also reaches the Rio Grande. Streamflow in DP Canyon is intermittent, consisting of industrial and sanitary effluents and stormwater runoff.

Discharge measurements collected by the USGS (Abrahams and Purtymun 1966) and the Laboratory (Purtymun 1974b, Purtymun 1975) are reported. There are two stream gages in Los Alamos Canyon and one in DP Canyon. Discharge of flow and sediment load for snowmelt runoff is reported by Purtymun et al. (1990). Purtymun (1975) describes sediment discharge. Summer runoff and snowmelt discharge were found to carry radionuclides in solution as well as in sediment.

Water quality measurements of surface water were collected as early as 1952 (Purtymun 1975) and continue today as part of the annual environmental surveillance program (LANL 1981, ESG 1971–1989). Samples at two surface water stations and at the Los Alamos Reservoir are analyzed for radiochemical and chemical constituents, and the results are reported annually (ESG 1971–1989). Results of radiochemical analyses from 11 soil-sampling stations in Los Alamos and DP Canyons are reported in the annual surveillance report. Radionuclide concentrations decrease downgradient in the canyon because of dilution and absorption by alluvial sediments.

Special studies that have been conducted in Los Alamos and DP include investigations of radionuclide transport in runoff by Purtymun (1974b), Purtymun (1966a, 1966b, 1966c), Hakonsonand Bostick (1976), Miera

(1976), and Purtymun et al. (1990). Investigations for organics, pesticides, and herbicides have been performed (Purtymun et al. 1988b). Measurements taken between 1975 and 1986 show that plutonium has been transported into the Rio Grande from snowmelt runoff. There were no organic compounds, pesticides, or herbicides detected in the Rio Grande at its confluence with Los Alamos Canyon.

2.6.4.4.2 Alluvial Aquifer

The surface water in Los Alamos Canyon consists of sanitary sewage effluent, cooling tower blowdown, storm and snowmelt runoff, and inflow of water from the alluvium in DP Canyon. The surface water recharges water in the alluvium that is perched on the tuff.

As the water in the alluvium moves downgradient, some is lost to evaporation, transpiration, and vertical movement into the underlying tuff, conglomerate, and basalts. Alluvial water extends from the upper reaches of Los Alamos Canyon down to near its confluence with DP Canyon.

DP and Los Alamos canyons have received treated industrial effluents that contain some radionuclides. Six observation holes located along the length of Los Alamos Canyon are sampled for chemical and radiochemical water quality (Appendix E). The results are reported annually in the Laboratory's annual environmental surveillance report (ESG 1971–1989). The shallow groundwater contains measurable but low amounts of radioactivity.

Purtymun et al. (1990) have studied the loss of groundwater from the alluvial aquifer into the underlying tuff. Transport of plutonium during snowmelt runoff has been determined from surface water data. Snowmelt losses in the channel have been estimated. Storage in the alluvial aquifer has been calculated, and losses into the underlying tuff and volcanic rocks have been estimated (Purtymun et al. 1990). Sampling for organics, pesticides, and herbicides has been performed (Purtymun et al. 1988b). The alluvial aquifer is recharged by streamflow. In a few instances, volatile organics, semivolatile organics, and base neutral acids were found in the shallow groundwater.

2.6.4.5 Sandia Canyon

Sandia Canyon has a small, 2.7-m^{i2} drainage area that originates on the Pajarito Plateau in TA-3 (Appendix C). The canyon receives cooling tower blowdown from the TA-3 power plant and treated sanitary effluents from the sanitary treatment plant at TA-3. The treated effluents form a perennial stream in a short reach of the upper canyon. Only during heavy summer thundershowers in the drainage area does streamflow reach the Laboratory

boundary at State Route 4. Two monitoring wells in the lower canyon west of State Route 4 indicate no perched water in the alluvium in this area. Three surface-water-sampling stations are located in the reach of the canyon that contains perennial flow. The samples are analyzed for radiochemical and chemical constituents and are reported in the Laboratory's annual environmental surveillance reports (ESG 1971–1989). Samples of surface waters have been analyzed for organics, pesticides, and herbicides (Purtymun et al. 1988b). Measurable amounts of radioactivity have been detected in the surface water; cyanide was also detected, but no organic compounds were found.

2.6.4.6 Mortandad Canyon

Mortandad Canyon drains a 1.8-mi^2 area west of the Los Alamos County line and located entirely on the Pajarito Plateau (Appendix C). An industrial waste treatment plant at TA-50 collects and processes liquid wastes containing radionuclides. After treatment, which removes most of the radioactivity, the effluents are released into Mortandad Canyon.

Hydrologic studies began in 1960 before the time the waste treatment plant at TA-50 began to operate. Since that time, there has been no surface flow in Mortandad Canyon beyond the Laboratory's boundary because the small area drained by the Canyon produces little runoff and a thick section of unsaturated alluvium in the lower canyon permits rapid infiltration and storage of effluent and runoff. This alluvial aquifer extends up to 130 ft below the ground surface. Monitoring stations include one surface-water-monitoring station and six observation wells in the shallow alluvial aquifer (Appendix E). The wells in the lower reaches of the canyon are dry.

2.6.4.6.1 Surface Water and Sediments

The USGS has conducted preoperational studies of streamflow to establish the background surface flow conditions before the installation of the TA-50 radioactive waste treatment plant (Baltz et al. 1963, Purtymun 1964). After operations had begun, a stream gage was installed, and discharge studies continued (Purtymun 1967, Purtymun and Kunkler 1967, Purtymun and Kunkler 1969). Hakonson (1981) has studied sediment transport.

Environmental monitoring for chemical and radiochemical quality in surface water began with USGS investigations (Purtymun 1964, Purtymun 1967, Purtymun and Kunkler 1967, Purtymun and Kunkler 1969, Purtymun 1975) and have been continued by the Laboratory (ESG 1970–1986). Radioactivity and elevated nitrate concentrations are present as a result of the effluent discharge into this canyon.

Special studies of plutonium in surface water and in sediments have been conducted (Purtymun 1975, Purtymun et al. 1977, Purtymun 1971, Hakonson et al. 1979, Hakonson 1981, Nyhan et al. 1976). Purtymun et al. (1988) have studied organic compounds in groundwater. Studies performed in 1979 sampled channel and bank sediments and vegetation for chemical constituents along the stream channel from the TA-50 waste outfall to a distance of 10,000 ft (Ferenbaugh and Gladney, in preparation).

2.6.4.6.2 Alluvial Aquifer

Perennial flow from industrial sewage effluent and intermittent storm and snowmelt runoff recharge a small body of water in the alluvium that is perched on the underlying tuff. As the water in the alluvium moves eastward, steady losses to evapotranspiration and minor losses into the tuff occur, limiting the amount of water in the alluvium. The alluvial aquifer does not extend to the surface water discharge boundary at the Los Alamos/ Santa Fe County line (Appendix C).

The USGS conducted a preliminary study of the geology and hydrology of the alluvial aquifer in 1960 and 1961 (Baltz et al 1963), which was followed by USGS and, later, Laboratory studies (Abrahams et al. 1962, Purtymun 1964, Purtymun 1967, Purtymun and Kunkler 1969, Purtymun 1975, Devaurs and Purtymun 1985). Six observation wells collect information on groundwater level and chemical and radiochemical quality (Appendix E).

Environmental monitoring of alluvial water began with preoperational surveys of chemistry and radiochemistry conducted by the USGS (Purtymun 1964). Environmental monitoring of chemistry and radiochemistry of alluvial water continued under the USGS (Purtymun and Enyart 1966, Purtymun 1967, Purtymun and Kunkler 1967, Purtymun and Kunkler 1969, Purtymun 1969) and by the Laboratory (Purtymun 1975, ESG 1971 to 1989). The shallow groundwater contains elevated levels of radioactivity and nitrates because of the waste effluent discharged in this canyon. The aquifer is contained within the Laboratory boundaries.
Numerous special studies have been conducted on the water quality of this shallow aquifer. Tritium and chloride concentrations have been used to calculate the rate of water movement in the aquifer. From these data, investigators have determined the permeability of the aquifer, the storage capacity, and the inventory of chemical constituents and radionuclides in the aquifer (Purtymun 1973, Purtymun 1974a, Purtymun et al. 1984). Concentrations of radionuclides decrease downgradient from the waste outfall. There has been some transport of radionuclides into the tuff underlying the alluvial aquifer.

Radiochemical studies (Purtymun et al. 1983, Purtymun et al. 1984) and chemical studies (Purtymun 1975, Purtymun et al. 1977, Purtymun et al. 1988b) have also been performed. The samples collected were analyzed for organics, pesticides, and herbicides (Purtymun et al. 1988b). Cyanide was detected, but there were no organic compounds in the groundwater.

2.6.4.7 Cañada del Buey

Cañada del Buey originates on the Pajarito Plateau. It drains a 3.4-mi^2 area and lies entirely in the Bandelier Tuff (Appendix C). Streamflow in the canyon is intermittent. One small stretch near TA-46 receives cooling tower blowdown. The alluvium in the canyon is quite thin; there is no alluvial water (International Technology Corporation 1987, Devaurs and Purtymun 1985).

Since 1973, the Laboratory has performed radiochemistry and chemical sampling of surface waters in Cañada del Buey as part of a routine environmental program (ESG 1974). Limited radiochemical sampling has been performed in sediments (Purtymun 1975). Since 1982, the Laboratory has routinely monitored stream sediments for radionuclides (ESG 1983 to 1989) and for hazardous and toxic constituents (Purtymun and Maes 1987, Purtymun and Maes 1988). Although there is some transport of cesium and plutonium on sediments from the active waste management area at TA-54, radionuclide concentrations in sediments were not detectable at the Laboratory boundary at State Route 4. Organic compounds 1,1,2,2-tetrachloroethane and 1,1,1,2-tetrachloroethane were detected in sediments in Cañada del Buey at State Route 4. No metals, pesticides, or herbicides were measured above the limits of detection.

2.6.4.8 Pajarito Canyon

Pajarito Canyon originates on the flanks of the Sierra de Los Valles and drains a large area of 10.6 mi^2 (Appendix C). The stream channel is cut into the Bandelier Tuff across the Pajarito Plateau. Streamflow in the canyon is ephemeral and is produced by storm runoff and snowmelt. This ephemeral flow moves downgradient and recharges the alluvium overlying the tuff (Purtymun and Kennedy 1971). The alluvial water in Pajarito Canyon is confined to the alluvium in the canyon and does not extend horizontally or vertically under Mesita del Buey (Devaurs and Purtymun 1985, International Technology Corporation 1987). There is a minor release of treated sewage effluent into the canyon below TA-18.

Since 1973, the Laboratory has routinely sampled surface water for chemical and radiochemical constituents (ESG 1974). Purtymun (1975) provides limited data on radiochemical and chemical surface water data and radio-

chemical analyses of sediment. Beginning in 1986, stream sediments have been analyzed for hazardous and toxic constituents (Purtymun and Maes 1987, Purtymun and Maes 1988). Radiochemical and chemical concentrations in alluvial water showed no effect from Laboratory operations. Analyses of sediments collected at the Laboratory boundary at State Route 4 showed no elevation in radionuclide concentrations. Results of analyses of sediments for metals, pesticides, and herbicides were below the limits of detection. The compound 1,1,2,2,-tetrachloroethane was detected in sediments in Pajarito Canyon at the Laboratory boundary at State Route 4.

2.6.4.9 Potrillo Canyon

Potrillo Canyon originates on the Pajarito Plateau and drains an area of about 2.4 mi^2 upstream of State Route 4 (Appendix C). The stream channel is cut into the Bandelier Tuff. The ephemeral streamflow in the canyon results from thunderstorms and snowmelt.

Potrillo Canyon drains five firing (explosives detonation) sites; consequently, depleted uranium from testing activities is found in the watershed. Studies have been made to characterize uranium concentrations in sediments (Hanson and Miera 1977, Hanson and Miera 1978) and to determine transport of uranium through runoff mechanisms (Becker et al. 1985, Becker 1986). The Laboratory began routine monitoring of radionuclides in sediments in 1977 (ESG 1978 to 1989). Monitoring for hazardous and toxic constituents in sediments began in 1986 (Purtymun and Maes 1987, Purtymun and Maes 1988). Levels of uranium in solution and in suspended sediments in runoff samples are within background concentrations at State Route 4. The compound 1,1,2,2-tetrachloroethane was detected in sediments at the Laboratory boundary at State Route 4. Levels of metals, pesticides, and herbicides were below the limits of detection.

3.6.4.10 Water Canyon

Water Canyon originates on the flanks of the Sierra de Los Valles, where it has cut canyons into the Tschicoma Formation and the Bandelier Tuff. Where it crosses the Pajarito Plateau, it cuts into the Bandelier Tuff. Along the eastern edge of the plateau near the Rio Grande, the canyon is cut into the basalts of the Chino Mesa and underlying Tesuque Formation. Cañon del Valle is tributary to Water Canyon in the upper reach, and Fence and Potrillo canyons are tributary south of State Route 4. Water Canyon drains an area of 12.8 mi^2 (Appendix C). Perennial flow occurs in the upper reaches, and waste water from S-Site is released to the canyon, also in the upper reaches. Streamflow moves into the alluvium for a short distance. In the remainder of the canyon, streamflow is ephemeral and results from storms and snowmelt.

Routine radiochemical analyses of surface water in Water Canyon are performed as part of annual environmental monitoring activities that began in 1973 (ESG 1974) and continues today. Purtymun (1974a) provides some earlier data on the chemical and radiochemical components of surface water and on the radiochemical components of sediments. Beginning in 1977, the Laboratory's annual environmental monitoring program included studies of the radiochemistry of sediments in Water Canyon (ESG 1978 to 1989). Some heavy metals in the canyon have been investigated (Kasunic et al. 1985, Becker 1986). Radionuclide concentrations in sediments are at background levels. Radionculide concentrations in surface water are at the limits of detection (ESG 1989). The compounds 1,1,2,2-tetrachloroethane and 1,1,1,2-tetrachloroethane were detected in sediments in Water Canyon at State Route 4, and some nickel was reported in sediments from Fence Canyon at State Route 4. No pesticides or herbicides were detected from Water Canyon or in its tributary canyons.

2.6.4.11 Ancho Canyon

Ancho Canyon originates in the middle of the Pajarito Plateau (Appendix C). The canyon is cut into the Bandelier Tuff on the plateau and through the basalts of the Chino Mesa and the Tesuque Formation on the eastern edge of the plateau as the channel drops into the Rio Grande. Stream flow on the plateau is ephemeral, although, in the lower reaches of the canyon, perennial flow originating from springs in the Totavi Lentil reaches the Rio Grande. Probably some small volumes of alluvial water occur seasonally in the upper reach of the canyon (Purtymun 1975).

In 1977, the annual environmental monitoring program began sampling sediments in Ancho Canyon for radiochemical constituents (ESG 1978), which continues today. Beginning in 1977, spring flow in Ancho Canyon was sampled for chemical and radiochemical constituents (ESG 1978 to 1989, Purtymun et al. 1980). Special studies have included sediment sampling for depleted uranium (Becker et al. 1985), plutonium (Purtymun et al. 1987), and radionuclide and chemical components of sediments (ESG 1989). Radiochemical constituents in water and sediments and chemical constituents in sediments are within background values.

2.6.4.12 Chaquehui Canyon

Chaquehui Canyon originates in the eastern part of the Pajarito Plateau (Appendix C). It drains an area of 1.8 mi^2 and cuts into the Bandelier Tuff and through the basalts of the Chino Mesa and the Tesuque Formation as the channel drops steeply into the Rio Grande. Little to no alluvium occurs in the upper and middle reaches of the canyon. Streamflow in the canyon is ephemeral. Near the eastern end of the canyon, above the Rio Grande,

water from springs and seeps in the Tesuque Formation (main aquifer) maintains a small stream and several large pools that infiltrate into the alluvium before the water reaches the Rio Grande. These springs have been sampled annually as part of the routine environmental monitoring program (ESG 1978 to 1989, Purtymun et al. 1980). Sediments have been sampled since 1978 as part of the same program (ESG 1979 to 1989). Cesium, plutonium, tritium, and total uranium activity in water was low; chemical concentrations were within drinking water standards. Radiochemical concentrations in sediments were also low.

2.6.5 Perched Water

Perched water occurs in conglomerates and basalts beneath the alluvium in a limited area about 120 ft beneath the surface in the midreach of Pueblo Canyon and in a second area about 150 to 200 ft beneath the surface in lower Pueblo and Los Alamos canyons near their confluence. The perched water in these two locations does not connect hydrologically with the main aquifer (LANL 1981).

The only known body of water perched in the Puye Formation above the main aquifer occurs in the midreach of Pueblo Canyon. The horizontal extent of the aquifer is limited. Changes in water levels over time indicate that the aquifer is hydraulically connected to the streamflow in Pueblo Canyon. The aquifer is sampled annually for chemical and radiochemical constituents (ESG 1977 to 1989 Purtymun 1975).

Perched water has been encountered in the basaltic rocks of Chino Mesa in the lower part of Pueblo Canyon, as well as in lower Sandia Canyon. Recharge to the aquifer occurs in the midreach of Pueblo Canyon, as well as in the midreach of Los Alamos Canyon. Surface flow from sewage effluent from the Bayo treatment plant in Pueblo Canyon and storm runoff in Los Alamos Canyon contribute to the perched water. Water moves eastward, as shown by some discharge from the basaltic rocks at Basalt Springs (Purtymun 1975). Early surveillance activities by the USGS and later by the Laboratory document the quality of water from these two perched water bodies (Weir et al. 1963, Abrahams 1966, Abrahams and Purtymun 1966, Purtymun 1969, ESG 1971 to 1989). The chemical quality of these two perched aquifers has increased in chlorides, nitrates, and total dissolved solids. Concentrations of radioactivity are below the limits of detection.

2.6.6. Hydrology of the Main Aquifer

2.6.6.1 General Conditions

The main aquifer of the Los Alamos area is the only aquifer capable of supplying municipal and industrial water. The surface water and groundwater in the alluvium are separated from water in the main aquifer by several hundred feet of unsaturated volcanic tuff and sediments. The upper surface of the main aquifer rises westward from the Rio Grande through the Tesuque Formation beneath the central and western parts of the plateau (Figure 2-5). The water in the aquifer moves from the major recharge area in the Valles Caldera eastward toward the Rio Grande, where a part is discharged into the river through seeps and springs.

The major recharge area for the aquifer is the intermontane basin formed by the Valles Caldera. The upper parts of the sediments in the basin are lacustrine deposits of clay, sand, and gravels, which are underlain by volcanic debris that resulted from collapse of the caldera. The sediments and volcanics are highly permeable and are saturated. The saturated "basin fill" recharges the main aquifer in the sediments of the Tesuque Formation. Minor amounts of recharge may occur in the deep canyons that contain perennial streams on the flanks of the mountains. The ephemeral streams in the canyon, which are cut into the plateau, add little, if any, recharge to the main aquifer (Purtymun 1984).

Purtymun (1984) summarizes general hydrologic characteristics, pumping rates, specific capacities, transmissitivies, and field coefficients of permeability as determined during aquifer tests or during periods of production of supply wells and test holes.

2.6.6.2 Water Supply

The Laboratory and the communities of Los Alamos and White Rock are supplied by water pumped from deep wells in three well fields located in Los Alamos Canyon, Guaje Canyon, and on the Pajarito Plateau (Appendix E). These wells draw water from the main aquifer of the Los Alamos area, which lies at depths varying from several hundred to more than 1,000 ft below the mesa tops.

The six original wells in the Los Alamos Field were drilled and completed between 1946 and 1948. An additional well was completed in 1960. Five additional wells completed in 1950 and 1951 form the Guaje Field. Two more wells were added in 1954 and 1965. The Pajarito Field consists of five wells developed between 1965 and 1982. In addition, the original surface water sources still contribute a small part of the Los Alamos water supply.

The radiochemical and chemical quality of the supply wells is also described in the Laboratory's annual surveillance reports. Annual reports since 1970 summarize hydrologic data of individual wells from 1948 through 1989 (e.g., Purtymun and Stoker 1988).

The Laboratory and the communities of Los Alamos and White Rock are supplied by water pumped from deep wells that range in age from 7 to 43 years. The production in these wells has declined significantly in the past few years. Failed attempts to rehabilitate older wells have focused attention on the need for a comprehensive plan to ensure a reliable water supply for the long term.

Purtymun and Stoker (1988) provide the history, capacity, and production of each well field. They also evaluate the potential for obtaining additional water through new wells by considering the geologic and hydrologic variables in each well field. As a result of this report, two new wells were added to the system in late 1989 and early 1990.

2.6.6.3 Test Wells

Eleven deep test holes have been drilled on the plateau and in canyon locations to investigate the potential for groundwater contamination. The test holes were also used to determine the geologic units, water-bearing formations, and hydrologic properties of the main aquifer. The wells were drilled into the main aquifer in 1949, 1950, and 1960. Seven of the original 11 are sampled for radiochemical and chemical constituents as part of the annual environmental monitoring program reported in the annual environmental surveillance report (ESG 1989) (Appendix E).

2.6.6.4 Springs in White Rock Canyon

The Laboratory and the communities of White Rock and Los Alamos are located on the Pajarito Plateau west of the Rio Grande. The eastern edge of the plateau is White Rock Canyon, which has been downcut by the Rio Grande. Twenty-seven springs discharge from the Totavi Lentil and the Tesuque Formation in White Rock Canyon (Purtymun 1966d). The water from these springs generally acquires its chemical characteristics from the rock units that compose the spring aquifer. Twenty-two of the springs fall into three groups of similar chemical composition. The five remaining springs make up a fourth group, whose chemical components differ from those of the first three groups because of localized conditions in the aquifer. These localized conditions may be related to recharge or discharge in or near basalt intrusions or through faults.

The chemical composition of water from individual springs varies slightly in samples collected from 1964 to the present. The variations are traceable to seasonal change and are not considered significant. Radiochemical quality has also been analyzed. Purtymun et al. (1980) and the Laboratory's annual environmental monitoring reports provide water quality data.

2.6.7 Fenton Hill Site

The Fenton Hill site is located about 40 mi west of Los Alamos on the western flank of the Valles Caldera (Figure 2-4). Investigations in progress at this site are focused on the extraction of heat from dry geothermal reservoirs known as hot dry rock.

2.6.7.1 Water Supply

The Fenton Hill site requires water for drinking and industrial needs. The water supply is furnished by Well FH-1 completed in a perched aquifer at a depth of about 450 ft. An aquifer test conducted in 1980 determined that this aquifer is of limited extent (Becker et al. 1981). The water levels in FH-1 vary according to the amount of pumpage, which reflects the demand for drilling or testing at the site. The water level has declined from 365 ft in 1976 to 382 ft in 1986. The decline in water level since 1976 indicates that the withdrawal of water has exceeded the amount of recharge to the aquifer. Overall, there have been no significant changes in the chemical quality of water (ESG 1989).

Environmental monitoring is performed in the vicinity of the site to assess any impacts from the geothermal operations. Water quality studies of surface and groundwaters, which include mineral and hot springs, wells, and streams, began before construction and testing of the hot dry rock reservoir. There have been no significant changes in the chemical quality of the water. The results of water sampling are published in the Laboratory's annual surveillance reports (e.g., ESG 1989) and in reports on water quality in the vicinity of Fenton Hill (e.g., Purtymun et al. 1988a).

2.6.7.2 Experimental Geothermal Holes

Investigations at the Fenton Hill site are based on the concept of extracting heat from dry geothermal reservoirs by developing artificial hydrothermal systems. The site contains a system of two deep holes completed in dry but hot Precambrian granitic rock. The holes are connected by a series of large cracks that have been developed through hydraulic fracturing. Water circulated under pressure in the cracks recovers heat from the geothermal reservoir. Two separate systems, one at 9,000 ft and another at 15,000 ft,

have been constructed and are being evaluated for potential energy development (Heiken 1985, Murphy et al. 1980).

2.6.8. Special Studies

2.6.8.1 Disposal Site Hydrology

2.6.8.1.1 Capping Studies

Research activities at the Laboratory have concentrated on evaluating the design and performance of different soil and rock materials in the design of trench cap and landfill covers. The studies have included both modeling and evaluation of field performance. Evaluation of trench cap and landfill covers design for managing water movement and biota intrusion has been performed by Nyhan et al. (1990), Perkins and Cokal (1986), Hakonson (1987), and Nyhan et al. (1989). Evaluation of the effectiveness of trench caps as biobarriers to both flora and fauna has been investigated by Hakonson (1987), Nyhan (1989b), Nyhan et al. (1986), Hakonson et al. (1982), and Hakonson and Gladney (1982). Nyhan et al. (1983b) have evaluated the effectiveness of trench caps in preventing erosion. Trench cap effectiveness has also been evaluated through model simulation studies (Devaurs 1989. Most studies have concentrated on investigating those scenarios that permit penetration through the trench caps, thereby exposing the buried waste.

2.6.8.1.2 Studies of Moisture and Contaminant Migration

Evaluation of moisture movement through the soil profile in the unsaturated zone and contaminant migration in the liquid phase have been investigated at Los Alamos through field studies in large-diameter caissons using different soil sequences and contaminant combinations. Tracer studies have been performed (Lane 1983, Polzer et al. 1987). Nyhan and Barnes (1989) have modeled storage of soil water in waste storage trenches.

2.6.8.2 Geochemistry

The Laboratory has been investigating local geochemical conditions using cations, anions, and actinides since the late 1950s. These investigations aimed at understanding the chemistry and resultant mobility of actinides, ions, and elements associated with wastes and included tracer simulation studies. Early investigations addressed the soil adsorption of radioactive wastes (Christenson et al. 1958); more recent studies have concentrated on adsorption processes. The latter studies include batch studies (Polzer and Fuentes 1985, Fuentes et al. 1984), batch and column studies (Fowler et al.

1979), and modeling adsorption (Fuentes et al.1987, Polzer and Essington 1984, Polzer et al. 1984). Leaching studies have examined ion exchange resins buried in Bandelier Tuff (Essington et al. 1986). The mobility of actinides has been examined (Polzer et al. 1984), as well as their association with colloids (Penrose et al. 1990, Polzer and Essington 1983). One-dimensional, steady-state, unsaturated models have been used to determine chemical mobility (Fuentes and Polzer 1987, Fuentes et al. 1987). Combined geochemical/geohydraulic modeling has also been used to investigate geochemical isolation (Gruber 1988).

2.6.8.3 Runoff and Erosion

Simulation studies of runoff and erosion processes have been performed. They range from use of the universal soil loss equation to predict movement of plutonium from fallout sources (Foster and Hakonson 1987) to development of hydrologic and sediment transport models to follow contaminants in alluvial channels (Lane and Hakonson 1982) to mathematical models of runoff, sediment yield, and contaminant transport on the scale of watersheds in semiarid regions (Lane et al. 1985).

2.6.8.4 Geohydrologic Modeling

Combined discharge and transport models have been developed and used in laboratory settings to predict the movement and redistribution of contaminants. One model that predicts runoff, sediment yield, and contaminant transport on a watershed-sized scale in semiarid environments was used to predict plutonium transport (Lane et al. 1985).

Other models were developed to predict flow in porous media flow. The TRACR3D code (Travis 1984), developed at Los Alamos, models transient and two-phase flow and multicomponent transport in porous media. This model has been applied to field and laboratory simulations (Perkins et al. 1985). In addition, TRACR3D has been used to model radiocolloid transport (Travis and Nuttall 1984). CREAMS has been used to model vertical transport of radionuclides (Devaurs and Springer 1988). Devaurs (1989) has developed spatial moment estimation techniques. Unsaturated flow and contaminant transport (a different, unnamed code) have been modeled at a former waste disposal area (HydroGeoLogic 1989).

2.6.8.5 Flood Plains

The HSWA Module requires that all 100-yr flood plains for major watersheds within the Laboratory complex be defined. Because maps of 100-yr flood plains do not exist, they must be generated for the entire facility. The

computational methodology used to define these flood plains conforms to all requirements specified in 40 CFR 270.14(b)(11)(iii). The computer models HEC-1 (Flood Hydrograph Package) and HEC-2 (Surface Water Profiles) prepared by the Army Corps of Engineers (1981, 1982) will be used to complete this task. These models are recognized as standard industrial and regulatory compliance tools for ungaged watersheds.

The HEC-1 computer code simulates the rainfall runoff process in a given watershed and produces a stream discharge hydrograph in response to a single-storm hyetograph. The HEC-2 model uses the peak discharge from this hydrograph, along with known flood plain geometry, to hydraulically compute water surface profiles. These computed profiles at numerous cross sections along a stream channel define the 100-yr flood plain. All input data requirements for both models are currently available or may be computed from known hydrologic relationships. The HEC-2 model input data consist of digitized stream channel topographic information that has been automatically extracted from the Laboratory's AUTOGIS MOSS mapping system using software developed specifically for this task. Once the HEC-2 simulations have been completed, definitions of the 100-yr flood plain for each major watershed will be automatically entered back in the MOSS system. This procedure will ensure that the Laboratory can meet the HSWA Module requirements for 100-yr flood plain maps for the entire facility. All flood plain definitions will be specified in standard New Mexico plane map coordinates.

A single map at a scale of 1:2000 showing all 100-yr flood plains is presented in Appendix D; however, scale maps at 1:400, or smaller, can also be made available from the MOSS system upon request. These flood plain definitions will be archived in the MOSS mapping system for future reference. In addition, a comprehensive report will document individual HEC-1 and HEC-2 model input data for each watershed. Explanations of data used in these simulations will be documented, and all assumptions will be justified by citing the professional literature. The Environmental Protection Group (HSE-8) will maintain model input data files on computer disks for future reference and will make this information available to the DOE, EPA, NMEID, or the Army Corps of Engineers upon request.

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3.0 DESCRIPTION OF THE ENVIRONMENTAL RESTORATION PROGRAM

This section of the Installation Work Plan (IWP) describes the Environmental Restoration (ER) Program that the Department of Energy (DOE)/University of California (UC) will implement for Los Alamos National Laboratory (the Laboratory). This plan provides information on solid waste management units (SWMUs) identified at the Laboratory and presents the overall technical approach for meeting the requirements of the Hazardous and Solid Waste Amendments (HSWA) Module VIII of the Resource Conservation and Recovery Act (RCRA) operating permit issued to DOE/UC. The approach and processes presented in the following sections are designed to meet the following goals of the ER Program at the Laboratory:

- To ensure that the environmental impacts associated with past and present activities at the Laboratory are thoroughly investigated and that appropriate corrective action is taken to protect human health and the environment;

- To comply with RCRA, the Comprehensive Environmental Response and Liability Act (CERCLA), the National Environmental Policy Act (NEPA), the Atomic Energy Act (AEA), their implementing regulations, and other applicable regulations by establishing procedures and schedules for efficiently developing and implementing corrective actions at the Laboratory and monitoring the results;

- To provide both formal and informal mechanisms through which all interested parties, [e.g., DOE, Environmental Protection Agency (EPA) Region VI, New Mexico Environmental Improvement Division (NMEID), and the public] can participate in the corrective action review process at the Laboratory.

The HSWA Module provides the principal framework for implementing the ER Program at the Laboratory. However, sites to be investigated and evaluated may include areas of concern that do not meet the RCRA definition of SWMUs, as well as materials that do not meet the RCRA definition of hazardous wastes. Thus, use of RCRA terminology (e.g., SWMU and hazardous waste) in this work plan implies that radioactive and hazardous substances as defined in CERCLA and elsewhere will be addressed as appropriate.

3.1 The Department of Energy's Environmental Restoration Program

In 1984, the DOE's Albuquerque Operations Office (DOE/AL) created an environmental cleanup program entitled the Comprehensive Environmental Assessment and Response Program (CEARP) to fulfill DOE's obligations under several statutes and regulations, including

- CERCLA, as amended by the Superfund Amendments and Reauthorization Act (SARA);

- RCRA (40 CFR 260-270 and 40 CFR 300) as amended by HSWA in 1984;

- NEPA (40 CFR 1500-1508); and

- The Atomic Energy Act of 1954 (10 CFR 200-1060).

DOE/AL began to implement CEARP at the Laboratory in 1984. At that time, no cleanup compliance agreements, orders, or permits under CERCLA or RCRA were in effect. Thus, CEARP provided guidance for implementing and conducting assessment and remediation activities from 1984 until March 1987, when DOE Headquarters (DOE/HQ) created the ER Program. DOE/HQ created a national ER Program for all DOE Defense Program facilities at the request of the House Armed Services Committee. This request arose from congressional concern over a 1987 General Accounting Office report that indicated that DOE could not account for funds used to conduct cleanup activities. In addition, public concern over environmental problems at DOE facilities was increasing throughout the country.

Responsibility for the ER Program is currently located in the Office of Environmental Restoration and Waste Management at DOE/HQ (DOE 1990b). The authority to implement the ER Program is derived from the following DOE orders:

- Comprehensive Environmental Response, Compensation, and Liability Act Program [DOE Order 5400.4 (DOE 1989b)];

- Hazardous, Toxic, and Radioactive Mixed Waste Management [DOE Order 5480.2 (DOE 1982)];

- Prevention, Control, and Abatement of Environmental Pollution [DOE Order 5480.1 (DOE 1986)];

- Environmental Protection, Safety, and Health Protection Information Reporting Requirements [DOE Order 5484.1 (DOE 1981)]; and

- Implementation of the National Environmental Policy Act [DOE Order 5440.1C (DOE 1985) and AL Order 5440.1B (DOE/AL 1985)].

The primary purposes of DOE's ER Program are to

- implement RCRA 3004(u) and (v), RCRA facility assessment (RFA), RCRA facility investigation (RFI), RCRA corrective measures study (CMS), and RCRA corrective measures for existing SWMUs;

- implement CERCLA preliminary assessment/site investigation (PA/SI), remedial investigation (RI), feasibility study (FS), remedial design (RD), and remedial action (RA), as appropriate;

- carry out corrective actions at RCRA land units in operation before March 1987, including those at which underground storage tanks are located;

- decontaminate and decommission surplus facilities;

- develop and demonstrate the technologies necessary to clean up;

- manage expenses associated with cooperative multiparty cleanup plans and activities;

- protect or restore natural resources damaged by contamination from past release of hazardous substances;

- install long-term environmental monitoring systems; and

- conduct the CERCLA assessments necessary before selling real property.

Significant items explicitly excluded from the DOE's ER Program include

- RCRA compliance for active waste streams;

- emergency response to spills and releases;

- new waste management facilities, except as an integral part of remedial actions; and

- routine monitoring of the postclosure environment and maintenance of postclosure monitoring systems.

To implement the ER Program, DOE/HQ requires that five-year plans be prepared for all Defense Program facilities. This plan is designed to coordinate and consolidate all DOE ER activities and is reviewed annually. The FY91 and FY92 five-year plans have been prepared and released to the public. The FY93 plan is currently in preparation. The plan prioritizes ER activities and is used by DOE for scheduling and budgeting purposes.

3.2 The Environmental Restoration Program at Los Alamos National Laboratory

In the 1970s, the DOE/UC began to identify contamination problems resulting from early defense activities, and, in 1983, it began site characterization studies. These efforts led to remediation of several sites, implementation of institutional controls, and collection of the information on which current investigations are based.

The Laboratory was evaluated under CEARP between 1985 and 1987. A major objective of this program was to determine whether past waste disposal practices—practices in effect before recognition of environmental hazards and passage of extensive environmental legislation—created environmental problems that require remedial action today.

During CEARP Phase 1, DOE/UC conducted and documented PA/SI activities specified by CERCLA and RCRA. This was the first comprehensive attempt to identify potentially hazardous waste sites at the Laboratory. The results of CEARP are summarized in the "CEARP Phase 1–Installation Assessment: Los Alamos National Laboratory, October 1987" (LANL 1987). The DOE submitted this document to EPA's Region VI in October of 1987 to fulfill the CERCLA 103(c) notification requirement. The CEARP Phase 1 report was also distributed to the state and the public.

Subsequent to establishment of the ER Program at DOE/HQ, the DOE/UC established the ER Program Office in the Laboratory's Health, Safety, and Environment (HSE) Division to implement the program at the Laboratory. Although the ER and CEARP programs differ somewhat in scope, the intent is to fulfill the DOE/UC's obligations under both CERCLA and RCRA. The ER Program retains the need for agency approval and oversight and for public review and comment during site characterization activities (RFI), selection of the appropriate remedial alternative (CMS), and implementation of the selected remedial action (CMI). SWMUs identified by EPA for corrective action have been included in the Laboratory's ER Program.

The DOE/UC ER Program at the Laboratory has been modified to address the requirements of the HSWA Module, which became effective May 23, 1990, and to incorporate site-specific needs, as well as management organization, reporting, funding, and program-tracking requirements established by DOE.

3.3 Structure of the Environmental Restoration Program at Los Alamos National Laboratory

The plan for management of the DOE/UC's ER Program is presented in Annex I of this IWP. The HSWA Module requires inclusion in the program of four additional planning and implementing elements described in Annexes II through V: Quality Program Plan, Health and Safety Program Plan, Records Management Program Plan, and Community Relations Program Plan.

The Laboratory is organized in several divisions that report through an associate director to the Director of the Laboratory (Figure 3-1). The HSE Division reports to the Associate Director for Operations. The ER Program Office of HSE tracks and manages the ER Program. The ER Program Office is located in the Environmental Restoration Group (HSE-13), where the group leader serves at the program manager. The manager of the ER Program reports to HSE's Deputy Division Leader (Figure 3-2). The program manager is responsible for effective implementation of the ER Program throughout the Laboratory. Project leaders, who report to the program manager, are responsible for ensuring that the Laboratory meets all regulatory requirements.

The ER Program is a large, interdisciplinary program that will continue for several decades. Technical teams are being created from various groups and divisions of the Laboratory (Figure 3-2), and external support from various universities and DOE facilities may be included. The technical teams will provide the ER Program Office with technical resources for implementing the program. Team members will interact with all ER project leaders to provide them with the expertise (e.g., geochemistry) needed to meet program goals. For each team, the ER Program Office will appoint a contact who will be responsible for establishing the team and providing management interface between the ER Program Office and the technical team. The ER Program Office coordinator will interact with the technical team leader to assign personnel to projects, to schedule effort, and to resolve conflicts among programs. Outside contractors will be used for program activities when limitations in Laboratory resources would threaten the Laboratory's ability to meet HSWA Module requirements (Figure 3-3).

Several teams will be involved with integrating technologies and methodologies, both new and existing, into the ER Program in order to enhance the cost effectiveness of DOE/UC's corrective action process. If appropriate, funding for new technologies will be sought from the Environmental Management (EM) Office of Technology Development (OTD). Implementation of these technologies will be contingent upon receiving adequate funding.

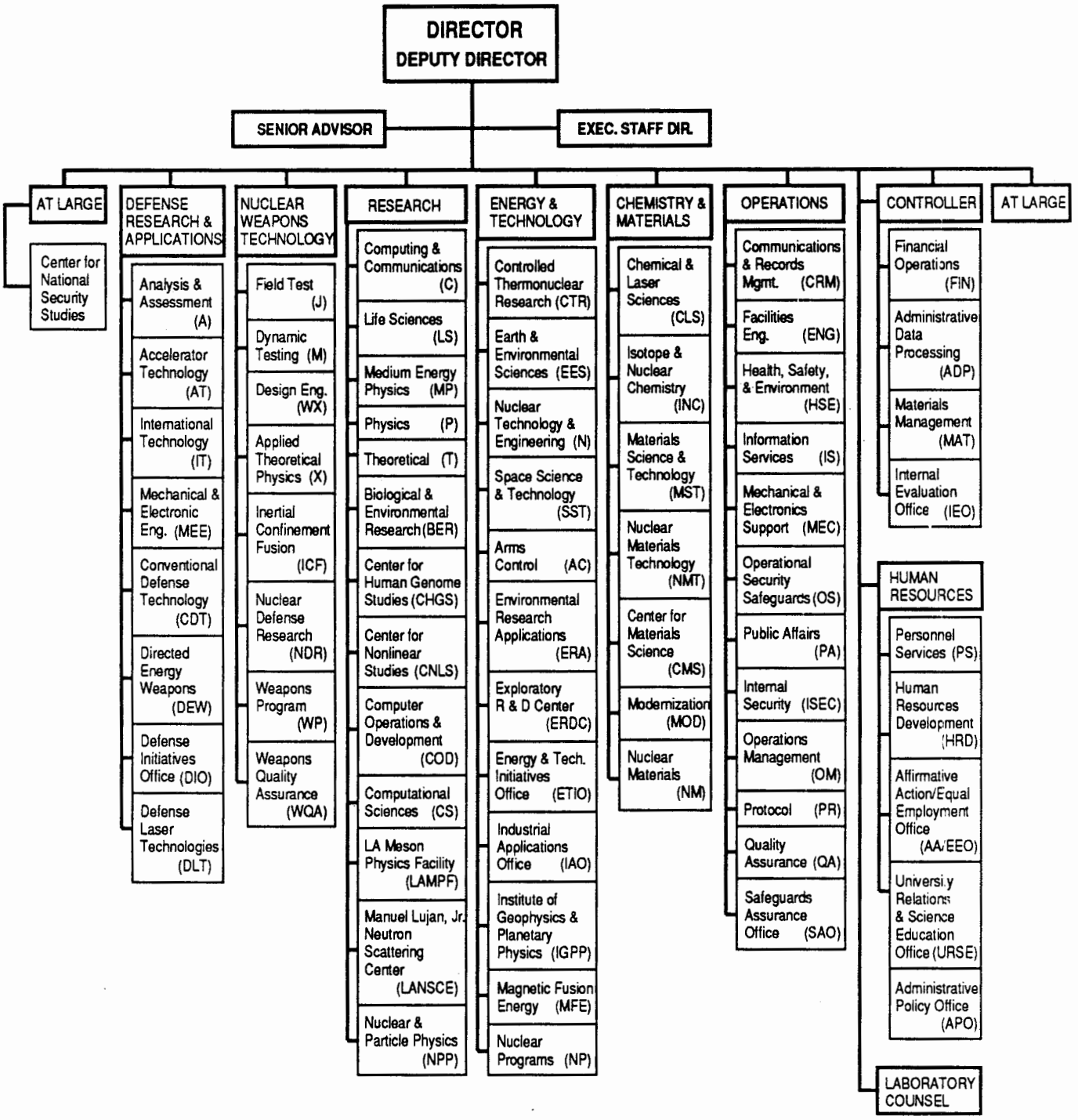
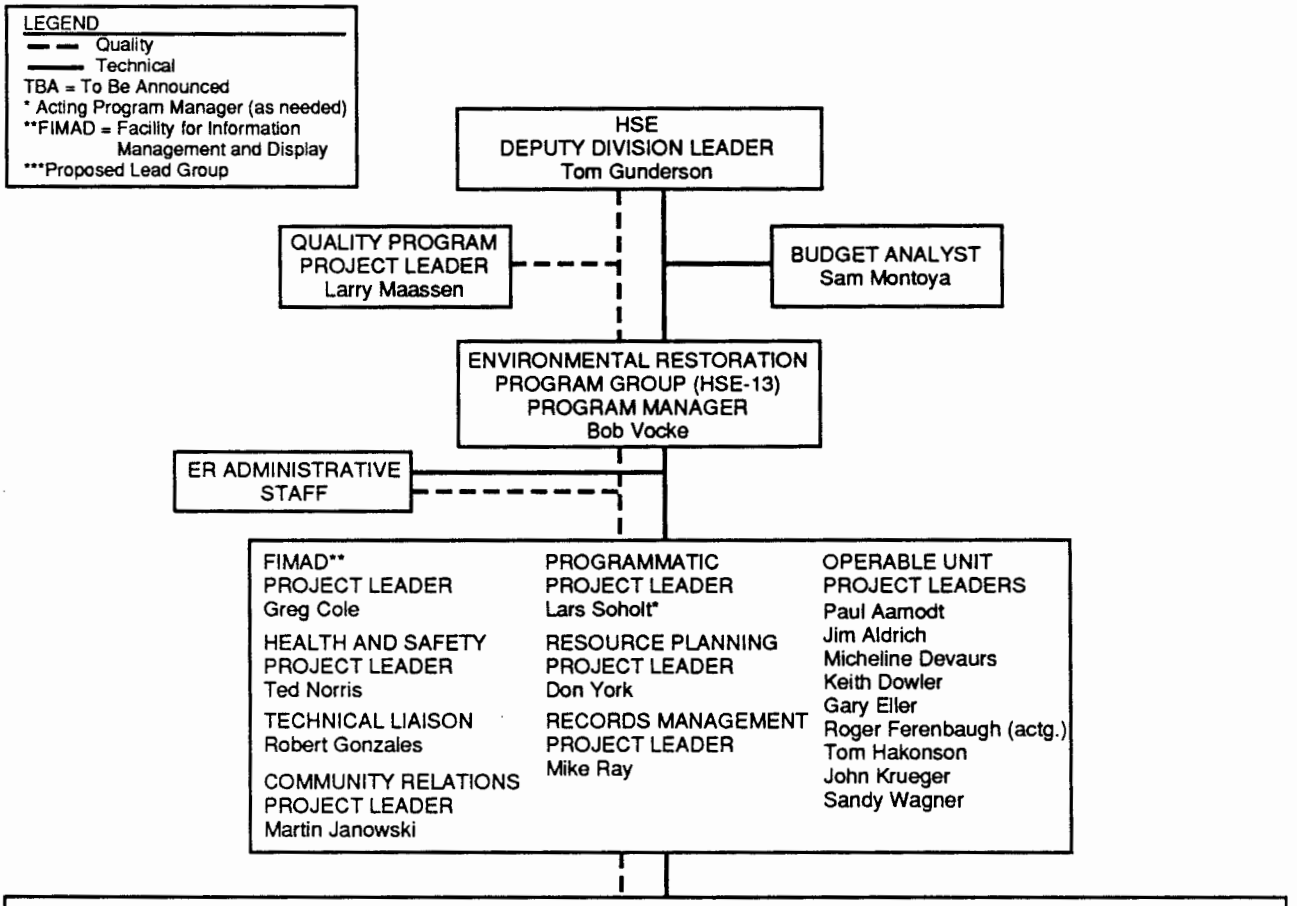


Fig. 3-1. Organization of Los Alamos National Laboratory.



TECHNICAL TEAMS	GROUPS/ DIVISIONS	TECHNICAL TEAM LEADER	QA REPRESENTATIVE	ER PROGRAM OFFICE TECH. TEAM COORDINATOR
Analytical Chemistry/Sample Coordination	HSE-9***, CLS, INC	Chuck Rzeszutko	TBA	Wagner
Analytical Chemistry Instrumentation Dev.	HSE-9***, CLS, ERA, INC	Craig Leasure	TBA	Wagner
Geochemistry	INC***, CLS, EES, HSE-9	Dave Curtis	TBA	Wagner
Geology, Geophysics, Drilling	EES***, HSE, MEE-13	Bill Laughlin	TBA	Aamodt
Project Health & Safety	ER***, HSE-1, 2, 3, 5, 10, 11	Ted Norris	TBA	Norris
Community Relations	PA-3***, PA-1	Martin Janowski	TBA	Janowski
FIMAD**	EES, HSE-9	Greg Cole	TBA	Cole
Records Management	EES-1***	Mike Ray	TBA	Ray
Statistics	A-1***, EES-1, UCLA	Kathy Campbell	TBA	Soholt
Decision Analysis	A-1***	Elizabeth Kelly	TBA	Devaurs
Cost Estimating	MEE-4***	Bob Gillis	TBA	Aamodt
Cost Benefit	A-4***	Linda Trocki	TBA	Devaurs
Hydrology	EES***, HSE, N-6, MEE-13	Micheline Devaurs (actg.)	TBA	Devaurs
Site Assess. and Remediation Tech. Devel.	HSE***, ERA, EES, MEE, INC	Harry Ettinger	TBA	Aamodt
Document Preparation	IS-9, 11, 12, OS-6	Lars Soholt (actg.)	TBA	Soholt
Environmental Assessment	HSE-8, EES-2	Doris Garvey	TBA	Aamodt
Corrective Action Imp. (Remediation)	ENG***, HSE-7	Chris Loggains	TBA	Soholt
Interim Remedial Measures	ER***, ENG, HSE-8	Robert Gonzales	TBA	Gonzales
Mixed Waste Storage/Disposal Facility	MEE***, ENG, HSE-7	Dean Nelson	TBA	Aamodt
Quality Assurance	ER***, MEE-9	Larry Maassen	TBA	Maassen
Engineering (Conceptual - Title II)	ENG***, MEE	Chris Loggains	TBA	Krueger
Regulatory Compliance	HSE-8	Dave McInroy	TBA	Krueger
Planning/Scheduling/Reporting	ER, HSE-DO	Don York	TBA	York
Solid Waste Management Unit Data Base	ER	Robert Gonzales	TBA	Gonzales
Air Quality	HSE-8***, EES-5	Craig Eberhart	TBA	Soholt
Risk Assessment	ER***, EES, HSE-1, 5, 8, 10, 11, A, UCLA	Lars Soholt (actg.)	TBA	Soholt

Fig. 3-2. Organization of the Environmental Restoration Program at Los Alamos National Laboratory.

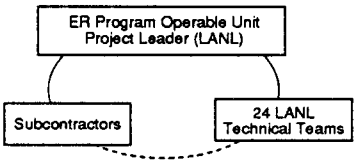


Fig. 3-3. Interactions of Environmental Restoration Program project leaders with technical teams and subcontractors.

The composition, leader, and function of each technical team are described in the following subsections.

3.3.1 Analytical Chemistry Team

The Analytical Chemistry Team will consist of personnel from the Health and Environmental Chemistry Group (HSE-9) and from the Chemical and Laser Sciences (CLS) and Isotope and Nuclear Chemistry (INC) divisions. The team will be responsible for performing all of the chemical analyses required by the ER Program. All ER Program project leaders will interface with the Analytical Chemistry Team leader to provide support for their specific operable units (OUs). The chemical analyses performed by the various divisions will be coordinated by this group. Because the assistance of external subcontractors will be needed, the team will obtain and manage a subcontract for this support and will ensure the quality of the work performed by the selected subcontractors.

The technical team leader will be responsible for establishing and maintaining a quality control (QC) program for analytical data. The QC protocols and requirements established by HSE-9 in coordination with the Quality Program project leader will be applicable to work performed by HSE-9, INC, CLS, and external subcontractors.

3.3.2 Analytical Chemistry Instrumentation and Method Development Team

The Analytical Chemistry Instrumentation and Method Development Team will consist of personnel from the ER Program Office, Environmental Research Applications (ERA), CLS, INC, and HSE-9. The purpose of this team is to identify more effective and economical means for performing RFI, CMS, and corrective measures implementation (CMI). Therefore, the team will submit proposals for developing methods and instruments to DOE for approval before the work is undertaken. This work is not included in the ER Program. Most of the proposals will provide near-term benefits directly applicable to the ER Program and will allow DOE/UC to use technologies that already exist at the Laboratory.

3.3.3 Geochemistry Team

The Geochemistry Team will consist of members from INC, Earth and Environmental Sciences (EES), and CLS divisions. The function of the Geochemistry Team is to provide technical expertise to support the preparation of RFI work plans, analyze and interpret data, prepare RFI reports, and evaluate RA alternatives. Its activities will include preparing descriptions of the natural and contaminant geochemistry of waste sites, characterizing waste, and identifying the migration and dispersal potential of wastes

through sorption, biodegradation, photolysis, hydrolysis, etc. Other responsibilities may include predicting contaminant movement, evaluating remedial technologies, designing pilot studies, and determining the effectiveness of the treatments selected.

In addition, the team will provide analytical geochemical services that differ from those to be provided by the Analytical Chemistry Team. Examples are identifying the cation exchange capacity, porosity, pH, and mineral content of the soil and performing thin-film and other petrographic analyses. The team leader is responsible for identifying and using expertise in other divisions of the Laboratory, as needed. INC will establish a QC program that will apply to all groups performing analyses for the ER Program.

3.3.4 Geology, Geophysics, and Drilling Team

The function of this technical team is to provide geologic support for RFI/CMS activities for the ER Program. This work will include preparation of appropriate sections of RFI/CMS work plans and reports, regional geologic maps, cross sections, stratigraphic correlations, structure maps (faults and fractures), and more detailed maps and geologic models for each site at which there is more than one SWMU. Geophysical and related noninvasive techniques will be used to delineate faults and structural features and to locate the boundaries of buried sources such as disposal trenches, pits, and shafts, and abandoned underground test chambers. The knowledge obtained from these investigations will guide the placement of drill holes to optimize data collection and to improve worker safety.

3.3.5 Health and Safety Team

The Health and Safety Team will consist of members from the Radiation Protection (HSE-1), Occupational Medicine (HSE-2), Safety and Risk Assessment (HSE-3), Industrial Hygiene (HSE-5), and the Environmental Protection (HSE-8) groups. The function of the Health and Safety Team is to ensure that ER work at Los Alamos fully complies with Occupational Safety and Health Act (OSHA) regulations, DOE orders, Laboratory policies, and other applicable requirements (Annex III). Parts of this program will draw on resources already available in the HSE Division. The team's responsibilities include radiation protection, health physics surveys, personal dosimetry, and whole-body counting (HSE-1); baseline medical examinations and medical surveillance for workers who may be exposed to hazardous wastes (HSE-2), and training hazardous waste workers and reviewing site health and safety plans (HSE-3). This team will also fit workers with respiratory protection and train them to use it; monitor hazardous organic vapors in the field; and provide personal protective clothing,

decontamination facilities, and site safety officers (HSE-5); HSE-8 will provide environmental data relating to health and safety concerns.

3.3.6 Community Relations Team

The ER Community Relations Team will integrate the community relations needs of ER with existing community relations and public affairs programs and policies at the Laboratory in an efficient and cost-effective manner (Annex V). The primary function of the Community Relations Team will be to develop a community relations plan (Annex V). The plan will include provisions for (1) informing the public in a timely manner of the technical activities of the ER Program; (2) responding to communities' concerns about these activities; (3) educating communities about ER technical activities, where needed, within the regulatory framework; and (4) gathering public comment on these activities at appropriate times.

3.3.7 Facility for Information Management, Analysis, and Display Team

The Facility for Information Management, Analysis, and Display (FIMAD) Team has been established to provide ER Program personnel access through work stations to a central data base that is capable of performing data analysis. The team will also generate maps, graphics, and text. Team members will include personnel from EES Division and HSE-9. The team will support the Records Management Program (Annex IV). All efforts will be directed toward providing an open, upgradable, user-friendly system.

3.3.8 Statistics Team

The members of this team will come from A-1, EES-1, and UC (Los Angeles).

Large amounts of data will have to be generated and analyzed to meet DOE/UC's obligations under the HSWA Module. However, the Laboratory recognizes that an attempt to collect all possible data regarding sites is not feasible or cost-effective. The ER Program staff intends to collect and analyze only those data that are relevant to the RCRA decision-making process.

The goal of this technical team is to design the most effective sampling methods possible. To accomplish this goal, the team will apply statistical tools to determine the number of samples necessary to answer questions, develop geostatistical relations within sites, and serve as advisers and reviewers in the application of these tools. Current team activities include preparing generic guidance for designing samples and analyzing data and

selecting sampling designs to be optimized for real and simulated situations.

3.3.9 Decision Analysis Team

The Decision Analysis Team consists of members of the Statistics Group (A-1). The purpose of this team is to provide the decision-making framework for the ER Program's corrective action process. The framework will emphasize investigations that accelerate the time frame for determining what, if any, cleanup is needed. This follows the fundamental principles of DOE's observational approach. The observational approach does not propose a specific technique to identify what is or is not a likely deviation from expected site conditions; rather, the observational approach is a conceptual framework for site characterization and remediation that consists of the following three basic tenets:

- Before characterization begins, goals should be carefully defined.

- A general approach to remedial action should be established as early as possible.

- More data do not necessarily result in more information.

3.3.10 Cost/Benefit Analysis Team

This technical team is composed of members of the Energy and Environmental Analysis Group (A-4). The purpose of this team is to initiate cost/benefit analysis to achieve the goals of ER within the time limits required by the HSWA Module and within a reasonable budget. Cost/benefit analysis provides a framework in which to measure the value of alternatives, choose one, and defend it before the public, EPA, NMEID, and DOE. The benefit is optimization of site characterization (and, later, implementation of a remedial action), given legal requirements and constraints on time, funding, and capabilities. The benefits should include reduced costs, higher levels of information per dollar spent, and improved operations, as well as documentation of how preferred alternatives were selected. Cost comparisons are performed within a decision analysis framework to ensure that other criteria, such as public acceptability, are systematically considered in RFI/CMS decisions.

3.3.11 Hydrology Team

Team members will include personnel from HSE-8, the Advanced Engineering Technology Group (MEE-13), and the Safety Assessment Group (N-6). The purpose of this technical team is to provide hydrological support

for RFI/CMS activities under the ER Program. This work will include preparing appropriate sections of RFI/CMS work plans and reports, testing borehole samples to determine hydrologic properties, and performing detailed hydrologic studies for each operable unit, corrective action management unit (CAMU), or SWMU, as required. Site characterization data will be used for hydrologic modeling, as appropriate.

3.3.12 Site Assessment and Remediation Technologies Development Team

The Site Assessment and Remediation Technologies (SART) Team will be interdivisional and interdisciplinary and will include personnel from HSE, EES, INC, CLS, MEE, A, ERA, and probably from other technical divisions and offices throughout the Laboratory. The functions of this team will be to identify, review, and recommend worthy research and development projects, from bench to pilot scales, that will effectively support the objectives of the ER Program at Los Alamos. The SART Team will focus both on site characterization technologies (exclusive of waste characterization and analytical methods and instrumentation for site monitoring) and on remediation technologies. The team will research, develop, and demonstrate technologies that will improve performance, reduce cost, or improve cleanup schedules.

3.3.13 Document Preparation Team

The Document Preparation Team is composed of members of the Photography and Printing Group (IS-9); the Writing and Editing Group (IS-11); Illustration, Design, and Video Group (IS-12); and the Classification Office (OS-6).

The goal of this team is to produce readable and technically sound documents for the ER Program. Information Services (IS) support will include technical writing and editing, graphics, and printing; OS-6 will review all documents to ensure that no classified information is released.

3.3.14 Environmental Assessment Team

This technical team is composed of members from HSE-8 and the Geology and Geochemistry Group (EES-1). This team supports DOE requirements for NEPA and resource assessments that are applicable to the Laboratory's ER Program. The assessments must focus on all facility conditions and pathways of contamination applicable to each OU. The NEPA assessments will include, at a minimum, an evaluation of the short- and long-term beneficial and adverse effects of the selected alternative, any adverse effects on environmentally sensitive areas, and an analysis of measures to mitigate adverse impacts.

3.3.15 Corrective Measures Implementation and Remediation Team

CMI will require careful engineering design and construction. The Los Alamos ER Program is supported in this effort by a technical team housed in the Facilities Engineering Division. This team will be responsible for providing engineering expertise to the ER Program. Quality engineering will be a major consideration in obtaining EPA approval of proposed corrective measures and in ensuring the ultimate success of these measures.

3.3.16 Interim Remedial Measures Team

The Interim Remedial Measures Team will consist of two sections: the Facility Quality Control Project Office (FQCPO) under the direction of HSE-3 and the Interim Remedial Measures Solid Waste Assessment Team (SWAT) in HSE-8. The purpose of the Facility Quality Control Project Office (FQCPO) is to review all engineering projects to ensure compliance with all environmental, safety, and health (ES&H) laws; DOE orders pertaining to ES&H; and Laboratory ES&H policies. Because this review encompasses concerns other than ER (e.g., archeology, endangered species, wetlands, and OSHA compliance), the ER Program does not fund the FQCPO but rather serves as one branch of the overall HSE review.

3.3.17 Mixed Waste Storage and Disposal Facility Team

The goals of the Mixed Waste Storage and Disposal Facility (MWSDF) Team are to select a suitable site, develop facility and operating criteria, and design and construct a proposed new MWSDF at Los Alamos. Associated tasks include preparing environmental assessments (EAs) and site suitability studies, obtaining required state (NMEID) and federal (EPA) permits, and ensuring compliance with all required quality assurance (QA) and health and safety (H&S) requirements. If constructed, the MWSDF will be used primarily for waste generated under the Laboratory's ER Program. The need for treatment facilities to accommodate the ER Program is yet to be addressed, but existing waste treatment facilities will be used to the extent they are available.

Contractors will perform many of the subtasks associated with the MWSDF; however, vital management functions, performance and design criteria, and technical reviews of all work will be the responsibility of the MWSDF team leaders and Laboratory staff.

3.3.18 Quality Assurance Team

The Quality Assurance Team consists of members of the ER Program Office and the Engineering Design and Quality Assurance Group (MEE-9).

The ER Program must address both DOE and EPA QA criteria. Although the two agencies have established many of the same criteria, each has adopted criteria not adopted by the other. The ER Program Office staff has been working closely with EPA's QA staff to be certain that EPA requirements are clearly understood. This work includes participation in EPA audits of other facilities. Laboratory QA personnel have also been in contact with DOE personnel to be certain DOE's requirements are understood. The Laboratory's goal is to assemble a QA technical team composed of QA specialists with backgrounds in engineering, chemistry, geology, and other sciences to correctly interpret and effectively implement the QA requirements of both agencies.

3.3.19 Engineering Team

This team will be needed when CMSs have been completed and design of the preferred corrective action alternative has been initiated. The Engineering Team will manage all remediation design and construction regardless of whether this work is done at the Laboratory (in the Engineering Division or by Pan Am World Services) or by an architect-engineer (A-E) subcontractor. This kind of centralized management will ensure a consistent approach to implementing corrective action and will ensure compliance with Laboratory policies, including security and ES&H requirements. In addition, the Engineering Team could serve as consultants to project leaders during the development of CMSs. Criteria used for evaluating corrective action alternatives include technical feasibility and implementability.

3.3.20 Regulatory Compliance Team

The Regulatory Compliance Team will consist of staff members from HSE-8. This team is responsible for ensuring compliance with various environmental laws, including the Clean Water Act (CWA); the Clean Air Act (CAA); the NEPA; the Toxic Substances Control Act (TSCA); CERCLA; the Historic Preservation Act; the Safe Drinking Water Act; and the Threatened and Endangered Species Act. The team will serve primarily as consultants for the ER Program project leaders and will review environmental compliance.

3.3.21 Records Management Team

The purpose of the Records Management Team is to provide support to ER Program participants in handling significant volumes of record packages, including technical data generated by the ER Program. Implementation of the Records Management Plan (RMP) will accommodate the ongoing need for coordinated protection of ER Program records. Activities associated with the RMP will ensure that ER Program records are handled in a defen-

sible manner consistent with regulatory guidelines and will include integration of Quality Program guidelines and standardized documentation controls.

3.3.22 Planning, Scheduling, and Reporting Team

The Planning, Scheduling, and Reporting Team will consist of members of the ER Program Office and HSE-13. The goal of the team is to provide the ER Program with the planning, scheduling, and reporting needed to ensure effective implementation of the ER Program. The ER Program Office has prepared a comprehensive listing of the Laboratory's SWMUs, which is being used for FY93 Five-Year Plan resource planning and scheduling purposes. The Laboratory is implementing a near-term cost and schedule control system using a software package called Primavera's Finest Hour. This package gives excellent control over the structure and details of the ER Program because it allows for an unusually high number of codes to be assigned to activities and costs. This capacity permits data to be collected in more ways than are offered by most other software packages.

3.3.23 Solid Waste Management Unit Data Base Team

The purpose of this team is to provide EPA with background information on all SWMUs at the Laboratory as specified in the HSWA Module. This background information includes location, operational history, waste type, contaminants, and quantity of waste for each SWMU. The EPA will review the information and determine which areas are sufficiently contaminated to require cleanup through the corrective action process. The Laboratory also needs a comprehensive list of all the SWMUs to ensure that routine operations comply with regulatory requirements. This information is also needed for the ER Program's resource planning. Until the SWMU data base is completed, the Laboratory will not have comprehensive documentation for all its contaminated sites.

3.3.24 Air Quality Team

The Air Quality Team is composed of members from HSE-8 and the Geoanalysis Group (EES-5). One of the concerns about site investigation and remedial action is the possibility that contaminated particulates will become airborne, either as a result of natural erosion or of physical disturbance of the site. Efforts to assess air quality problems at SWMUs will commence when it is determined that air quality is an issue.

3.3.25 Risk Assessment Team

The Risk Assessment Team is composed of staff from HSE, EES, and A divisions, as well as from UC (Los Angeles). The Laboratory recognizes the need for a risk assessment team that consists of representatives of all pertinent disciplines. The heart of any comparison of alternative corrective measures, including the no-action alternative, is a risk assessment. Risk assessment is also necessary to establish the baseline risks to be addressed at each site. A well-done risk assessment could preclude the costs of studying and implementing alternatives based on overly conservative estimates. The Risk Assessment Team will be an interdisciplinary team whose functions are to define general pathways of exposure for the public, to define ecologically sensitive areas, to develop the risk criteria used in the decision-making process, and to make preliminary risk assessments based on available data so that priorities for cleanup can be set.

3.3.26 Cost-Estimating Team

The ER Program Cost-Estimating Team is housed in the Technical Engineering Support Group (MEE-4) and has responsibility for developing detailed cost estimates for all program activities. Costs will be developed based on personnel resource requirements by discipline, as well as by rate per hour, day, week, etc., as needed. Costs for equipment use will be developed based on purchase, lease, rental, and/or operating rate, as needed. When requested, costs for materials, contacts, or other significant program expenditures will be estimated using DOE-approved methods. The team will prepare a cost-estimating manual to be used for all ER Program estimates to ensure consistency and compliance with DOE guidelines in DOE Order 4700.1 (DOE 1987), the DOE-EM Cost Estimating Handbook, and EPA guidelines under RCRA. The cost estimators will work closely with the ER project leaders to identify the activities and elements that require cost estimates and to ensure that such estimates are developed, when needed. The Cost-Estimating Team will also work closely with the Cost /Benefit Analysis Team (Section 3.3.10), particularly for tracking earned value. It will also work closely with the Planning, Scheduling, and Reporting Team (Section 3.3.22) to assist with the development of resource-loaded activity networks. Finally, the team will be responsible for maintaining documentation of its activities and products in sufficient detail to undergo the scrutiny of audit.

3.4 TECHNICAL APPROACH TO OPERABLE UNITS

3.4.1 Operable Unit Information

Potential release sites exist throughout the Laboratory, and several exist off Laboratory land. The sites have been aggregated into OUs under the ER Program to address site characterization and potential remediation in an efficient, cost-effective manner, as required by the HSWA Module. These OUs are logical groupings of potential release sites (SWMUs), which may include geographical aggregations that have similar physical features, contaminant sources or types, schedules, or likely response actions. OUs and the geographical Laboratory technical areas (TAs) do not necessarily coincide. Some OUs may encompass more than one TA (e.g., OU AL-LA-30 includes TA-22 and TA-40). Because DOE's management structure relies on OUs for funding and tracking purposes, the ER Program Office will need to meet the compliance requirements of the HSWA Module through the use of OUs.

Each OU will have a separate work plan, which will result in the development of approximately 24 such plans over the 4 years extending from May 23, 1990. The schedule shown in Table 3-1 is derived from tables found in the HSWA Module, and the schedules in each work plan will be incorporated in the permit and will become enforceable upon EPA approval.

TABLE 3-1
SCHEDULE FOR WORK PLAN COMPLETION

SWMU Due Date	HSWA Module Table A SWMUs (%)	HSWA Module Table B (%)
5/23/91	10	20
5/23/92	35	55
5/23/93	55	100
5/23/94	100	100

Table B of the HSWA Module is a subset of Table A and includes all SWMUs that EPA considers high priorities. Currently, Table A contains 603 SWMUs and Table B contains 182, but this number will change as EPA modifies the HSWA Module during the course of the RFI/CMS process.

In compliance with HSWA Module Section H.(3)(a), DOE/UC has started to prepare the RFI work plan for TA-21, which includes 68 SWMUs from

Table A (11%) and 37 from Table B (20%). This plan, which must be delivered to EPA on May 23, 1991, will be the first OU document. In addition to preparing the RFI work plan for TA-21, DOE/UC has begun archival searches and is preparing work plans for several other OUs. This work has been started in preparation for meeting the RFI work plan requirements for additional SWMUs as defined in Section H.(3)(b) of the HSWA Module.

3.4.2 Solid Waste Management Unit Data Base and Notification of New Units

In early 1987, EPA Region VI performed an RFA to identify all potential SWMUs at the Laboratory. The RFA was completed in August 1987 but was not formally released. Upon receipt of the RFA, DOE/UC prepared an SWMU report in an attempt to incorporate additional information in the RFA SWMU list and to correct inaccuracies in the RFA. This report was released in December 1988, and it combined lists from the CEARP Phase 1 report (LANL 1987), the RFA, and internal records searches and interviews. The report identified approximately 1,100 potential release sites. The EPA selected the 603 SWMUs identified in the HSWA Module from this report based on the EPA's preliminary assessment of the potential impact to human health and safety.

In 1989, an effort was initiated to further revise and verify existing information, which resulted in a comprehensive SWMU data base completed in November 1990. This effort involved site visits and discussions with operating groups. No sites were eliminated, but many were combined, some were added, and areas of concern were included. The field information was coupled with an extensive search of maps and archives. Each SWMU is coded with a unique identification number that ties it to a particular TA.

The primary function of the SWMU data base is to provide a baseline of potential release sites from which the RFI for each OU will be developed. In most cases, the scope of the RFI will be to confirm a release and to determine the nature and extent of contamination. In some cases, sufficient historical information may be available to justify a recommendation of no further action. These options are discussed further in Sections 3.5 and 3.6.

As new SWMUs or other areas of concern are identified during the RFI process, environmental surveillance, audits, or other activities, DOE will notify EPA in writing of its concurrence with identification of a unit within 15 days. This notification will include an SWMU summary data sheet containing all information available at that time [e.g., location, type of unit, dimensions, waste types (known and suspected), and period of operation]. In addition to this technical information, DOE will submit to DOE a plan

for future action. After reviewing the action plan, EPA will either approve it or instruct DOE/UC to prepare a formal SWMU assessment plan.

Because DOE/UC has been identifying and investigating SWMUs for the past few years, it seems unlikely that SWMUs posing a significant environmental threat have yet to be discovered. To streamline the RFI process, any new SWMUs and other areas of concern will be incorporated in existing OUs, as practical. DOE/UC will submit plans for future action within 15 days of identifying a new SWMU or other area of concern. Identification formally occurs when DOE concurs that a new SWMU or area of concern exists. Action plans may include, as appropriate,

- completing the SWMU Summary Data Sheet, using historical and operational information from records searches and interviews with long-term employees;

- assigning the new SWMU to an existing OU for which an RFI is to be conducted;

- addressing proposed interim remedial measures; and

- preparing a formal SWMU assessment plan, including sampling and analysis.

In the unlikely event that a potentially significant threat to human health or the environment is discovered, DOE/UC will prepare an assessment plan. Upon receipt of information on the newly identified SWMU, EPA will notify DOE/UC of its selection of the proposed action as discussed in the action plan. EPA may, at that time, request an SWMU assessment plan. DOE/UC would prepare this plan to be consistent with Section F.2-6 of the HSWA Module. The assessment plan will contain a sampling and analysis program adequate to determine the nature and extent of contamination. EPA will approve the proposed assessment plan, provide comments for revision, or revise the plan. DOE/UC will implement the plan within 15 days of receipt of a written notice of approval.

Within 60 days of completion of the work described in the SWMU assessment plan, DOE/UC will submit an SWMU assessment report. The report will present the findings of the investigation and will include, as appropriate for each unit,

- location,

- type and function,

- structural description,
- period of operation,
- type and volume of wastes managed, and
- results of sampling and analysis.

EPA will review the assessment report and will determine the need for additional investigation or corrective measures. DOE/UC may be required to prepare an additional plan for these activities, which will be incorporated in an RFI work plan for EPA review and approval.

Discovery of new releases of hazardous materials from existing SWMUs or sites previously identified as needing no further action will be reported to EPA within 24 hours of discovery. DOE/UC will follow oral notice with a written notification that presents existing information related to the location, nature, and type of release and proposed corrective measures. For the purposes of the DOE/UC ER Program, a release will be considered to exist when hazardous wastes are found adjacent to an SWMU in concentrations exceeding action levels presented in Appendix F. EPA has proposed these levels in proposed Subpart S of 40 CFR 264 (EPA 1990) as criteria for determining that no further corrective action is required at an SWMU after an RFI. These levels are discussed further in Section 3.5. DOE/UC proposes that most newly discovered releases at existing SWMUs be incorporated in the RFI work plan for the OU in which the SWMU is located. For those few instances when it is impractical to incorporate the release site in an RFI (e.g., when the RFI is almost complete), an assessment plan will be prepared if EPA so requests.

3.4.3 Solid Waste Management Unit Summary Data Sheets

The SWMU summary data sheets are included as Appendix G. These sheets summarize the status of currently known potential release sites and provide a brief description of each SWMU and of the potential environmental problems to be addressed by the DOE/UC ER Program. Detailed discussion of SWMUs is provided in the Solid Waste Management Units Report (LANL 1990) submitted concurrently with this plan.

3.5 RESOURCE CONSERVATION AND RECOVERY ACT FACILITY INVESTIGATIONS

The HSWA Module defines the scope of the RFI as five tasks: (I) description of current conditions; (II) RFI work plan; (III) RFI; (IV) investigative analysis; and (V) reports. The first task, which requires a discussion of

facility background, a discussion of the nature and extent of contamination, identification of past and present permits, and a discussion of the implementation of interim measures, is satisfied by the submittal of this IWP. This IWP also satisfies the generic requirements of the second task [preparation of the Project Management Plan (Annex I)].

Because little release information is available for many of the SWMUs at the Laboratory, it is important that neither the RFA nor the SWMU data base be used as a screening mechanism. The most appropriate point in the corrective action process for eliminating sites unlikely to have released hazardous wastes into the environment is during the development of the RFI work plan. Only after thoroughly searching files and archives and visiting sites (activities necessary during preparation of a sampling plan) can a determination be made that a release is unlikely. Therefore, all SWMUs identified in the SWMU data base (which includes those identified in the RFA) will be taken into account in the RFI process and discussed in the RFI work plan. It will be the responsibility of the ER Program project leaders to characterize each site listed in the SWMU data base unless there is sufficient reason to believe that a release of hazardous wastes from a particular SWMU is unlikely to have occurred (or to occur in the future). If appropriate, DOE/UC will recommend no further action in each RFI work plan. Each RFI work plan, therefore, will contain a table listing both those sites for which further investigation is deemed unnecessary and those that require a full RFI. An application for a HSWA Module Class III permit modification to modify Table A (both by adding and removing SWMUs based on initial research) will be included in or accompany each work plan, as appropriate.

3.5.1 Resource Conservation and Recovery Act Facility Investigation Work Plans

Work plans for the conduct of RFI will be prepared by the ER Program Office.

The generic requirements for preparing RFI work plans can be found in proposed Subpart S regulations (EPA 1990). The specific requirements are described in detail in the HSWA Module, and EPA has provided specific guidance in Volume I of the interim final RFI guidance (EPA 1989). This IWP provides the framework for the preparation of specific OU work plans. These specific work plans will refer readers to the IWP for general information.

In a general sense, the RFI work plan must include a description of the overall approach, technical and analytical approaches and methods, QA procedures, and data management procedures. The HSWA Module also

specifically requires the concurrent development of five plans as part of the RFI work plan: the Program Management Plan, Quality Program Plan Data Management Plan, the Health and Safety Program Plan, and the Community Relations Plan. However, the HSWA Module allows the Laboratory to deviate from the specific guidance if the RFI plan work still covers the essential elements discussed above.

It is the policy of the ER Program Office to adhere to Section 2, Volume I, of EPA's RFI guidance document to the extent practicable. To facilitate compliance with this detailed guidance while complying with the HSWA Module's requirements, the ER Program Office has developed a standard outline for all RFI work plans (Table 3-2).

TABLE 3-2. OUTLINE OF WORK PLANS FOR RESOURCE CONSERVATION AND RECOVERY ACT FIELD INVESTIGATIONS

Executive Summary
1.0 Introduction
2.0 Task (or Area of Investigation) Description and Identification of Data Needs
- 2.1 Background
  - 2.1.1 History of Task (or Area) Activities
  - 2.1.2 Past Waste Management Practice
- 2.2 Current Description
- 2.3 Existing Information
  - 2.3.1 Environmental Setting
  - 2.3.2 Potential Pathways for Contaminant Migration
  - 2.3.3 Cumulative Public Health and Environmental Impacts
- 2.4 Task (or Area) Data Needs

3.0 SWMU [or Corrective Action Management Unit (CAMU)] Descriptions and Identifications of Data Needs
- 3.1 Title of First SWMU (or CAMU)
  - 3.1.1 Existing Information
    - 3.1.1.1 Source Term
    - 3.1.1.2 Migration Pathways
    - 3.1.1.3 Potential Public Health and Environmental Impacts
    - 3.1.1.4 Preliminary Identifica-tion of Potential Response Actions
    - 3.1.1.4 Bench and Pilot Scale Studies
  - 3.1.2 Data Needs
    - 3.1.2.1 Source Term

3.1.2.2 Migration Pathways
3.1.2.3 Potential Public Health and Environmental Impacts
3.1.2.4 Preliminary Identifica tion of Potential Response Actions
3.1.2.5 Bench- and Pilot-Scale Studies
3.1.3 Data Quality Objectives
3.1.3.1 Source Term Data
3.1.3.2 Migration Pathways Data
3.1.3.3 Data on Potential Public Health and Environmental Impacts
3.1.3.4 Data Required for Identification of Potential Response Actions
3.1.3.5 Data Required for Bench- and Pilot-Scale Studies
3.2 Title of Second SWMU (or CAMU)
4.0 Field Sampling Plan
4.1 Task (or Area) Sampling Plan
4.2 Title of First SWMU (or CAMU)
4.3 Title of Second SWMU (or CAMU)
5.0 Implementation of Field Sampling Plan
5.1 Management Plan
5.2 Schedule
6.0 Quality Program Plan
7.0 Health and Safety Program Plan
7.1 General Requirements
7.2 Site-Specific Requirements
7.2.1 First SWMU (or CAMU)
7.2.2 Second SWMU (or CAMU)
8.0 Records Management Plan
9.0 Community Relations Plan

The outline may be modified for a given OU, but each plan must comply with RFI guidance, permit requirements, and regulatory requirements. DOE/UC RFIs will also comply with the substantive requirements of CERCLA. The outline is designed to guide the development of the RFI toward a logical and reasonably minimized sampling program by moving from the analysis of existing data to identifying data gaps in the conceptual model and finally to proposing a sampling plan to fill those gaps. One of the first responsibilities of the project leader during the development of the work plan will be to identify logical aggregations of SWMUs in a manner that facilitates the RFI in accordance with the definition in proposed Subpart S. Sampling programs can then be conducted on CAMUs or SWMUs, as appropriate. Proposals to modify Table A of the HSWA Mod-

ule (based on a project leader 's request after research to determine the likelihood of a release) will be located in Section 3 of the work plan.

3.5.2 Field Investigations

Project leaders will implement RFI work plans according to the schedules provided in those work plans approved by EPA. Subpart S defines the scope of field investigations conducted to characterize a SWMU and/or its contaminants. Such investigations may include, but are not limited to, characterization of the environmental setting; characterization of SWMU(s) from which releases have been or may be occurring; descriptions of human populations and environmental systems that are, have been, or may be exposed to releases; information that will assist EPA in the conduct of a risk assessment; extrapolations of future movement, degradation, and fate of contaminants; laboratory, bench-scale, or pilot-scale studies (as appropriate); and statistical analyses to aid in data interpretation. The ER Program Office intends to comply, to the extent practicable, with the detailed guidance for conducting RFIs provided in Volumes I, II, and III of EPA's interim final RFI guidance (EPA 1989). The investigations will be carried out such that site characterization will provide sufficient information to make reasoned decisions on whether further action is needed. Characterization will be focused so that needed actions can be implemented in a timely manner. Thus, in most investigations full characterization will not be necessary. Specific requirements for RFIs are mandated in the HSWA Module. Compliance with these requirements is discussed below.

3.5.2.1 Goals of Resource Conservation and Recovery Act Field Investigations

Although the scope of the RFI is defined by the objectives discussed above, the actual goals are to determine whether individual SWMUs or CAMUs contain or will release hazardous materials into the environment in concentrations great enough to require CMSs and to provide adequate data for performing CMSs. Section 3.5.2.3. discusses the techniques to be used to ensure that adequate data are collected during the RFI for CMSs. Such criteria are derived using conservative exposure scenarios and a health protection goal of 1×10^{-6} excess lifetime cancer risk for carcinogens and a goal of no deleterious effects over a lifetime as the result of exposure to systemic toxicants.

3.5.2.2 Action Level Criteria

The DOE/UC will adopt the action level criteria that EPA published in the preamble to the proposed Subpart S regulations (Appendix F) as a starting point for initiating CMSs. Using statistical analysis as appropriate, project

leaders will compare concentrations of hazardous waste and its constituents found in each SWMU and CAMU with EPA's proposed action levels to determine the need for restoration. However, the detection of contaminants in concentrations greater than those of the action level criteria does not always indicate the need for corrective action. A further site-specific risk assessment based on hazards to human health and the environment may indicate that no action is appropriate.

The DOE/UC recognizes, however, that the current list of action level criteria is incomplete. Therefore, when a hazardous constituent is detected for which no action level criterion exists, the following rules from EPA (1989, 1990) will be used for deriving an action level criterion, regardless of the medium:

- Applicable federal and state health standards must be applied [e.g., those for maximum contaminant levels (MCLs)].

- Concentrations must be determined in a manner consistent with the principles and procedures set forth in EPA guidelines for assessing the health risks of environmental pollutants.

- Toxicology studies must be scientifically valid and must be conducted in accordance with good laboratory practice standards in 40 CFR 272 (EPA 1989).

- Concentrations must be consistent with a 1×10^{-6} upper-bound excess cancer risk for Class A and B (known and probable, respectively) carcinogens, and Class C (possible) carcinogen concentrations must be set consistent with a 1×10^{-5} upper-bound excess cancer risk.

- Concentrations of systemic toxicants should be set so that a human population could be exposed on a daily basis without appreciable risk of adverse effects over a lifetime.

- If available information is insufficient to permit compliance with the five rules listed above, background concentrations will be developed and used for action level criteria.

Action level criteria for groundwater apply only to aquifers. As defined in 40 CFR 260.10, an aquifer is a geologic formation, group of formations, or part of a formation capable of yielding a significant amount of groundwater to wells or springs.

Groundwater action level criteria will be the MCLs or as calculated by Appendix F, Table F-1. EPA action level criteria for compounds not listed

in Appendix F will be established using the rules listed above and the standard exposure scenario of ingestion of 2 L/d of untreated groundwater for a 70-kg adult over a 70-yr lifetime.

Surface water is defined as "waters of the United States." The implementing regulations of the CWA, 40 CFR 122.2, define "waters of the United States" as lakes, rivers, streams (including intermittent and ephemeral streams) and other surface water bodies (and their tributaries) that could be used for recreational purposes, fishing, or industrial purposes. Because most canyon streams in the Los Alamos area are intermittent or ephemeral tributaries to such surface water bodies (e.g., the Rio Grande), the DOE/UC will apply action level criteria for the surface waters described below to canyon stream water.

Proposed Subpart S specifies that state water quality standards expressed as numerical values established pursuant to CWA Section 303 should be used as action level criteria. When numerical standards are not available, proposed Subpart S specifies the use of MCLs as action level criteria (Appendix F). When hazardous constituents are found in surface water and if no promulgated standard or EPA-calculated concentration exists (Appendix F), project leaders will propose action level criteria using the rules above and the standard exposure scenario of ingestion of 2 L/d of untreated surface water for a 70-kg adult over a 70-yr lifetime. For comparison with the action level criterion, the DOE/UC will measure concentrations of hazardous constituents at or near the point or points where releases from SWMUs enter the surface water.

EPA (1990) intends that action level criteria for air apply at the facility boundaries. This application is inappropriate for the Laboratory because the public can approach a number of potential source areas via uncontrolled access roads. For this reason, DOE/UC will apply action level criteria for air at the point of closest public access to the SWMU or CAMU under investigation. Air-monitoring locations for SWMUs or CAMUs likely to contain volatile hazardous wastes or constituents will be identified in the appropriate RFI work plan.

The DOE/UC will use EPA's proposed action level criteria for air (Appendix F). Project leaders will use applicable, promulgated state and/or federal air standards when constituents are found for which EPA has not calculated an action level. If no standard is found, project leaders will develop action level criteria using the rules above and an exposure scenario of 20 m^3/day of air inhaled by a 70-kg adult over a lifetime of 70 yr.

The DOE/UC will apply the EPA-derived action level criteria shown in Appendix F to shallow soils, sediments, and saturated soils that are not part

of an aquifer. EPA calculated its levels based on an exposure scenario of ingestion of 0.1 g/day of carcinogen-contaminated soil by an adult weighing 70 kg over a 70-yr lifetime and 0.2 g/day for a 16-kg child for noncarcinogenic toxins. This scenario is appropriate for soils to which the public may be exposed daily (e.g., surface and near-surface soils). Because EPA has not recommended action level criteria for sediments or saturated soils that are not part of an aquifer, the Laboratory will use soil action level criteria for these media.

If contaminants are detected in unsaturated deep soils at concentrations in excess of EPA's action level criteria for surface soil, the RFI will assess whether contaminants in the deep soil might be found in an aquifer in concentrations exceeding action level criteria for groundwater. Determination that such a potential exists would trigger a CMS. However, if contaminants are shown to be stable or if they will be diluted so that they do not appreciably affect the aquifer by the time they migrate through the vadose zone, the project leader may suggest in the RFI report that a CMS is unnecessary. If an EPA-derived soil action level criterion for a particular constituent is not available, the project leader will have to develop a criterion using the rules stated above.

The DOE/UC, in cooperation with EPA, will develop action level criteria for radiation. These criteria will be presented in later updates of this IWP.

3.5.2.3 Approach to Resource Conservation and Recovery Act Field Investigations

The approach discussed in this section is designed to minimize the number of samples and the amount of time needed to determine whether a CMS is necessary and to support the performance of a CMS or the design and implementation of a corrective measure. Data needs for field investigations are identified after existing data have been analyzed and potential corrective action alternatives have been evaluated. This approach allows the project leader to focus the investigation on sufficiently fine-tuning a conceptual model of an SWMU or a CAMU to support a CMS or to design a corrective action on those occasions when a preferred alternative can be selected early in the process. The ER Program Office intends to use Laboratory statisticians to assist in developing statistically valid and reasonably minimized sampling plans (Appendix H). This approach will ensure a valid comparison with established action level criteria and will maximize the overall efficiency of the sampling program. In addition, the ER Program Office in conjunction with faculty from UC (Los Angeles) is developing a pilot study to evaluate efficient sampling designs that are cost-effective. The frameworks for decision making and for assessing the relative costs and benefits associated with collecting data are described in Appendixes I and J.

The overall approach described here is consistent with the observational approach advocated by the DOE. Appendix K provides two hypothetical case studies that demonstrate in a general fashion how this approach will be applied to SWMUs and CAMUs at the Laboratory.

The ER Program Office proposes a three-phase approach using sequential sampling, which is an approach to site characterization that often allows all three phases to be conducted concurrently. Phase I of the RFI consists of a records search and/or sampling program designed to confirm that hazardous waste has been or could be released to the environment. In Phase II, it is determined whether action level criteria have been exceeded and a CMS is required. Phase III involves the collection of any additional data necessary to support a CMS or to design a corrective action alternative. The theory and application of the phased approach are described in Appendix H.

As a matter of policy, the ER Program intends to create, implement, and audit against its own standard operating procedures (SOPs). SOPs will govern all of the sampling and analysis methods described for Phases I, II, and III. The ER Program Office is currently preparing SOPs.

In many cases, EPA has required an RFI for a particular SWMU or CAMU because current evidence suggests, but is not conclusive, that a release has occurred or may occur in the future. Thus, the primary goal of Phase I of the RFI is to confirm that a SWMU or CAMU is releasing or may release hazardous waste.

Laboratory personnel will conduct standard reconnaissance activities to identify and locate releases from SWMUs and CAMUs. Personal interviews, existing drawings, maps or archive data, geophysical surveys, and invasive sampling may all be used to delineate the boundaries of SWMUs and to identify adjacent affected areas and geomorphological characteristics. Specific geophysical techniques may include use of ground-penetrating radar to investigate natural soil and rock conditions and to identify the location of buried waste, pipes, and other discrete objects; electromagnetic induction to locate areas of disturbed soil and chemical spills; magnetometry to locate buried metallic objects; and borehole logging.
In addition to geophysical techniques, surveys of soil gas and other invasive field methods may be used. A gas chromatograph/mass spectrometer (GC/MS) currently being converted to a portable unit may be used to screen environmental media for the presence of organic contaminants. Although the ultimate purpose of this instrument will be to provide quantitative results for both volatile and semivolatile organic compounds, it can also run in a semiquantitative mode and provide results for volatile compounds in as little as 5 to 10 min per sample.

The DOE/UC is evaluating the following techniques for screening metals in the field. These techniques are expected to save time and money in Phase I because they eliminate most of the usual sample preparation and dissolution. If appropriate, funding will be sought from OTD to develop these techniques.

- X-Ray Fluorescence (XRF)—The Analytical Chemistry Group (CLS-1) has proposed to develop a rapid, inexpensive, on-site XRF screening method to analyze solids for several trace elements, including silver, arsenic, barium, chromium, cadmium, mercury, lead, selenium, and uranium. The device may also be able to detect copper, nickel, antimony, tin, zinc, and other elements. This technique could be used to indicate the presence of trace element releases for purposes of Phase I sampling. XRF could also be used to quickly survey samples so that only those with elevated amounts of hazardous elements need be sent to a laboratory for analysis.

- Laser-Induced Breakdown Spectroscopy (LIBS)—The Photochemistry and Photophysics Group (CLS-4) is developing LIBS for the purpose of rapidly determining the elemental composition of soil, liquid, and air samples. The technique may be capable of identifying at least 10 elements.

- Glow Discharge Mass Spectrometry (GDMS)—The INC Division is proposing to apply GDMS to trace element analysis of soils. Analysis for silver, arsenic, barium, beryllium, cadmium, chromium, mercury, lead, selenium, uranium, plutonium, americium, and neptunium (including isotopic information) can potentially be performed automatically in as little as 10 min.

The DOE/UC is also concerned about screening for radiation in the field and currently has the capability to detect in real time gross alpha and gamma contamination. A portable FIDLER (for gross alpha) and a Phoswich detector (for gross gamma) are currently used for emergency response purposes. The ER Program Office is considering working with emergency response personnel to augment the types of instruments that can be used in the field for detecting radioactive releases. Increased detection capability would be especially useful when knowledge of the source indicates that any releases will consist primarily of alpha and gamma emitters, and, therefore, that tritium is not a concern.

Currently, HSE-8 screens all environmental samples for gross alpha, beta, and gamma activity before chemical analysis in HSE-9's laboratories. Samples that are above background are analyzed in dedicated laboratories and undergo the appropriate isotopic analyses. The ER Program will perform this operation in the field by purchasing a field instrument capable of simultaneously analyzing for gross alpha, beta, and gamma activity.

The results produced by some of the Phase I sampling techniques discussed above could guide the selection of locations for soil borings or surface soil samples, for monitoring the vadose zones, and for placing monitoring wells in alluvial and perched groundwater systems. Screening techniques such as those described above may also be used in the field to determine which samples should be submitted for laboratory (quantitative) analysis.

The goal of Phase II sampling is to determine whether a CMS is necessary based on a quantitative comparison of collected data with action level criteria. Thus, it is important that project leaders clearly specify the intended data uses and associated QA requirements in their work plans. In many cases, the goals of Phase I and Phase II can be satisfied in a single sampling effort.

Many of the Phase I techniques have shortcomings and cannot be used for a comprehensive comparison with action level criteria. The DOE/UC is proposing two techniques to expedite collection of quantitative data for organic and trace elements. These data will be compared with action level criteria to determine whether a CMS is necessary.

For the field analysis of organic contaminants, including volatile and semivolatile hazardous constituents, the DOE/UC proposes to use the GC/MS. This instrument is capable of generating Data Quality Levels III, IV, and V as defined by EPA (1987) and is, therefore, valuable for comparing data with action level criteria. A mobile laboratory (trailer) will be developed as a base of operations for site investigations lasting more than one day. The instruments will operate in a semicontinuous mode, pausing only to introduce samples and identify data files. Analytical results will be reported automatically within 20 to 40 min after analysis and data reduction have been completed. A discussion of the development, validation, and uses of the mobile GC/MS can be found in Appendix L. The ER Program will not use mobile GC/MS data for purposes other than screening until EPA is convinced that its performance parameters for evaluating solid wastes (EPA 1986) have been met.

The ER Program is considering using instrumental neutron activation analysis (INAA) to provide rapid quantitative trace element analyses in soils. The Laboratory's Omega West Reactor, operated by the Research Reactor Group (INC-5), is the only DOE facility in the country capable of running fully automated INAA. Although the INAA is capable of analyzing a large number of elements, there are three elements, thallium, beryllium, and lead, that cannot be detected by traditional INAA. Lead is a metal analyte listed as a RCRA hazardous waste. A modification of the INAA to include a photoneutron step will allow analysis of beryllium. Since soil samples have to be dried and ground for any analytical technique, it will be simple to take another sample split and submit it for quantitative XRF. This

technique will allow analysis of several metals but will be used primarily for lead and thallium. Although two analytical techniques will be used, it is expected that time and cost savings will be realized over the traditional techniques.

DOE/UC intend to pursue EPA functional equivalency for both the photoneutron-modified INAA and laboratory XRF with the EPA-approved methods, although both methods are expected to be used by the ER Program.

If radioactivity levels in samples are above background as defined by HSE-8, the samples will be submitted to a laboratory for the appropriate isotopic analysis and the results will be compared with action level criteria to determine whether a CMS is needed.

Once project leaders identify a release that requires remediation (Phases I and II), the expected conditions at the SWMU or CAMU are developed and the conceptual model of the site is refined. If necessary, additional (Phase III) data may be collected to demonstrate the need for a CMS. The following sections describe the options available and the techniques to be used to characterize a site and the surrounding environment for purposes of supporting a CMS or designing a corrective action. Again, many of the techniques described are also applicable to Phases I and II. In most cases, a CMS will require a risk assessment; thus, the methods described below will have to generate data of Data Quality Levels III, IV, and/or V (EPA 1987).

3.5.3 Field Sampling Methods

3.5.3.1 Soil Sampling

According to the SOPs listed in Appendix M, surface and near-surface soil samples may be collected using a spade and scoop, a stainless-steel surface-soil sampler, or a hand auger and thin-wall sampler. Sampling will be documented on field forms, and soil descriptions will be entered on a form for test-pit logging.

Soil borings may be taken to determine the vertical extent of contamination, to characterize the nature and volume of contamination, and to support the characterization of the unsaturated zone. Core samples may be collected from strategically placed boreholes to give further information about the contamination present. The selection of sampling locations will be based on the type of contamination, previous knowledge of the site, visual appearance, qualitative screening, and relative stratigraphic positions. To the extent possible, the number and type of samples analyzed for each boring will be specified in the work plans.

Soil water samplers may be installed to characterize the unsaturated zone to support or complement the work already completed in the unsaturated zone. It may be necessary to install soil moisture monitors or to collect soil water samples using soil suction instruments. Seasonal sampling of the unsaturated zone is important because fluxes in the shallow subsurface change seasonally in magnitude and direction.

3.5.3.2 Volcanic Tuff Sampling

Bandelier Tuff will be sampled at a variety of depths to characterize material disposal areas (MDAs) and other types of subsurface disposal facilities. Numerous successful boring programs have been conducted in the past. Hollow-stem auger drilling and split-barrel coring are likely be as the primary technologies used to sample the vadose zone (Bandelier Tuff) at Los Alamos for depths up to 150 ft. Below this depth, other conventional drilling methods may be selected, depending on site-specific drilling and sampling objectives. These methods would include mud rotary, air rotary, air rotary casing hammer, and dual-tube percussion.

In addition to sampling programs geared to identifying the chemical characteristics of the Bandelier Tuff, the physical and hydrogeologic characteristics are likely to be investigated because of the role of moisture and vapor transport in the matrix and fractures of the Bandelier Tuff. Where appropriate, the potential for migration of contaminants in the unsaturated and saturated tuff will be studied. Boreholes may be instrumented with a variety of testing equipment, such as downhole packers, thermocouple psychrometers, neutron moisture probes, heat dissipation probes, electrical resistance probes, and pressure transducers. The use of these instruments under certain physical conditions may not be appropriate, and their use will be determined based on the particular data needed from each borehole or study.

Parameters such as moisture content, porosity, permeability, unsaturated and saturated hydraulic conductivity, and matrix and fracture potential are likely to be obtained so that moisture or vapor movement in the vadose zone, perched water zones, or in the saturated zone at depth can be examined. The relationships between moisture content and matrix and fracture potential will provide important insight into the likelihood of contaminant transport under a variety of conditions.

3.5.3.3 Surface Water Sampling

Surface water will be sampled to help define the potential for sediment transport and contaminant migration via the surface water pathway. Characterization of the vadose zone, alluvium, and perched groundwater may be

enhanced by characterizing surface water flow. Surface water sampling can also be used to characterize the effect of water infiltration on potential movement of contaminants into the vadose zone and perched groundwater.

Sediments may be sampled to obtain information about the rate of contaminant movement, the amount of contaminant transported, and the distance contamination is transported during rain storms. This sampling may be performed in drainage areas within or adjacent to Laboratory boundaries.

3.5.3.4 Groundwater Sampling

There are three groundwater systems at Los Alamos: alluvial, perched, and deep aquifer. The DOE/UC currently collects groundwater samples from existing groundwater monitors and reports the results of these analyses annually as part of the Laboratory's routine surveillance program. No contamination from Laboratory activities has been found in the deep aquifer; therefore, the ER Program Office is not now planning to sample groundwater in that system. Routine sampling of the deep aquifer system will be reported in future environmental surveillance reports.

In compliance with Special Permit Condition C.1 of the HSWA Module, DOE/UC has expanded its perched-zone-monitoring system (Appendix N). This appendix provides details on installation of required wells, survey locations and elevations, and geologic logs and a map that delineates the extent of perched groundwater at the Laboratory. Samples were collected from these wells and will be analyzed for the parameters required in the permit. The report on these analyses will be submitted to EPA on December 19, 1990.

The information from the perched zone investigation, as well as information previously gathered at the Laboratory, will be used as appropriate as a baseline for RFIs. Additional data needs will be developed through individual OU work plans. These needs may include characterization of the presence and distribution of contaminants, water level measurements for potentiometric mapping, development of a conceptual model, vertical and horizontal extent of the aquifer, and hydraulic conductivity data.

3.5.3.5. Air Sampling

Air sampling may be necessary to further identify radionuclide concentrations in the atmosphere within Laboratory boundaries. This sampling would be concentrated around facilities that are currently the most likely sources of above-background airborne radionuclide concentrations. Any sampling would be done to supplement current environmental surveillance. During invasive sampling, particulate and organic vapor levels will be monitored

on a site-specific basis to protect the health of the sampling team. The data obtained will be used to determine the need for additional air quality sampling during site characterization.

3.5.3.6. Biota Sampling

Biological systems have been routinely sampled in the past. Further ecological investigation will be carried out in the RFI to provide the basis for an ecological risk assessment.

3.5.4 Waste Management

Proposed Subpart S states that wastes may be moved around or consolidated within the boundaries of a SWMU or CAMU without triggering land disposal restrictions (LDRs). The Laboratory proposes to manage wastes generated during the RFI process in a manner consistent with this proposed regulation; thus, disturbed soil and borehole cuttings will be returned to their place of origin within SWMU and CAMU boundaries.

If well construction or groundwater sampling generate a large volume of contaminated wastewater (so that discharge to the ground is likely to spread contamination beyond the unit boundary), the sample will be packed in drums for testing and appropriate disposal. Disposal of any packaged liquid wastes will depend on the results of analytical tests of samples drawn from the drums. A composite sample will be taken from each lot of five drums. If the material in a lot is determined to be hazardous, that lot will be disposed of at a licensed hazardous waste facility. If the material in a lot is determined not to be hazardous, it will be disposed of at the Laboratory. Solid wastes, such as disposable booties or overalls, contaminated paper, plastic wrap, and other items generated during the sampling task, will be considered hazardous wastes for disposal purposes. The sampling team will ensure that these materials are disposed of properly in accordance with the Laboratory's waste management plan (Appendix B).

3.5.5 Sample Handling, Tracking, and Documentation

All data collected in the field will be recorded on field forms and entered in the data base as described in the Records Management Plan (Annex IV). Field observations and other pertinent information about sample collection will be recorded in ink in bound logbooks. Each notebook will be identified by a document control number. The cover of the notebook will contain the following information: organization, document control number, project number, start date, and end date. Each page of the field book will be signed by the person entering information, and no blank spaces will be left. When corrections are made, a single line will be drawn through the incorrect

entry, and the person making the entry will initial the correction. Information will be legible, even after the line has been identified as incorrect.

The sample coordination system, which is to be implemented by HSE-9 for the ER Program, is described in Appendix O. This appendix covers all aspects of sample handling, including sample numbering; chain of custody; on-site transportation; sample delivery, receipt, scheduling, and preparation; and disposal of excess material and sample containers. The ER Program Office intends to use HSE-9 as a sample clearinghouse so that even samples submitted to external laboratories adhere to procedures defined in the sample coordination system.

3.5.6 Analytical Program

Appendix P provides a comparison of the standard analytical program for hazardous constituents at the Laboratory and EPA methods. Analysis for those compounds indicated with a "Y" in the right-hand column of Appendix P will be the extent of the Laboratory's attempt to identify hazardous wastes in samples. These wastes are the compounds that can be analyzed with confidence using accepted EPA methodologies (EPA 1986). The list will be expanded if site-specific process knowledge indicates a need or if EPA requires a broader analysis.

3.5.7 Resource Conservation and Recovery Act Facility Investigation Reports

The HSWA Module of DOE/UC's permit to operate the Laboratory requires several different reports associated with RFI: (1) monthly and management reports, (2) technical progress reports, (3) investigative analysis reports, and (4) RFI reports (with associated summaries). Monthly and quarterly reports will be submitted to EPA, NMEID, and DOE.

Within 60 days of the completion of the RFI, the Laboratory is required to submit an RFI report and a summary report. The 60-day period will begin at the time DOE determines that the RFI has been completed (e.g., approval of the working draft of an RFI report). The Laboratory proposes to include an executive summary as a stand-alone section of the RFI report to fulfill the obligation to submit a summary report. Consistent with proposed Subpart S, the executive summary will also be submitted to interested parties on the facility mailing list. The ER Program Office will develop a standard RFI report outline for EPA review and approval to be included in the first revision of this IWP. It will be several years before the first RFI report is prepared.

It is the policy of the ER Program Office to see that RFI reports comply to the extent feasible with EPA's RFI guidance. At a minimum, the reports will describe the procedures, methods, and results of field investigations and will include information on the type and extent of contamination, sources and migration pathways, and actual and potential receptors. The report will contain adequate information to support further corrective action decisions (e.g., comparisons with action level criteria). Project leaders will make the report available to the public through the FIMAD.

All deliverables to EPA must be accompanied by the following certification, which must be affirmed by the responsible DOE and UC authorities:

> I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

3.6 CORRECTIVE MEASURES STUDY

This section provides information to satisfy the requirements of Sections K, L, M, N, parts of O, and Q of the HSWA Module. The CMS process will be developed and implemented in accordance with the guidance presented by EPA (1988) and proposed in Subpart S.

If required by EPA, DOE/UC will submit for review and approval a Corrective Measures Study Work Plan (CMS plan) that lays out the activities to be conducted during the CMS. The draft CMS plan is due to EPA within 90 days of notification of the requirement to conduct a CMS. EPA will review and approve the CMS plan or will suggest revisions to DOE/UC.

DOE/UC implementation of the study will commence no later than 15 days after they receive written notification of EPA approval of the CMS plan. DOE/UC will conduct the CMS in accordance with the approved CMS plan, and the CMS will include

- evaluation of performance of the remedy(ies),

- assessment of the effectiveness,
- assessment of time required for implementation,
- estimation of costs for implementation, and
- assessment of institutional requirements.

The draft CMS report will be prepared within 60 days after completion of the CMS. The draft report will be based on the results of the study, evaluating corrective measures and recommending the final corrective measure for the release site or groups of sites (OU). EPA will approve the proposed DOE/UC remedy based on the proposed remedy's ability to meet the criteria established for selection of the remedy. The criteria will be developed through implementation of the CMS process as discussed in the following sections. At a minimum, these criteria will address

- standards for remedies,
- remedy selection criteria,
- schedule for remedy implementation,
- media cleanup standards, and
- compliance with media cleanup standards.

Because of the wide variety of potential release sites at the Laboratory, each study will be tailored to the needs of each site. In many cases, site conditions may not require extensive evaluation of several alternatives. Often, a less detailed study will be required than is discussed in the following sections. In those cases in which there are a limited number of possible remedies, the process will be as focused and streamlined as possible, consistent with the nature and extent of contamination, to expedite the cleanup process. In those instances in which there is only one obvious remedy, DOE/UC will propose that single option, which may be a conditional remedy. For example, in-place stabilization with long-term monitoring and institutional controls will be proposed for several MDAs at the Laboratory. Proposed implementation of a conditional remedy approach is discussed in Section 3.8.

The two technical teams that will have a significant impact on the implementation of CMSs as discussed in detail in this section are the Analytical Instrument and Method Development Team and the Site Assessment and Remediation Technologies Team.

3.6.1 Corrective Measures Study Work Plan

The first step in the process of selecting alternatives for remedial action is to prepare the CMS plan. The CMS plan is used to identify and develop a scheme for evaluating alternatives for final remediation of the SWMUs or CAMUs within OUs. The plan will provide sufficient information to allow EPA to evaluate the appropriateness and adequacy of the activities proposed for evaluating potential cleanup alternatives. The CMS is to be flexible enough to allow evaluation and proposal of only one alternative whenever site-specific conditions permit. Each OU-specific CMS will be unique to the environmental setting and to the nature of contamination within the unit.

The Laboratory has not yet developed an outline for the OU-specific CMS plan, but this information will be completed and included in a later IWP for EPA review and approval. The overall Laboratory RFI/CMS schedule is such that no OUs will be in or near the CMS phase of the process before that time. The CMS plan will be consistent with the requirements of proposed Subpart S and with the scope of work for a CMS, Section Q, Task VI, of the HSWA Module. At a minimum, the plan will contain

- a description of the general approach to investigating and evaluating potential alternatives (e.g., only reasonable alternatives will be considered);

- a definition of the overall objectives of the study;

- a description of the specific remedial alternatives to be studied;

- a plan for conducting treatability (bench- or pilot-scale) studies to determine the suitability of alternatives for site restoration;

- a plan for evaluating remedial alternatives to ensure compliance with the standards for remedies as specified in proposed Subpart S as approved;

- a schedule for conducting the CMS; and

- a proposed format for the presentation of the results (CMS report and technical memorandum).

In addition to the requirements discussed above, HSE-8 will review the CMS plan outline to ensure that adequate information will be available to determine whether the plan for each OU complies with NEPA requirements. DOE/UC propose to integrate RCRA and NEPA compliance through the CMS process. The CMS plan will be used to trigger a preliminary NEPA determination, and the CMS report will satisfy DOE's NEPA

requirements for an EA, if it has been determined that an EA is required. The scope and period of performance of the CMS will be adequate to meet NEPA requirements for an EA. In the event that a full environmental impact statement (EIS) is required, the CMS report will be a support document for that effort.

After receiving written approval of the CMS plan, revised as necessary, DOE/UC will initiate work on the study within 15 days. The conduct of the OU-specific CMS will comply with the CMS plans approved by EPA, consistent with the scope of work for a CMS provided in Section Q of the HSWA Module, Task VII, and other specified permit requirements. The scope and level of technical detail in the study will be adequate to allow DOE/UC to propose a remedy based on the results of the study and to allow EPA to review and approve that choice. The evaluation of the alternative(s) will be based on technical, environmental, human health, and institutional concerns.

3.6.2 Corrective Measures Study Report

Within 60 days of completing the CMS, a draft report will be prepared that summarizes the results of that study. The preliminary results of the study may be provided to EPA by means of a technical memorandum, as specified by EPA when approving the CMS plan. The format of the CMS report is not presented here but will be developed as part of the CMS plan. At a minimum, the report will present the evaluation of alternatives consistent with the scope of work for a CMS report described in the HSWA Module and proposed Subpart S.

The primary purpose of the CMS report is to enable DOE/UC to justify and recommend a corrective measure for EPA approval. The report will include a detailed description of the remedies assessed and will describe how the proposed remedy meets the standards for remedies specified in the CMS plan. The primary criteria from which the standards for selecting the remedy will be developed are

- long-term reliability and effectiveness;
- reduction of toxicity, mobility, or volume;
- short-term effectiveness;
- implementability; and
- cost.

Within 120 days of receipt of the draft report, EPA will approve or request a revision of the CMS report. EPA's response will consider comments received from NMEID and the public. DOE/UC will finalize the draft CMS report, incorporating comments received from EPA within 30 days of receipt.

3.7 SELECTION OF THE REMEDY

In selecting a final remedy, the EPA will evaluate the proposed alternative in light of several criteria to determine whether the alternative meets the requirements of proposed Subpart S. The basic decision factors to be used in this evaluation are discussed in the following sections and include

- general standards for remedies,
- factors considered in selecting the remedy,
- schedule for implementing the remedy,
- standards for cleaning up various media,
- determination that remediation of a release is not required,
- demonstration of compliance with cleanup standards, and conditional remedies.

3.7.1 Standards for Remedies

The CMS will generate data sufficient to evaluate potential remedies for their ability to meet the following standards:

- protect human health and the environment,
- attain established cleanup standards,
- control the source of release, and
- comply with waste management requirements (as required under proposed Subpart S).

These standards are broad and include the major technical requirements for controlling sources, conducting waste management activities, and cleaning up the environment. Waste management requirements for those sites that require excavation may be met through use of the proposed MWSDF to be developed at the Laboratory. Compliance with media cleanup standards

will be to the extent practicable. In all cases, however, the overriding concern in selecting remedies will be protection of human health and the environment.

3.7.2 DECISION FACTORS

In order for DOE/UC to propose and for EPA to select a remedy, five specific criteria from proposed Subpart S will be considered for the four general standards presented above.

- long-term reliability and effectiveness;
- reduction of toxicity, mobility, or volume;
- short-term effectiveness;
- implementability; and
- cost.

The decision factors for each proposed remedy for different OUs may be weighed differently because conditions at the OUs vary. Trade-offs may be possible for some factors, but the overriding concern in remedy selection will be protection of human health and the environment.

3.7.3 Schedule for Remedy Implementation

DOE/UC will provide a schedule for implementing the proposed remedy to EPA for approval. As appropriate, the schedule will address the following factors, although additional factors may influence the timing of the implementation:

- extent and nature of contamination,
- capability to implement remedy,
- availability of treatment technology,
- desirability of currently unavailable technologies that may offer significant advantages,
- potential risks related to implementation of the remedy, and
- any other relevant factors.

DOE/UC recognizes the need for innovative and more cost-effective remedial technologies (Section 3.6). The products expected from the two teams responsible for developing instrumentation and methods should offer distinct advantages over currently available technologies. Although DOE/UC recognize that work must begin now on new and improved technologies (e.g., downhole monitors and stabilization strategy), it is conceivable that the desired technologies will not be fully developed at the time the remedy is selected. In such cases, DOE/UC may propose that EPA postpone selecting a remedy until these technologies are functional if there is a distinct technical, time, or cost advantage to do so.

3.7.4 Media Cleanup Standards

Media cleanup standards will limit contaminant concentrations to levels that protect human health and the environment. Existing standards primarily address drinking water. Therefore, the DOE/UC will use health-based risk assessments to determine the effort needed to clean up most contaminated soils, sediments, and soil vapor. Factors to be considered in determining cleanup standards include multiple contaminants, sensitive receptors, site-specific exposures, the effectiveness of the proposed treatment, and current and future land uses.

Risk-based determinations will be consistent with proposed Subpart S, which proposes that "cleanup standards for carcinogens shall be established at levels which represent an excess upperbound lifetime individual risk between 1×10^{-4} and 1×10^{-6}" Cleanup standards for noncarcinogenic toxicants will be established to allow daily exposure without appreciable risk of deleterious effects during a lifetime.

Cleanup levels may be raised or lowered, depending on the circumstances at individual sites. Such circumstances may include a determination that concentration levels of certain contaminants must be lowered to protect human health and the environment, higher concentrations will be permitted because background levels are elevated, and groundwater that is not a potential source of drinking water or is not hydraulically connected to a drinking water source need not meet drinking water standards. In addition, the technical feasibility of remediation will be taken into account.

DOE/UC will propose for EPA approval the specifics for compliance with established cleanup standards. This proposal will address point of compliance, monitoring and sampling locations, analytical parameters and methods, statistical analyses, and length of time required for monitoring restored sites.

3.7.5 Determination That Cleanup Standards Cannot Be Met

Some sites at the Laboratory may involve full cleanup, i.e., soil excavation, treatment, or some other method that physically removes the contaminant from the environment. However, there are several sites at the Laboratory from which it would be impractical to physically remove all contaminants. Therefore, the definition of cleanup must include other remedies that involve controlling migration of contaminants from a source.

As used in proposed Subpart S, cleanup refers to any measure taken to ensure protection of human health and the environment, not to total removal of a contaminant. Areas of widespread, low-level contamination, such as the canyons that drain the Laboratory site, are locations that may not be required to attain media cleanup standards. For example, low levels of risk to human health resulting from contamination in local canyons would not be significantly reduced by cleanup because contaminant concentrations are so close to background levels. Thus, cleanup will be approached on a case-by-case basis, and it will be the responsibility of DOE/UC to demonstrate to EPA that remediation would provide no significant reduction in risk.

One of the primary remedial measures that the Laboratory intends to propose for several MDAs is in-place stabilization followed by long-term monitoring, when an RFI supports such an approach (Appendix Q). This choice would not meet media cleanup criteria because the contaminants would remain in the environment. However, remediation of these large, mixed-waste landfills would be an extremely large and complex undertaking. In these cases, DOE/UC intend to propose that technical impracticability precludes attainment of media cleanup standards.

3.7.6 Demonstration of Compliance with Media Cleanup Standards

DOE/UC will propose for EPA approval several conditions for demonstrating that implementing a remedy complies with the cleanup standards. Those requirements include identification of

- the location where the compliance levels must be achieved,

- the sampling and analytical methods that will be used to determine compliance, and

- the length of time that DOE/UC must monitor a site to demonstrate that cleanup levels have not been exceeded.

The primary limiting cleanup standards for the Laboratory will be those for soils and sediments. In general, the point of human exposure will be the

likely compliance location. However, it may be that the point of compliance for some sites will have to be determined on a case-by-case basis. The Analytical Method and Instrumentation Development Team may provide innovative and unique methods and instrumentation for monitoring compliance, including a variety of downhole sensors and high-speed analytical units for use in the field. EPA approval of these methods and instruments for several OUs will be requested in future revisions of this IWP. Approval of those specific to an OU will be proposed in the CMS report for the individual unit.

3.8 CONDITIONAL REMEDIES

When EPA cannot select a final remedy or when both DOE/UC and EPA agree that it is in the interest of the environment to delay implementation of the final remedy (e.g., to complete technology development), conditional remedies may be proposed and approved. Such remedies include prompt corrective measures that can reduce risk or incomplete cleanup when a total cleanup is impractical. Conditional remedies are appropriate for actively managed, financially viable facilities such as the Laboratory. When a conditional remedy is used, the site must be revisited after a pre-established period to determine whether the remedy can be considered final and certified as complete before terminating the schedule of compliance specified. Several criteria must be met before implementation. These criteria include

- protecting human health and the environment,
- achieving media cleanup standards beyond the facility boundary,
- preventing further significant environmental degradation,
- implementing institutional controls,
- continuing monitoring, and
- complying with waste management standards.

DOE/UC will propose site stabilization and long-term monitoring and institutional controls as a conditional remedy for some of the large MDAs, which are similar to large municipal landfills. The concentrations of contaminants in hazardous materials in the MDAs that meet criteria for conditional remedies do not currently threaten human health. Institutional controls currently provide long-term control of access and prevent potential exposure of Laboratory workers. The potential for contamination of the main aquifer is limited throughout the Laboratory site and is even more

limited at the MDAs. For these reasons, DOE/UC believe that site stabilization and institutional controls will protect human health. Required long-term monitoring will control further degradation of the environment, although existing contaminant concentrations will not be reduced.

As practicable, the conditional remedy will be identified in the RFI work plan, and data collection will focus on obtaining adequate information to evaluate the effectiveness of the likely remedy. The RFI will be structured to support the ultimate selection of the proposed remedy. When possible, a treatability study will be incorporated in the RFI work plan, and the findings of that study will be presented in the RFI report. Data generated through the RFI will provide EPA with a sufficient basis for selecting a remedy that protects human health and the environment.

Where the results of the RFI support a single obvious remedy for which extensive pilot testing has been performed, a formal CMS will not be conducted and the proposed remedy will be presented to EPA as part of an RFI report. Based on the results of the RFI, DOE/UC will request that the permit be modified to allow a conditional remedy. Upon EPA approval, DOE/UC will prepare a CMI plan for implementing the remedy. The CMI plan will provide for obtaining adequate information to design and implement the remedy, maintenance plans, schedule, QA program, progress reports, and a proposal for determining a complete and final remedy.

Because DOE/UC intend to propose in-place stabilization with long-term monitoring as a remedial alternative for some SWMUs, it is acknowledged that, to ensure compliance, sensitive and dependable instruments will be required for long-term monitoring; therefore, DOE/UC have initiated several efforts to develop appropriate equipment, such as polymer film field sensors, optical fiber-flow optrode, fieldable Raman with fiber optics, and tritium plume detectors.

DOE/UC realize that conditional remedies may not be final remedies. Therefore, DOE/UC propose that the remedy decision be reviewed after a period of implementation to compare the performance of the conditional remedy with established remedy standards. The conditional remedy may be declared the final remedy at that time, or EPA may require further corrective action to supplement or replace the conditional remedy. Final remedy selection and termination of the permit will comply with the procedures described in Section 3.9.

3.9 PERMIT MODIFICATION FOR SELECTION OF THE REMEDY

The preliminary selection of the remedy based on EPA's response to the CMS report will be finalized by a major modification of the Schedule of

Compliance given in the HWSA Module. The EPA will modify the permit to specify the remedy selected through the CMS process. The permit modification will be conducted according to the procedure established in proposed Subpart S, consistent with Section N of the HSWA Module. The modification process will include a formal public comment and revision period before the written notice of the permit modification is issued, not before reissuance of the permit.

The remedy specified may be separated into phases, and the proposed modification will include

- a description of the technical features of the remedy;
- the media cleanup standards established through the CMS process;
- requirements for achieving compliance with media cleanup standards;
- requirements for complying with waste management standards, land disposal restrictions, etc.;
- requirements for final disposition of the equipment used to implement the remedy;
- schedule and major milestones for implementing the remedy, including submission of the CMI plan; and
- reports and documentation to be submitted by DOE/UC during the implementation of the remedy.

3.10 CORRECTIVE MEASURES IMPLEMENTATION

DOE/UC will prepare a CMI plan after approval of the permit modification and upon request by EPA. The outline for the DOE/UC CMI plan has not been developed but will be submitted for approval in a future revision of this IWP, consistent with proposed Subpart S. In general, the CMI plan will include

- remedy design, i.e., detailed construction plans and specifications to implement the selected remedy;
- type and frequency of reports to be submitted on the progress of implementation;
- type of EPA reviews of implementation;

- requirements for completion of the remedy; and
- determination of technical impracticability.

3.10.1 Remedy Design

The CMI plan will contain a section that provides detailed construction plans for implementing the remedy. In some cases, the technical details may have been provided in the CMS report. The CMI plan may cite those specifics and propose to EPA that they be adopted in the final design. In either case, EPA approval of the CMI plan will constitute approval of the remedy design and schedule. The remedy design should include

- design specifications for SWMUs,
- implementation and long-term maintenance plans,
- major milestones,
- project schedule, and
- a QA plan for the construction.

EPA will approve or revise the CMI plan, and DOE/UC will implement the remedy as approved. The approved CMI plan will be placed in the ER Program's reading room (Annex V). DOE/UC will provide written notice of the availability of the approved plan to all individuals on the ER Program mailing list. In addition, the cost estimate provided in the CMS report will be revised as necessary.

3.10.2 Progress Reports

Remedies may involve long-term monitoring, institutional controls, or other activities that take place over an extended period. DOE/UC will submit monthly management and quarterly technical progress reports on remedy implementation. Depending on the type of remedial action being implemented, it may be necessary to provide frequent and detailed information about the effectiveness and progress of the remedy. DOE/UC will maintain information developed during implementation in the FIMAD and will make it available for public review.

The schedule and content of the progress reports will be developed in the CMI plan and will thus be tailored to each OU. The reports may include

- summaries of progress,
- problems encountered and resolutions,
- personnel changes,
- upcoming work for the next reporting period, and
- laboratory and field sampling reports.

3.10.3 Review of Remedy Implementation

EPA will periodically review the progress of the remedy and may recommend modification of the schedule of compliance or additional remedial measures. The reviews may consist of reviews of the progress reports and visits. Because each remedy will require varying levels of EPA oversight, CMI plans will be tailored to each site according to the level of review and progress evaluation required.

3.10.4 Completion of Remedies

The CMI plan will contain the criteria to be used to demonstrate completion of the remedy. Upon completion of the remedy, DOE/UC will submit a request for termination of the schedule of compliance for the corrective action. The request will contain a certification that DOE/UC have met or exceeded all of the criteria established for this purpose. The request to EPA will include verification that

- all media cleanup standards have been achieved,
- actions required for source control have been satisfied, and
- procedures for final disposition of equipment and materials associated with the remedial action have been followed.

EPA will review the request, along with public comments, and determine whether the remedy has been completed in accordance with the requirements of the HSWA Module and CMI plan. After such determination, the EPA will modify the HSWA Module to terminate the schedule of compliance for the corrective action (Section 3.11).

3.10.5 Determination of Technical Impracticability

For numerous reasons, it may be technically impractical to achieve compliance with the requirements for the remedy. DOE/UC expect to minimize

such situations through the use of new and innovative remedial technologies developed by and for the Laboratory. However, if compliance is impossible for technical reasons, DOE/UC will propose that EPA modify the permit so that additional or alternate methods may be used. This approach will be developed further in an update of this plan.

3.11 Coordination of Corrective Actions with Resource Conservation and Recovery Act Closures

Eight sites (SWMUs or CAMUs) listed in the HSWA Module are subject to both the corrective action and closure provisions of RCRA (e.g., RCRA hazardous wastes were intentionally managed at these sites after November 19, 1980). DOE/UC will manage all of these sites in accordance with proposed Subpart S in a manner consistent with the management of all of the other SWMUs listed in the Laboratory's SWMU data base. As a result, the corrective action process will occur concurrently with the closure process, thereby satisfying both sets of regulations. It is understood that the NMEID will maintain its role as the lead regulatory agency for these sites in spite of the change in approach.

DOE/UC will implement this strategy for several reasons: (1) The RFI/CMS portions of the corrective action process ensure that releases are identified and mitigated as part of a final remedy (simple compliance with closure standards does not always guarantee mitigation). (2) The strategy allows for a consistent, coherent approach to environmental restoration [e.g., some CAMUs currently contain SWMUs subject only to RCRA Section 3004(u) and SWMUs subject to both sets of regulations. (3) This strategy prevents duplication of effort. (4) The strategy is consistent with the preamble to proposed Subpart S, which states EPA's intent to allow extension of closure deadlines as necessary to complete corrective actions.

ER Program project leaders will incorporate the closure sites in RFI work plans and other activities associated with the corrective action process. The final remedy for these sites will be consistent with closure performance standards, and postclosure monitoring will continue if waste remaining in these sites releases concentrations of contaminants that exceed closure standards.

There are two categories of closure sites: (1) sites at which field work has been initiated or completed; and (2) sites at which work has not been initiated. For those sites at which closure activities have already been initiated (either under an approved closure plan or in accordance with institutional controls before a closure plan has been approved), DOE/UC will complete closure activities according to the standard approach and will document the work in the RFI work plans as voluntary corrective actions.

Because DOE/UC intend to close all of these sites in clean condition, the RFI work plans will probably not recommend further action. Sites at which corrective action (except the TA-40 scrap detonation site) has not yet been initiated will follow the integrated approach outlined above, which will involve delaying completion of closure activities until the RFI/CMS process has been completed. DOE/UC will pursue a letter of agreement with the state that delays at these sites are acceptable, thereby eliminating the need to revise existing closure plans.

3.11.1 Surface Impoundment for Burning Ground at TA-16

The approved closure plan for this task was received from the NMEID on February 21, 1990, and the closure was completed on September 20, 1990, according to the mandated schedule. To adhere to the strategy outlined above, the closure report will be appended to the RFI work plan for TA-16, along with an argument to remove the site from further consideration because it has met the cleanup requirements for closure.

Much of the field work had already been completed in accordance with the original closure plan (submitted February 6, 1989) when the new NMEID-approved closure plan arrived at the Laboratory. Water and sludge had been removed, treated, and disposed, and the liner had been removed, decontaminated, cut up, and drummed. Also, 12 verification samples had been taken from the bottom of the impoundment in accordance with the closure plan. However, the approved closure plan called for additional sampling of underlying soils, additional rinsing of the liner, and background composite sampling. Because the liner had already been cut up [telephone conversation with Dr. Elizabeth Gordon, NMEID (February 23, 1990)], the Laboratory obtained permission to incinerate the liner as hazardous waste off the Laboratory site in lieu of collecting additional samples.

In late April 1990, the analytical results for the 12 verification samples were received. Only 1 of the 12 samples was contaminated; it contained 29 ppb of tetrachloroethane and a duplicate sample contained 16 ppb PCE. A conversation with the NMEID (Dr. Elizabeth Gordon, May 10, 1990) indicated that this level of residual contamination is insignificant and that no further excavation was required. Dr. Gordon's position was confirmed in a letter from NMEID to the ER Program Office received on May 20, 1990. Thus, NMEID considers the site a clean closure that does not require postclosure monitoring. The Laboratory submitted a closure report with accompanying certification to the NMEID (copy to EPA) on September 19, 1990.

3.11.2 TA-35 Waste Oil Storage Pits

The DOE/UC submitted closure plans for two waste oil pits (#85 and #125) at TA-35 in October 1988, and NMEID gave oral approval to proceed with closure activities. In late March 1989, the contents of the pits were removed for incineration. In April, samples of the underlying soils at #125 obtained by chiseling through the liner showed contamination. Discussions between the Laboratory and NMEID indicated that a clean closure could be achieved even if residual contamination remained in place, provided that residual contaminant levels were below a health-based limit. NMEID agreed to leaving the contamination in place and calling it a "clean closure" if the Laboratory would restore the site to less than 1 ppm (volatile and semivolatile organic compounds) and would prove that the residuals were not a threat to human health. This strategy was adopted, and the closure, including backfilling, was essentially completed early in FY90.

Samples were taken during excavation to determine whether the contaminant levels in the remaining soil were acceptable. A review of the sampling results, however, indicated some weaknesses. First, holding times were exceeded for some of the volatile constituents. Second, detection limits for some analyses were skewed because of the presence of waste oil. Hence, a second set of verification samples will be obtained in FY91 by drilling through the fill. The purpose of the second analysis will be to determine the extent of contamination caused by waste oil (total hydrocarbons from petroleum) and to duplicate the analyses of volatile and semivolatile components. The DOE/UC will consult NMEID before deciding to further excavate the two former waste oil pits.

The closure plan for this site will have to be updated to reflect activities that actually occurred in the field. At a minimum, it will be necessary to document the agreement with the NMEID to develop a risk assessment and to report the results of the final verification sampling. The RFI work plan for TA-35 will report these activities as voluntary corrective actions performed for two SWMUs at TA-35. Because the corrective actions will result in a clean closure, the RFI work plan will probably not recommend further action.

3.11.3 TA-16 Area P Landfill

The closure of Area P presents a significant technical challenge. Clean closure seems impractical at this site, but it would also be difficult to encapsulate the landfill because it is located on a canyon rim. The existing closure plan, submitted in November 1985 and supplemented in 1987, proposed leachate collection and partial encapsulation. This plan has not yet been approved.

This site is an excellent example of the need for the integrated approach discussed above. In this case, a thorough RFI/CMS will resolve any outstanding issues and will lead to implementation of the most protective, cost-effective solution. The RFI/CMS could include a series of studies, including (1) an analysis of existing data and a proposal to define the extent of barium contamination, (2) an engineering study to develop the most effective cap design, and (3) bench-scale studies to determine the potential effectiveness of in-situ chemical fixation and/or leaching.

Thus, each of the RFI/CMS documents prepared during implementation of the corrective action process for TA-16 would be submitted to NMEID as modifications of the existing, unapproved closure plan. Approval of the final closure plan could then occur when the NMEID agrees with the corrective action alternative indicated in the CMS.

An alternative approach would be to modify the existing plan to simply reference the forthcoming RFI/CMS documents (as above), followed by NMEID approval of the plan. The DOE/UC would then submit the RFI/CMS documentation as a permit modification to an approved closure plan, in accordance with Subpart S, at the completion of the RFI/CMS process. The CMI plan, which would be incorporated in the closure plan, would have to take into account all of the applicable closure requirements (40 CFR 264.310), including the closure performance standard (40 CFR 264.111) and postclosure care requirements (40 CFR 264.117 through 264.120 and 264.310) if clean closure is not feasible.

3.11.4 TA-40 Scrap Detonation Site

The existing closure plan for this site (amended December 1985) is out of date. For example, it implies an intention to use the scrap detonation site as an active firing site, but the goal has changed to clean closure with no further use. In FY90, the ER Program Office prepared an updated closure plan for NMEID approval that would have triggered closure activities no longer consistent with DOE/UC plans.

Although field work has not yet been initiated at this site, DOE/UC will treat this work as an ongoing activity since the revision of the closure plan is complete and the plan is ready to be implemented. Nothing would be gained by delaying closure of this site until the RFI/CMS for TA-50 is complete since it is a simple, discrete site, and the closure plan now defines a logical approach to closure. Thus, the revised closure plan will be submitted as an amendment to NMEID in November 1990, and initiation of field activities will begin in FY91.

3.11.5 TA-54 Areas H, L, and G

Certain trenches, pits, and shafts in Areas H, L, and G qualify as hazardous waste landfill cells subject to partial closure. However, other units in these areas last received hazardous waste before 1980 and are therefore subject to corrective action under RCRA Section 3004(u). Thus, two different sets of cleanup regulations apply to units that are similar in content and geographic location.

The situation at TA-54 is similar to that at the Area P landfill, where the integrated approach is most appropriate, and TA-54 will be treated similarly. Although two separate closure plans have already been submitted, one for Areas L and H and one for Area G, an agreement with NMEID will delay implementation until the RFI/CMS has been completed and the closure plan has been revised.

3.11.6 TA-54 Area L Waste Oil Storage Tanks

With the oral approval of NMEID, six aboveground storage tanks containing waste oil were pumped out in FY89 and were moved from Area L to Area G to make room for new facilities. Although closure of these tanks was originally scheduled that same year, it was delayed to FY90 because NMEID had not approved the closure plan in FY89.

In early FY90, the Waste Management Group (HSE-7) expressed a desire to get rid of the tanks as soon as possible (for housekeeping purposes and to increase space in Area G). In order to decontaminate the tanks as quickly as possible, it was decided that the tank closure would not include any associated contaminated soil that may exist in Area L; any of this contaminated soil would be treated during closure and corrective action at Area L. The decontamination of these tanks was completed in FY90, and a closure report has been initiated. The closure report will document the work as it actually occurred in the field and will be incorporated in the RFI work plan for Area L and/or Area G. No further action will be recommended for the tanks themselves, but contaminated soil will have to be characterized and possibly cleaned up.

3.12 Interim Remedial Measures

The HSWA Module and proposed Subpart S provide for interim remedial measures (IRMs). The paragraphs below discuss the two types of IRMs to which EPA refers in Section I of HSWA Module. The DOE/UC will modify this section to make it consistent with the voluntary corrective action provisions in the preamble to proposed Subpart S.

3.12.1 Interim Remedial Measures Based on Health Risks

If EPA determines that a release of hazardous waste or its constituents poses a threat to human health or the environment, it may mandate that DOE/UC implement IRMs to mitigate the risk. EPA may also specify a schedule (by modifying the HSWA Module) for implementing the interim measure and may require the Laboratory to prepare and submit a work plan to be approved before action is initiated. To date, EPA has not required the Laboratory to take any IRMs because no imminent threats to human health or the environment have been identified. However, in the unlikely event that EPA requires an interim measure in the future, DOE/UC would modify the work plan. DOE/UC may at that time request EPA to modify the schedule of compliance for the corrective action.

Proposed Subpart S specifies that, in determining the need for IRMs based on health risks, EPA will consider at least the following factors:

- the time required to implement a final remedy;

- actual and potential exposure of human and environmental receptors;
- actual and potential contamination of drinking water supplies and sensitive ecosystems

- the presence of hazardous waste that may pose a threat of release;

- the presence of hazardous waste or constituents in soil that have the potential to migrate to groundwater or surface water;

- weather conditions; and

- risks of fire, explosion, or accident.

3.12.2 Interim Remedial Measures Based on Institutional Needs

Other IRMs referred to in the HSWA Module are triggered by institutional need. The HSWA Module states, "If, for institutional reasons not related to permit work, i.e. routine construction, an interim measure is required, the permittee will submit appropriate documentation to the Administrative Authority (EPA) for approval." Proposed Subpart S, published after the effective date of the HSWA Module, terms this category of IRMs "voluntary corrective actions." DOE/UC conduct interim measures based on institutional needs consistent with the proposed Subpart S provisions concerning voluntary corrective actions.

The institutional need for voluntary corrective actions at the Laboratory has been and will continue to be associated with construction projects, routine maintenance, and other activities. The Laboratory identifies the need for such actions during the normal review process used by the HSE Division to ensure that construction projects comply with environmental and safety laws, DOE orders, and Laboratory policies. Engineering Division construction project managers (CPMs) are responsible for ensuring that their plans are submitted to HSE for review before implementation. A central point of contact for CPMs has been established in HSE-3 from which plans are directed to the various organizations in HSE responsible for ensuring compliance with various laws and regulations. The ER Program Office is one of these organizations and is responsible for ensuring that CPMs are informed when their projects overlap with an identified SWMU or area potentially influenced by a SWMU.

All drawings, siting proposals, and other projects that could be affected by the presence of an SWMU are reviewed by the ER Program Office as part of the overall HSE review process. Procedures for ER Program Office review are provided in the Laboratory's SOP for the ER Program. The first step in the ER Program Office review process, illustrated in Figure 3-4, is to compare engineering plans with the SWMU data base to determine whether or not a potential conflict exists. When there is no overlap between the plans and an SWMU, HSE-3 modifies the CPM. If, however, excavation or some other activity is likely to be affected by an SWMU, the CPM is advised (through HSE-3) to consult with the appropriate ER Program project leader for interim measures.

The project leader will be concerned with three aspects of the project:

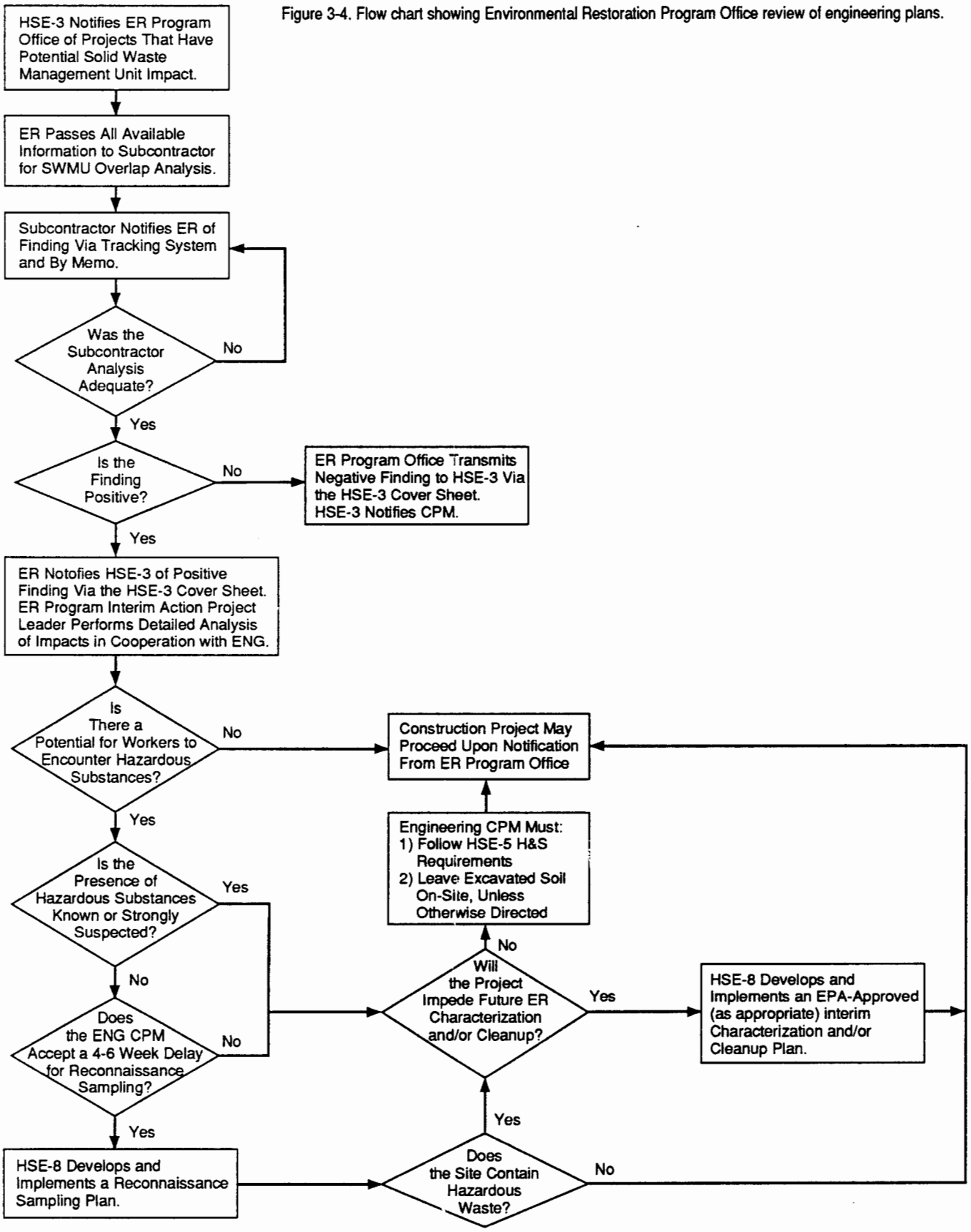
- health and safety of construction workers;

- whether construction workers will be generating hazardous waste subject to the RCRA hazardous waste management regulations, including land disposal restrictions; and

- whether the project will interfere with the ER Program final remedy (corrective action) for the SWMU.

To satisfy the first concern, the ER Program Office simply recommends that the CPM consult with HSE-5, HSE-3, and/or HSE-1 concerning matters of occupational health, worker safety, and radiation protection, respectively. The ER Program Office will assist these organizations in identifying any hazards that may be encountered in the field because of the presence of an SWMU.

Figure 3-4. Flow chart showing Environmental Restoration Program Office review of engineering plans.



The second concern, RCRA compliance, is referred to HSE-8, which is responsible for RCRA compliance. However, since the publication of proposed Subpart S, wastes can be moved around and/or consolidated within an SWMU or a CAMU without triggering LDRs. Adherence to this guidance will greatly simplify voluntary corrective action for construction projects. Where feasible, construction workers will be advised to leave disturbed or excavated soil from an SWMU or a CAMU on the site to avoid the issue of RCRA compliance. When this approach is not possible, HSE-8 and HSE-7 will provide guidance on the management of hazardous and/or radioactive wastes. This strategy will apply not only within existing SWMU boundaries but also to areas of contamination because the Laboratory will include such areas in CAMUs. For example, if drillers were to encounter the vapor plume outside of MDA-L, contaminated drill cuttings could be returned to the hole without triggering LDRs because this plume and all of Area L will be considered a single CAMU.

Resolving the third concern on a case-by-case basis will require a great deal of effort on the part of the ER Program Office. If ENG requires the placement of a permanent facility on an SWMU or within its area of influence, the ER Program Office must implement a voluntary corrective action consistent with the final remedy for that site, otherwise, the Laboratory runs the risk of having to interfere with operations at the facility should EPA require further action at the site. However, most engineering projects that overlap SWMUs do not involve placement of a permanent facility (e.g., a new underground waste line) that would interfere with the final cleanup of an SWMU or a CAMU.

As illustrated in Figure 3-4, a voluntary corrective action associated with the construction of a permanent facility can range from reconnaissance sampling to complete removal of the facility or other form of cleanup. If reconnaissance sampling indicates that the site of a proposed construction project is not contaminated, the project may proceed. However, if contamination is known to be present or is confirmed through reconnaissance sampling, the ER Program Office will perform some sort of voluntary cleanup to accommodate the project or will recommend that the facility be moved to an uncontaminated location.

It is important that the Laboratory obtain approval from EPA on voluntary corrective actions intended to serve as the final remedy. DOE/UC will submit to EPA for approval plans for voluntary corrective actions associated with the construction of permanent facilities that would interfere with mandatory ER Program work. If the Laboratory does not receive comments from EPA in a timely manner (e.g., one month) and if the Laboratory's management finds that the benefits of proceeding with the project outweigh the potential risks and costs associated with doing so without EPA ap-

proval, the Laboratory may choose to proceed with construction. Information concerning voluntary corrective actions not associated with permanent facilities will be provided to EPA upon request and will be reported in the monthly and quarterly reports required by the HSWA Module.

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■ **PROGRAM MANAGEMENT PLAN**

1.0 INTRODUCTION

1.1 BACKGROUND

The US Department of Energy (DOE) established its Environmental Restoration (ER) Program in 1987. DOE's ER Program operates within the Office of Environmental Restoration and Waste Management (EM), which also houses associate directorates for Waste Operations and Technical Development. EM presents its goals as well as projected schedules and coats in its annual five-year plan (DOE 1990a). The plan incorporates information provided in site-specific plans for each DOE installation, including Los Alamos National Laboratory (the Laboratory). This program management plan (PMP) describes the framework within which the DOE and the University of California (UC) are implementing the ER Program at the Laboratory.

1.2 OVERVIEW

In November 1989, the New Mexico Environmental Improvement Division (NMEID) issued a Resource Conservation and Recovery Act (RCRA) permit to the DOE and UC for operating the Laboratory. Additionally, on March 8, 1990, the Environmental Protection Agency (EPA) issued a Hazardous and Solid Waste Amendments (HSWA) Module, effective on May 23, 1990, to the RCRA operating permit. The HSWA Module mandates procedural requirements for assessing and remediating sites that meet the definition of solid waste management units (SWMUs).

The HSWA Module of the RCRA permit is documented in RCRA Sections 3004(u) and 3004(v) and in Sections 206 and 207 of the HSWA Module. RCRA Section 3004(u) provides for corrective actions to remediate continuing releases at permitted facilities, whereas RCRA Section 3004(v) provides for corrective actions of continuing releases beyond a facility's boundary.

The HSWA Module requires DOE/UC to complete the RCRA Facility Investigation/Corrective Measure Study (RFI/CMS) portion of the ER Program within ten years. The purpose of the RFI/CMS is to evaluate existing and potential environmental impacts resulting from SWMUs and to evaluate corrective measures proposed to mitigate these impacts. All corrective measures implemented at the Laboratory will comply specifically with RCRA regulations and the HSWA Module, the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as appropriate, the National Environmental Policy Act (NEPA), and other applicable regulations.

Laboratory sites that will be investigated include areas of concern and SWMUs which are aggregated into operable units (OUs) based on geographic location. The OUs will be assessed by means of the RFI/CMS and will be remediated by means of either corrective measures implementation (CMI) or RCRA closure, as appropriate.

The ER Program logic implementation concerning the RFI, CMS, and CMI is contained in the RCRA Corrective Action Plan (Figure I-1).

1.3 SCOPE

The primary responsibility of the ER Program is to formulate, assess, and implement remediation activities as required for SWMUs, or aggregates thereof [identified as corrective action management units (CAMUs) or OUs] at the Laboratory. The ultimate goal of the ER Program is to bring identified areas of concern or SWMUs and facilities into compliance with applicable environmental regulations and to protect public health and safety and the environment.

The scope of the ER Program includes

- implementation of RCRA Sections 3004(u) and 3004(v), the RCRA Facility Assessment (RFA), the RFI, the CMS, and corrective measures for existing SWMUs;

- implementation of CERCLA preliminary assessment/site investigation (PA/SI), remedial investigation (RI), feasibility study (FS), remedial design (RD), and remedial action (RA), as appropriate;

- remediation and closure of RCRA land units operated before March 1987, including underground storage tanks (USTs);

- decontamination and decommissioning (D&D) of surplus facilities;

- implementation of new technologies necessary to conduct cleanup;

- management of expenses associated with cooperative multiparty cleanup plans and activities;

- protection of natural resources or restoration of natural resources damaged as the result of past releases of hazardous substances;

- installation of long-term environmental monitoring systems; and

- conduct of CERCLA assessments necessary before accessing real property assets.

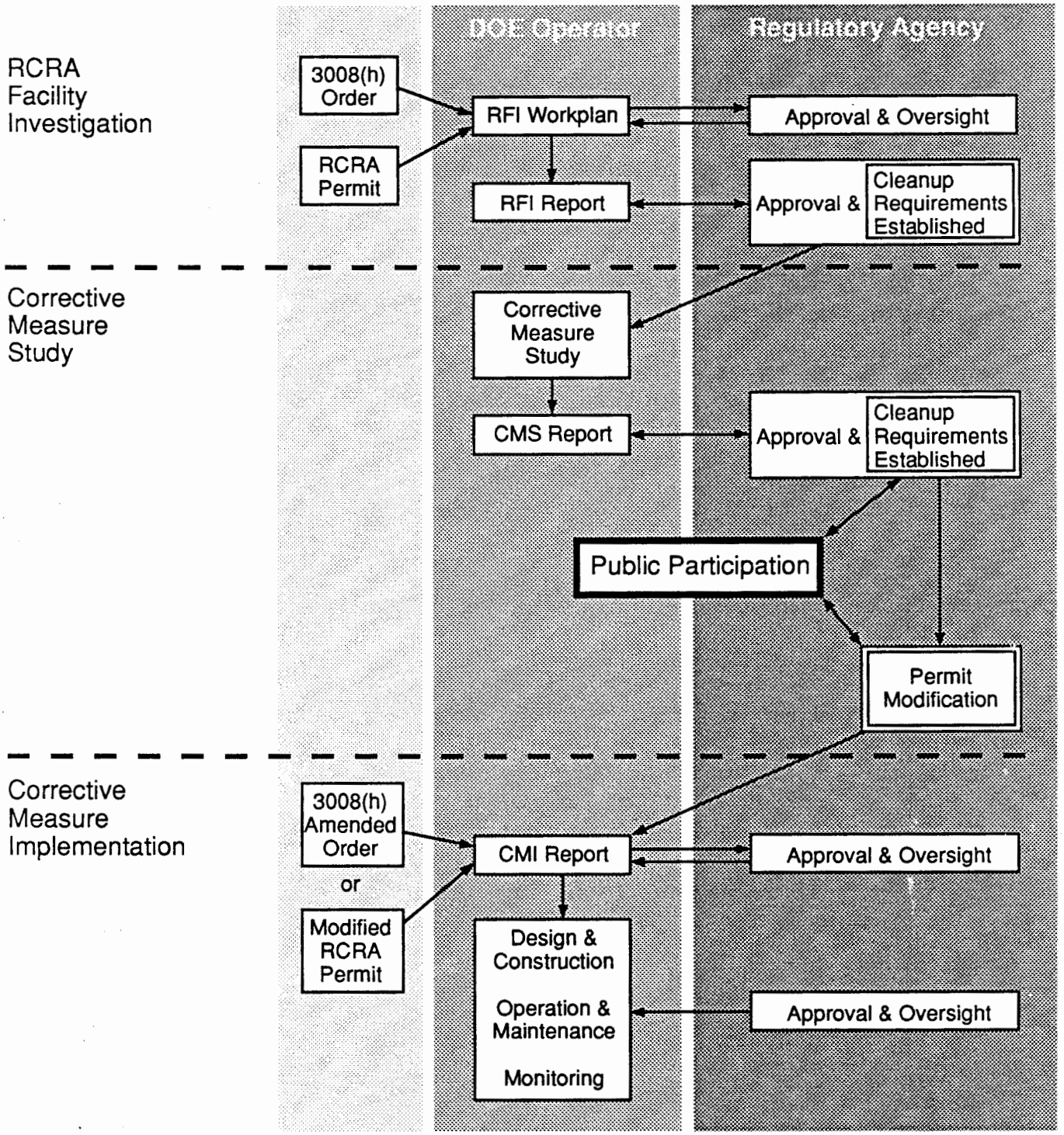


Figure I-1. RCRA corrective action process.

The EM D&D Program, although part of the ER budget category, is not covered by this PMP because they are separate programs. Limiting the ER Program to cleanup of contamination from past activities reflects a strategic decision not to reassign responsibility for management of hazardous wastes that are currently being generated in active processes and facilities.

This PMP describes DOE/UC's approach for the ER Program. The PMP sets forth the plans, organization, and systems that will be used by those responsible for managing the ER Program. This plan is based on the management principles outlined in DOE Order 4700.1, Project Management System (DOE 1987).

The principal regulatory requirements for the ER Program are derived from the statutory provisions of RCRA, CERCLA, NEPA, and the Atomic Energy Act (AEA). Requirements specified by responsible regulatory agencies of the State of New Mexico and Los Alamos County may supersede applicable DOE orders.

The ER Program will be planned and executed in accordance with applicable EPA guidelines.

1.4 KEY STATUTORY REQUIREMENTS

1.4.1 Principal Statutes

The principal requirements for the ER Program are those derived from RCRA Sections 3004(u) and 3004(v), CERCLA, AEA, and New Mexico state law. The ER Program must respond to RCRA concerns with the assessment and cleanup of sites under the jurisdiction of active installations. Section 3004(u) provides for remediation of all releases of hazardous waste. Section 3004(v) extends this requirement to contaminated properties located beyond the site boundary but in its vicinity. CERCLA is mainly concerned with the assessment and remediation of inactive sites; however, the ER Program will comply with applicable CERCLA requirements.

Hazardous materials are regulated under the provisions of both RCRA and CERCLA. Radioactive materials are regulated under the provisions of both AEA and CERCLA. The hazardous constituents of mixed waste are also subject to RCRA. RCRA and CERCLA define New Mexico's authority in the assessment and remediation process.

DOE Order 5400.1, General Environmental Protection Program (DOE 1989), establishes the environmental protection program requirements, authorities, and responsibilities for DOE operations to ensure compliance

with applicable federal, state, and local environmental protection laws and regulations, executive orders, and Laboratory policies.

The statutes described in the following sections form the basis for the ER Program technical performance criteria presented in Section 2.2 of this plan. A general list of the most current environmental permits for Laboratory operations is included as Table I-1.

1.4.2 Resource Conservation and Recovery Act

RCRA authorizes the establishment of hazardous waste management regulations governing the generation, transportation, treatment, storage, and disposal of hazardous and solid wastes and provides for the recovery of materials and energy resources from the wastes. HSWA Sections 201, 202, 203, 206, 207, 212, 215, and 224 modified Sections 3004 and 3005 of RCRA. HSWA requires corrective action for all releases of hazardous materials or hazardous constituents from any SWMU at a treatment, storage, or disposal (TSD) facility.

Under RCRA, permits are issued by EPA or by states that have received authorization from EPA to administer their own compliance programs. Although the NMEID has received state authorization to issue RCRA operating permits for managing hazardous and mixed wastes, it has no state authorization to enforce the regulations promulgated under the HSWA. Therefore, in New Mexico, EPA currently enforces HSWA regulations and will continue to do so until the NMEID acquires state authority for enforcement.

1.4.3 Comprehensive Environmental Response, Compensation, and Liability Act

CERCLA provides for the liability for, compensation for, cleanup of, and emergency response to the release of hazardous substances into the environment and the cleanup of inactive hazardous waste disposal sites. Under provisions of the National Contingency Plan, the EPA ranks facilities throughout the nation according to their potential hazard to human and environmental health and safety. The higher-ranking facilities are included on the National Priorities List (NPL) for near-term assessment and cleanup. The EPA's ranking of the Laboratory found no priority hazards, and therefore, the Laboratory is not on the NPL for cleanup under CERCLA.

Table I-1 Operating Permits for Activities at Los Alamos National Laboratory (October 1990)

Permit Type	Permitted Activity	Issue Date	Expiration Date	Administering Agency
RCRA hazardous waste facility	Hazardous waste storage, treatment, and disposal	November 1989[a]	December 1999	NMEID
	Postclosure care	Application submitted September 1988	—	EPA
HSWA Module	Corrective Activities	March 1990	December 1999	EPA
PCBs[b]	Disposal of PCBs	June 5, 1980	—	EPA
PCB oil	Incineration of PCB oils	May 21, 1989	—	EPA
NPDES,[c] Los Alamos	Discharge of industrial and sanitary liquid effluents	Modified permit May 29, 1987	March 1, 1991	EPA
NPDES, Fenton Hill	Discharge of industrial and sanitary liquid effluents	October 15, 1983[d]	—	EPA
Ground-water discharge plan, Fenton Hill	Discharge to ground water	June 5, 1985	June 1990	NMOCD[e]
NESHAP[f]	Construction and operation of four facilities using beryllium	December 26, 1985 March 19, 1986 September 8, 1987	—	NMEID

[a]Under appeal.
[b]Polychlorinated biphenyls.
[c]National Pollutant Discharge Elimination System.
[d]Renewal pending.
[e]New Mexico Oil Conservation Division.
[f]National Emission Standards for Hazardous Air Pollutants.

1.4.4 Integration of the Provisions of the Resource Conservation and Recovery Act and Comprehensive Environmental Response, Compensation, and Liability Act

Although the Laboratory is not on the NPL, some provisions of CERCLA apply for the following reasons:

- The Laboratory is a designated RCRA facility, and no owner or operator of a facility regulated under the Solid Waste Disposal Act (SWDA) may be indemnified under CERCLA.

- CERCLA is applicable if hazardous substances not regulated by RCRA are released into the environment or if a substantial threat of release exists.

- CERCLA specifies that the remediation requirement applies equally to federal and nonfederal entities.

1.4.5 Integration of the Provisions of the Resource Conservation andRecovery Act and the National Environmental Policy Act

NEPA provides a national policy to encourage protective environmental practices, to promote efforts that will prevent or eliminate damage to the environment, to enrich the understanding of ecological systems and natural resources, and to establish a Council on Environmental Quality (CEQ). In accordance with the provisions of DOE Order 5400.4, the requirements of NEPA and the process for assessment and cleanup under RCRA are integrated. In most cases, the primary instrument for this is the RFI/CMS process prescribed by RCRA. The process will be supplemented to the extent necessary to meet procedural and documentation requirements of NEPA. Such supplements might include the development of environmental assessments (EAs) or information for use in environmental impact statements (EISs).

The DOE has proposed a programmatic EIS (PEIS) to address implementation of the department's overall ER Program. This PEIS will describe corrective measures alternatives and their potential and cumulative impacts; however, it will not specify a remedial action decision for each area of concern. The appropriate regulatory agency (or agencies) will be responsible for selecting the necessary remedial action and alternative(s). Section 7 of "Environmental Restoration On-Site Remediation Program Management Plan" (DOE 1990b) describes additional mandates concerning NEPA conformance. Integration of NEPA and the CMS process is discussed in Section 3.6 of the Installation Work Plan (IWP).

1.4.6 Relationship to Other Statutes

1.4.6.1 Federal Statutes

The following federal acts also affect the conduct of DOE/UC's ER Program.

The American Indian Religious Freedom Act (AIRFA) of 1978 establishes a policy to protect and preserve for Native Americans their inherent right of freedom to believe, express, and exercise their traditional religions.

The AEA of 1954, as amended, authorizes energy research and development.

The Clean Air Act (CAA) of 1970, as amended, regulates emissions from a facility that could affect air quality. Such emissions must meet the performance standards established in this act.

The Clean Water Act (CWA) of 1972, as amended, seeks to restore and maintain the chemical, physical, and biological integrity of the nation's waters. The CWA regulates waste discharges into navigable waters and sets pretreatment standards for hazardous waste discharges into sewer lines that lead into publicly owned treatment works.

The Department of Energy Organization Act establishes statutory responsibility to ensure incorporation of national environmental protection goals in energy programs; to advance the goals of restoration, protection, and enhancement of environmental quality; and to ensure public health and safety.

The Department of Transportation Act of 1966 defines the US Department of Transportation's (DOT's) regulatory responsibility for safety in the transportation of all hazardous materials, including radioactive materials.

The Endangered Species Act (ESA) of 1973, as amended, requires federal agencies, "in consultation with and with the assistance of" the Secretaries of the Interior and Commerce, to ensure that their actions are "not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of the critical habitat of such species... ."

The Fish and Wildlife Coordination Act (FWCA) ensures that fish and wildlife resources receive consideration equal to that given other values during the planning of development projects that affect water resources. Final regulations which were proposed in 1979 and 1980 and withdrawn in

1982, have not yet been promulgated. Meanwhile, guidance for implementing the FWCA is based on court interpretations and past DOE experience.

The National Historic Preservation Act (NHPA) of 1966 requires federal agencies to take into account the effects of their proposed actions on properties listed on or eligible for the National Register of Historic Places.

The Occupational Safety and Health Act (OSHA) provides for the general welfare by ensuring that, so far as possible, every working man and woman in the nation has safe and healthful working conditions.

The Safe Drinking Water Act (SDWA), as amended, defines safety standards for public water systems. The maximum contaminant levels developed under SDWA are the levels with which drinking water must comply.

The Toxic Substances Control Act (TSCA), as amended, ensures that technological innovation and commerce in chemical substances and mixtures do not present an unreasonable risk of injury to health or the environment. TSCA provides for the identification of toxic hazards posed by chemical substances and regulates their discharge into the environment.

1.4.6.2 State Statutes

This section lists state statutes that apply to the Laboratory's ER Program.

The Air Quality Control Act (AQCA) of 1967 provides the basic framework for air pollution control in New Mexico.

The Emergency Planning and Community Right-to-Know Act creates an emergency management task force to develop and distribute to emergency response personnel a comprehensive plan for assessing and managing hazardous materials spills. This plan stipulates the requirements for reporting and performing cleanup activities.

The Ground Water Protection Act (GWPA) of 1990 provides for the regulation of hazards associated with leaks and spills from USTs, containment and remediation of pollution incidents, and funding of groundwater protection activities.

The Hazardous Chemicals Information Act (HCIA) establishes state-level systems of emergency planning and notification to deal with releases of extremely hazardous substances and to provide a means whereby members of the public can learn of the presence of hazardous chemicals used in their communities and of any releases of those chemicals.

The Hazardous Waste Act (HWA) of 1977, as amended, establishes the State of New Mexico's program for hazardous waste management and control. The state also has authority to regulate site closures under RCRA.

The Radiation Protection Act (RPA) establishes the general rule of radiation protection. The RPA specifies that levels of radiation be kept as low as reasonably achievable (ALARA) taking into account the state of technology and the economics of improvements in relation to public health and safety benefits and to the use of ionizing radiation in the public interest.

The Radioactive and Hazardous Materials Act prescribes the conditions for transporting radioactive material on the highways. Such conditions include a means of transportation that protects the health, safety, and welfare of the citizens and criteria for establishing the safest route.

The Solid Waste Act (SWA) of 1990 establishes a comprehensive statewide solid waste management program to regulate the reduction, storage, collection, transportation, separation, processing, recycling, and disposal of solid waste and to promote source reduction, recycling, reuse, treatment, and transformation of solid waste.

The Water Quality Act (WQA) gives the Oil Conservation Division (OCD) exclusive authority over the prevention of water pollution resulting from oil or gas operations.

1.4.7 DOE Orders and Secretary of Energy Notices

1.4.7.1 DOE ORDERS

The DOE orders applicable to the ER Program are listed below:

DOE 1324.2, Records Disposition
DOE 1332.1A, Uniform Reporting Systems
DOE 2200.1, Accounting Policies and Practices
DOE 2250.1C, Cost and Schedule Control Systems Criteria for Contract Performance Measurement
DOE 3790.1A, Occupational Safety and Health Program for Federal Employees
DOE 3791.1, Federal Employee Occupational Safety and Health Program Safety and Health Inspection and Abatement Procedures
DOE 4700.1, Project Management System
DOE 5000.3A, Unusual Occurrence Reporting
DOE 5100.3, Field Budget Process
DOE 5400.1, General Environmental Protection Program
DOE 5400.2, Environmental Compliance Issue Coordination

DOE 5400.4, Comprehensive Environmental Response, Compensation, and Liability Act
DOE 5400.5 Radiation Protection of the Public and the Environment
DOE 5440.1C, Implementation of the National Environmental Policy Act
DOE 5480.1A, Environmental Protection, Safety, and Health Protection Program for DOE Operations
DOE 5480.1B, Environment, Safety, and Health Program for Department of Energy Operations
DOE 5480.2A, Radioactive Waste Management
DOE 5480.3, Safety Requirements for the Packaging and Transportation of Hazardous Materials, Hazardous Substances, and Hazardous Wastes
DOE 5480.4, Environmental Protection, Safety, and Health Protection Standards
DOE 5480.10, Contractor Industrial Hygiene Program
DOE 5480.11, Radiation Protection for Occupational Workers
DOE 5482.1A, Environmental Protection, Safety, and Health Protection Appraisal Program
DOE 5482.1B, Environment, Safety, and Health Appraisal Program
DOE 5483.1A, Occupational Safety and Health Program for DOE Contractor Employees at Government-Owned Contractor-Operated Facilities
DOE 5484.1, Environment, Safety, and Health Protection Information Reporting Requirements
DOE 5500.1A, Emergency Management System
DOE 5500.2, Emergency Planning, Preparedness, and Response for Operations
DOE 5500.2A, Emergency Notification, Reporting, and Response Levels
DOE 5500.3, Reactor and Nonreactor Nuclear Facility Emergency Planning, Preparedness, and Response Program for DOE Operations
DOE 5500.3A, Emergency Planning and Preparedness for Operational Emergencies
DOE 5500.4, Public Affairs Policy and Planning Requirements for Emergencies
DOE 5700.2C, Cost Estimating, Analysis, and Standardization
DOE 5700.6B, Quality Assurance
DOE 5700.7A, Field Work Package Proposal and Authorization System
DOE 5820.2, Radioactive Waste Management
DOE 6430.1, General Design Criteria

1.4.7.2 DOE/AL Orders

DOE/Albuquerque Area Office (AL) orders applicable to the ER Program are

DOE/AL 5440.1B, Implementation of the National Environmental Policy Act
DOE/AL 5480.1A, Environmental Protection, Safety, and Health Protection Program for DOE Operations
DOE/AL 5481.1A, Safety Analysis and Review System
DOE/AL 5482.1A, Environmental Protection, Safety, and Health Protection Appraisal Program
DOE/AL 5484.1, Environmental Protection, Safety, and Health Protection Information Reporting Requirements

1.4.7.3 Executive Orders

Executive Orders (EOs) applicable to the ER Program are

EO 11988, May 24, 1977, Floodplain Management
EO 11990, May 24, 2977, Protection of Wetlands
EO 11991, May 24, 1977, Relating to Protection or Enhancement of Environmental Quality
EO 12580, Federal Compliance with the Requirements of Other Federal Agencies

1.4.7.4 Secretary of Energy Notices

Secretary of State Notices (SENs) applicable to the ER Program are
SEN-7-89, May 19, 1990, Policy on Line Management's Responsibility to Achieve Environmental Compliance
SEN-15-90, February 5, 1990, National Environmental Policy Act
SEN-24-90, June 25, 1990, Strengthening the Department of Energy Project Management System
SEN-25-90, July 24, 1990, Strategic Planning Initiative
SEN-27-90, August 15, 1990, Strengthening the Department of Energy Project Management System.

■ OBJECTIVES

2.1 PROGRAM OBJECTIVES

The objectives of the UC's ER Program are

■ to ensure that environmental impacts associated with past and present activities at the Laboratory are investigated and that appropriate corrective action is taken to protect human health and the environment;

■ to establish at the Laboratory a procedural framework and schedules for developing, implementing, conducting, and monitoring appropriate corrective actions that are in accordance with RCRA, CERCLA, and NEPA and their implementing regulations;

■ to identify all sites for investigation at the Laboratory;

■ to minimize duplication of analysis and documentation;

■ to expedite corrective actions with a minimum of delay caused by administrative procedures;

■ to provide both formal and informal mechanisms through which all interested entities (i.e., DOE, EPA, NMEID, and the public) can review, comment on, and generally participate in the corrective action review process for the Laboratory;

■ to conduct corrective actions consistent with the requirements of the HSWA Module and interim RFI/CMS guidance;

■ to conduct and manage the RFI/CMS, prepare preliminary and final design specifications, and evaluate the best available technology for implementation of corrective measures;

■ to conduct the ER Program in accordance with all applicable federal, state, and local laws, regulations, guidelines, and relevant DOE orders; and

■ to record plans, procedures, and costs and other data and prepare progress and technical reports so that the knowledge and experience gained early in the ER Program can be used to manage later elements in a cost-effective manner.

2.2 TECHNICAL OBJECTIVES

The overall technical objective of the ER Program is to effectively formulate, evaluate, implement, and manage the RFI, CMS, and CMI in a manner that ensures environmentally sound regulatory compliance and provides

protection of public health. This objective will be met in a cost-effective manner by using existing technologies or through pilot studies that demonstrate the efficacy of simple corrective measures.

The ER Program will implement the corrective measures required by CERCLA in a manner that complies with federal standards, criteria, requirements, and limitations that are determined to be applicable or relevant and appropriate requirements. Additionally, any New Mexico requirement that is more stringent than its federal counterpart will be attained, as appropriate.

2.3 SCHEDULE AND COST OBJECTIVES

The ER Program at the Laboratory will meet all applicable requirements of federal, state, and local regulatory agencies. The activities will be conducted to meet the conditions of the HSWA Module (Section 6). The cost of the ER Program will be kept as low as possible without diminishing the program's effectiveness.

2.4 QUALITY ASSURANCE OBJECTIVES

The basic intent of all quality programs is to ensure that appropriate controls are applied to a program, project, or activity; that the quality of the results is known and documented; and that the effectiveness of the controls, as implemented, can be evaluated. The UC's Quality Program Plan (QPP) (Annex II) states the quality assurance (QA) objectives and requirements applicable to the ER Program. ER Program activities will be planned, implemented, and maintained as required by the QPP.

The QPP has been prepared in accordance with Interim Guidelines and Specifications for Preparing Quality Assurance Program Plans (EPA 1980a) and NQA-1, Quality Assurance Requirements for Nuclear Facilities (ANSI/ASME 1989), as specified in DOE Order 5700.6B. The intent of the QPP is to present a comprehensive, coherent QA program compatible with both NQA-1 and QAMS. The approach taken will seek to satisfy the QA requirements of both the DOE and EPA. The guidelines established in the QPP will be implemented by ER personnel through written documents such as quality assurance project plans (QAPjPs), quality administrative procedures (QPs), and standard operating procedures (SOPs). The QPP describes the project to be controlled and the planned approaches for implementing QA controls. The QPs, QAPjPs, and SOPs describe in detail the means by which the QA controls will be implemented. QAPjPs will be prepared in accordance with QAMS-005/80, Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans (EPA 1980b).

2.5 HEALTH AND SAFETY OBJECTIVES

The ER Program is committed to performing its work in a manner that protects health or safety of UC workers and the public. ER work will also be conducted in a manner that protects the environment and in compliance with all applicable federal, state, and local laws and regulations; with all applicable DOE orders and health and safety standards for the Laboratory; with the UC's health, safety, and environmental standards; and with the health and safety requirements specified in the HSWA Module.

The Health and Safety Program Plan (H&SPP) (Annex III) describes the health and safety aspects of the ER work and is designed to identify, evaluate, and control safety and health hazards and to provide for emergency responses in conjunction with hazardous waste characterization and remediation operations. The H&SPP annex addresses ER Program organizational structure, employee training, medical surveillance, monitoring in the field for ionizing radiation and respiratory hazards, access control measures, decontamination procedures, emergency responses, and safety briefings for workers. Each OU will have a specific health and safety plan that addresses the hazards and risks at that unit, appropriate personal protective equipment, specific decontamination procedures, names and telephone numbers that might be needed in an emergency, and emergency responses for the location. Audits will be conducted to ensure that the H&SPP is implemented effectively.

2.6 RECORDS MANAGEMENT OBJECTIVES

The statutory definition of "records" includes technical data. The term is used in the Records Management Plan to reflect the need to protect all records essential to ER Program interests (Annex IV of the IWP). The specific activities implemented to achieve records management will be delineated in QPs and SOPs developed in cooperation with the Quality Program staff.

The Records Management Program ensures that records are managed to maintain their integrity and to ensure that ER Program actions retain an auditable set of documentation. The ER Program Office has established a records-processing facility for receiving and processing record packages and a Facility for Information Management, Analysis, and Display (FIMAD) to support the needs of program participants and the public. The latter facility will include the hardware and software necessary to capture, display, and analyze data.

ER Program records, including technical data sets, will be organized, indexed, stored, and protected to provide efficient access by a diverse group

of users. The plan will be consistently implemented to provide an auditable and legally defensible system for records management. The development of useful guidelines for handling record packages requires coordination with other parts of the ER Program such as quality, health and safety, resource planning, and community relations.

2.7 COMMUNITY RELATIONS OBJECTIVES

In accordance with the HSWA Module of DOE/UC's RCRA operating permit, a Community Relations Program Plan (CRPP) (Annex V) is being implemented as part of the ER Program. The purpose of the Community Relations Program is to provide to the public in a timely manner factual information concerning the ER Program portion of the UC's environmental management activities. Specifically, the CRPP will address the following objectives:

- to provide information about technical issues in the ER Program in a timely manner;

- to respond to communities' concerns about the ER Program in a manner that encourages two-way communication between the interested parties and the UC;

- to provide opportunities for education of the public in a manner that addresses the broadest audiences and a variety of educational backgrounds and technical expertise;

- to provide for timely public comment on ER Program activities within the regulatory framework;

- to provide for the general public a library that will contain documentation on past, current, and proposed activities concerning the ER Program; and

- to encourage public participation as a way of enhancing the public's understanding of the ER Program.

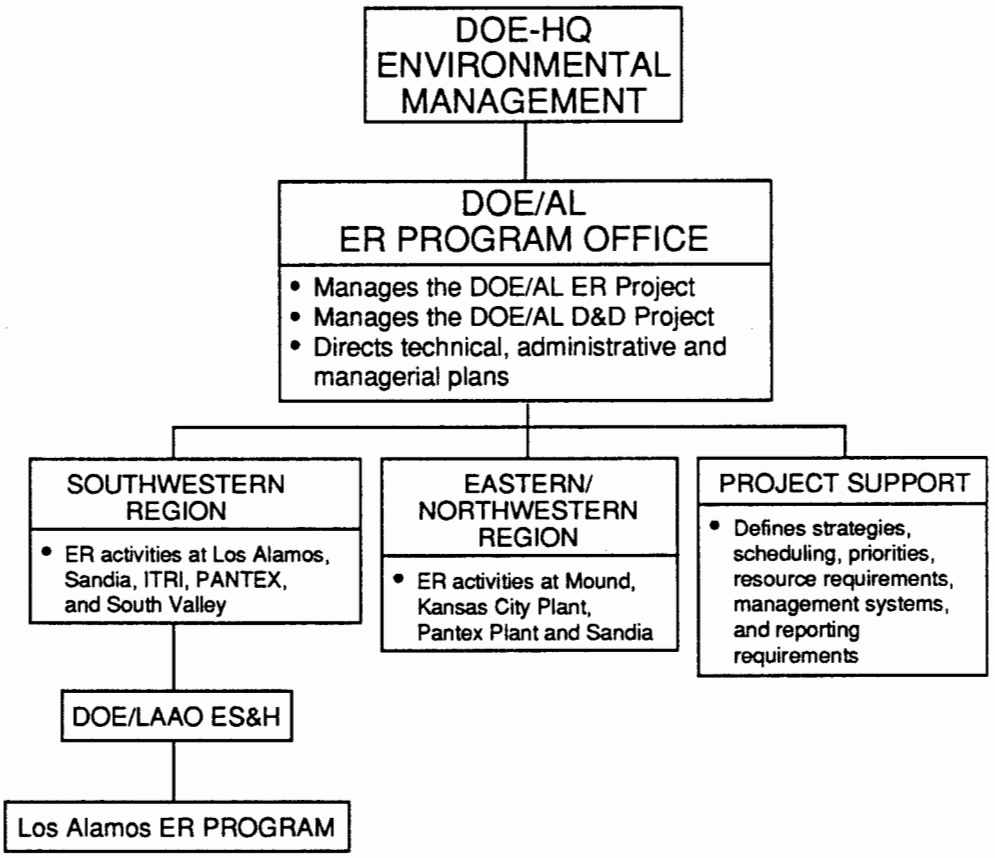
The CRPP describes the Community Relations Program. UC policy requires a proactive approach concerning the dissemination and exchange of ideas affecting the general public and UC employees at the Laboratory.

2.8 PROCUREMENT PLAN OBJECTIVES

The procurement objective of the ER Program is to follow Laboratory Procurement Policies and Procedures (LANL 1981), which have been

approved by DOE. The policies and procedures combine the tenets of the Federal Acquisition Regulation (FAR), the Department of Energy Acquisition Regulation (DEAR), UC Procurement Policy, federal laws, and the EOs. Subcontracts will be awarded competitively to the maximum extent practicable. Source selection in competitive procurement actions will be accomplished in general accord with the procedures of DOE's DEAR Handbook Source Evaluation Board.

Figure I-2. DOE/AL orgfanizational chart.



3.0 MANAGEMENT ORGANIZATION AND RESPONSIBILITIES

This section describes the ER Program organization structure and associated key responsibilities.

3.1 MANAGEMENT APPROACH

The DOE/AL Project Office is responsible for implementing the operations office's ER Program. The DOE/AL ER Project Office consists of three line divisions: Region of Southwest Projects, Region of Eastern/Northwestern Projects, and Project Support. The two regional divisions provide ER Program interface and oversight of remedial actions, whereas Project Support provides resource management, regulatory compliance, and project integration support to all projects. The DOE area offices and the management and operations (M&O) contractor execute and control the approved assessment and remediation tasks at their installations and provide support to DOE/AL.

At the Laboratory, the DOE/Los Alamos Area Office (DOE/LAAO) is the primary line of communication for day-to-day operations. DOE/LAAO interfaces with the DOE/AL ER Program Project Office. For policy matters and ER Program direction, the line of communication is through the area office managers.

3.2 ORGANIZATIONAL CONCEPT

The DOE/AL manager is ultimately responsible for conducting the DOE/AL ER Program. DOE/HQ delegates authority for conducting the DOE/AL ER Program to the DOE/AL ER Project Office. The DOE/AL ER Program organizational chart is presented in Figure I-2

The responsibilities of the DOE/AL ER Project Group include

- implementing management systems in accordance with environmental management guidance,

- providing programmatic guidance to DOE/LAAO,

- submitting prioritized task lists (based on submittals from DOE/LAAO to DOE's Budget and Resource Management Division (BRMD) for budget consideration,

- reviewing and approving the Laboratory's five-year plan,

- reviewing and approving the Laboratory's current-year work plan,

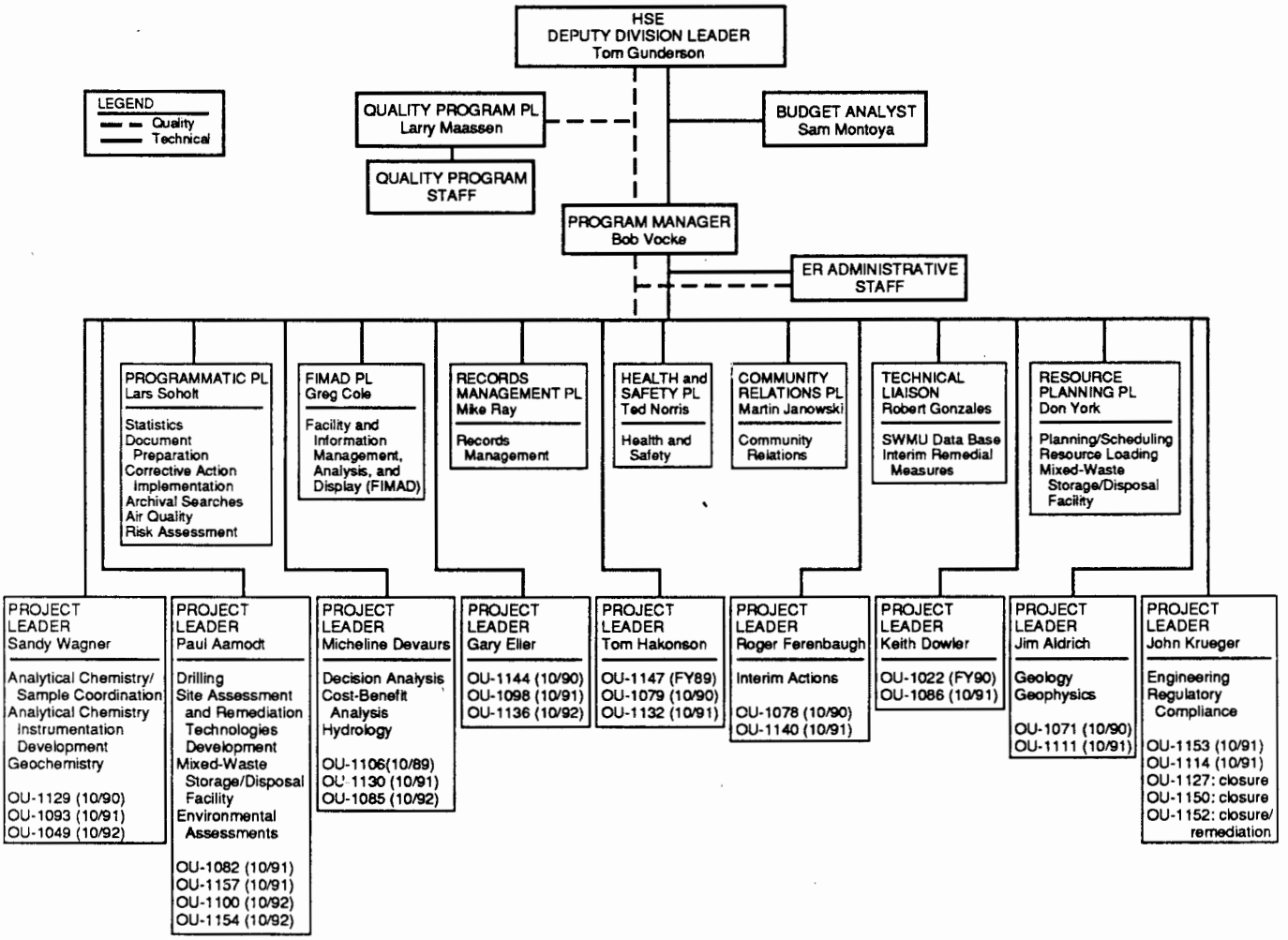


Figure I-3. The Laboratory's ER Program organizational chart. Dates in parenthesises are for start of work.

- reviewing RFI/CMS and NEPA documents,
- analyzing the Laboratory's cost and schedule status,
- reporting the Laboratory's status to environmental management,
- approving reallocation of funds among DOE/AL-approved tasks at the Laboratory,
- preparing and submitting required documentation, and
- participating with DOE/LAAO and UC in negotiations with regulatory agencies.

The functions of DOE/LAAO and UC include

- providing primary interface (including negotiations) with regulatory agencies,
- conducting community relations activities,
- conducting RFI/CMS activities,
- preparing and reviewing RFI/CMS and NEPA documents,
- distributing RFI/CMS documents for DOE and regulatory review,
- designing corrective measures design and implementing corrective measures required by CERCLA and RCRA 3004(u) and 3004(v),
- conducting activities related to RCRA closures, including NEPA documentation,
- proposing activities for budget year submittal,
- developing the Laboratory's five-year plan for RFI/CMS/CMI activities and RCRA closures,
- developing the Laboratory's current-year work plan,
- preparing monthly management reports,
- preparing quarterly technical progress reports, and
- preparing completion reports for completed CMI and RCRA closures.

The UC's ER Program organization and responsibilities are presented in Figure I-3 and Table I-2. Education and experience of key participants in the program are summarized in Appendix R.

3.3 PARTICIPANT RESPONSIBILITIES

The manager of the ER Program, who reports to the deputy division leader of the Health, Safety, and Environment (HSE) Division, is responsible for the overall management of the ER Program. The program manager

- ensures that the Laboratory's ER activities are consistent with the goals and objectives of the HSE Deputy Division Leader, DOE, EPA, NMEID, and others, as appropriate;

- ensures compliance with the HSWA Module;

- ensures compliance with change control procedures;

- conducts cost, schedule, and performance measurements;

- submits monthly and quarterly reports to DOE, EPA, and NMEID;

- tracks deliverables and milestones established by the DOE, EPA, and NMEID; and

- ensures the establishment, implementation, and support of the quality, health and safety, records management, and community relations programs.

The programmatic project leader

- serves as acting ER Program manager during the program manager's absence;

- works with the program manager and the HSE Deputy Division Leader to provide overall program coordination, oversight, and direction;

- interfaces with personnel and programs external to the ER Program Office, both inside and outside the Laboratory

OU project leaders

- oversee day-to-day operations, including planning, scheduling, and reporting of technical and related administrative activities;

Table I-2. ER Program Technical Teams

Technical Team	Technical Group/Division	Team Leader	ER Project Leader (Technical Team Coordinator)
Analytical Chemistry/ Sample Coordination	HSE-9,[a] CLS, INC	Chuck Rzeszutko	Wagner
Analytical Chemistry Instrumentation Development	HSE-9,[a] CLS, ERA, INC	Craig Leasure	Wagner
Geochemistry	INC,[a] CLS, ERA, INC	Dave Curtis	Wagner
Drilling	EES,[a] HSE	Bill Laughlin	Aamodt
Geology, Geophysics	EES, HSE	Bill Laughlin	Aldrich
Project Health and Safety	ER,[a] HSE-1,-2,-3,-5,-10, -11	Ted Norris	Norris
Community Relations	PA-3,[a] PA-1	Martin Janowski	Janowski
FIMAD	EES,[a] HSE-9	Greg Cole	Cole
Records Management	EES-1[a]	Mike Ray	Ray
Statistics	A-1,[a] EES-1, UCLA	Elizabeth Kelly	Soholt
Decision Analysis	A-1[a]	Kathy Campbell	Devaurs
Cost Benefit	A-4[a]	Linda Trocki	Devaurs
Hydrology	EES,[a] HSE, N-6, MEE-13	Micheline Devaurs	Devaurs
Site Assessment and Remediation Technology Development	HSE,[a] ERA, EES, MEE, INC	Harry Ettinger	Aamodt
Document Preparation	IS-9, -11, -12, OS-6	Lars Soholt (acting)	Soholt
Environmental Assessment	HSE-8, EES	Doris Garvey	Aamodt
Corrective Action Implementation (Remediation)	ENG,[a] HSE-7	Chris Loggains	Soholt
Interim Remedial Measures	ER,[a] ENG, HSE-8	Robert Gonzales	Gonzales
Mixed Waste Disposal Facility	MEE,[a] ENG, HSE-7	Don York	Aamodt
Quality Assurance	ER,[a] MEE-9	Larry Maassen	Maassen
Engineering (Conceptual — Title II)	ENG,[a] MEE	Chris Loggains	Krueger
Regulatory Compliance	HSE-8	Dave McInroy	Krueger
Planning/Scheduling/ Reporting	ER, HSE-DO, MEE-4	Don York	York
Solid Waste Management Unit Data Base	ER	Robert Gonzales	Gonzales
Air Quality	HSE-8,[a] EES-5	Craig Eberhardt	Soholt
Rick Assessment	ER,[a] EES, HSE-1, -5, -8, -10 -11, UCLA	Lars Soholt	Soholt
			QA Representative
[a]Proposed Lead			TBA

- ensure preparation of scientific investigation planning documents and procedures;

- prepare monthly and quarterly reports for the PM;

- oversee subcontractors, as necessary;

- coordinate with technical team leaders;

- conduct technical reviews of milestones and final reports;

- interface with the UC QPP leader (QPPL) to resolve quality concerns and coordinate audits;

- ensure compliance with the ER Program health and safety, community relations, and records management plans; and

- ensure compliance with the technical and QA requirements of the Laboratory's ER Program.

The QPPL is responsible for directing and managing the Laboratory's ER quality program. The QPPL operates independently from the cost and schedule of project management. The QPPL is not assigned duties that preclude full attention to QA responsibilities or that conflict with the reporting and resolution of QA issues and problems. The QPPL reports to the Program Manager (PM) on day-to-day activities and to the HSE deputy division leader when necessary to resolve QA issues. The QPPL

- ensures that the adequacy and effectiveness of the ER quality program is evaluated by independent organizations,

- verifies the implementation of the ER quality program by UC and its subcontractors,

- resolves disputes regarding quality,

- oversees a QA staff,

- assists project leaders in the development of QAPjPs,

- reviews and approves all ER QA program and project plans and implements procedures,

- ensures that QA audits are conducted, and

- serves as liaison between the Laboratory's ER QA Program and EPA's Regional Office of QA.

The Health and Safety project leader

- prepares the ER Program health and safety program and ensures its implementation;

- reviews OU-specific health and safety plans prepared by subcontractor or UC personnel;

- interfaces and coordinates with Laboratory personnel to use resources as appropriate for the ER health and safety program;

- ensures that the ER Program complies with applicable environmental regulations, DOE orders, UC requirements, and applicable state regulations;

- oversees the maintenance of the health and safety data base for the ER Program in such areas as worker training and medical surveillance; and

- prepares monthly and quarterly reports for the program manager.

The Community Relations project leader

- prepares the CRPP and implements its provisions;

- interfaces and coordinates with program personnel to use resources for the Community Relations Program;

- ensures that the Community Relations Program meets the requirements of the HSWA Module;

- serves as the primary interface between the public and the ER Program Office; and

- prepares monthly and quarterly reports for the program manager.

The FIMAD supports all electronic information needs of the ER Program at Los Alamos. The project leader for the FIMAD

- oversees development and continued operation of the FIMAD;

- conducts continued systems analyses of information processing needs and supervises the incorporation of these analyses in development of the FIMAD;

- oversees testing, evaluation, and purchase of requisite hardware and software;

- oversees development of quality implementing procedures and configuration management for the FIMAD;

- determines staffing needs and provides training and supervision for using FIMAD;

- initiates and maintains an active collaborative effort with local universities, the National Center for Geographic Information and Analysis (NCGIA), industry, and government organizations (foreign and domestic) in professional training, research, and applied technology;

- assists in technical projects at the FIMAD, such as development of graphic user interfaces, system integration and networking, development of operating system tools for back-up, security, and disaster recovery, and development of applications software to support two- and three-dimensional modeling, integration of raster and vector graphics, and still-video archival and retrieval across a network; and

- prepares monthly and quarterly reports for the program manager.

The project leader for records management

- provides a single contact for project participants with respect to matters regarding records and technical data,

- coordinates the flow of records to the FIMAD,

- develops and implements a records management plan,

- ensures that records management procedures comply with regulatory guidelines and requirements,

- standardizes documentation controls to ensure the integrity of data and records,

- initiates and oversees development of QA procedures to implement the QPP,

- assists with the identification of reporting requirements (including reporting frequency, formats, and types of information),

- serves as primary interface with the Laboratory's Communications and Records Management (CRM) Division for ensuring compliance with Laboratory records policy,

- collaborates closely with key ER Program personnel on records management issues, and

- prepares monthly and quarterly reports for the program manager.

The project leader for resource planning

- oversees development of a master logic network (schedule) for the ER Program,

- integrates the schedule with the work breakdown structure (WBS),

- supervises resource loading of the schedule for purposes of current-year and long-range planning to meet the requirements, of the HSWA Module,

- assists other project leaders in their resource planning efforts, and

- prepares monthly and quarterly reports for the program manager.

Technical team leaders

- assist in scoping activities,

- provide direction for team members,

- coordinate team activities with the project leader,

- review and ensure quality deliverables, and

- provide QP support.

3.4 MANAGEMENT PROCEDURES

A set of procedures composing the UC Management Control System (MCS) is being developed for application to all projects at the Laboratory. The MCS will be a set of policies, procedures, practices, computer systems, forms, reports, and documents that collectively provide for the systematic and effective management of projects.

4.0 STRATEGY FOR IMPLEMENTING THE ENVIRONMENTAL RESTORATION PROGRAM

4.1 PROJECT ELEMENTS AND DEFINITIONS

At present, the ER Program at the Laboratory is divided into 24 OUs for corrective action assessment (Table I-3). These OUs represent discrete facilities or concerns composing the major scope of the ER Program. The definition of these OUs has been based primarily on geographic location.

5.0 WORK BREAKDOWN STRUCTURE

A WBS is a graphic representation that completely defines a project by relating elements of work to each other and to the end product. A WBS is the primary tool that DOE uses in performing its project responsibilities. The individual products specified in the WBS are called elements. Each element is a discrete portion of the WBS; the element may be either an item of hardware, a service, or data. Descending levels of explanation provide increasingly detailed definitions of the end objective. The number of levels depends on the scope and complexity of the individual project and the degree of control it warrants.

A WBS shows the relationship of all elements supporting the project and provides a sound basis for technical cost and schedule control.

Each level of the structure is closely related to a management sphere within the project and provides the framework for relating time and cost summaries to appropriate levels of contractor, UC, and DOE management. A WBS provides both a basis and an integrating mechanism for managing key functions of the project. Uses of the WBS to support management control are

- planning and budgeting,
- funding,
- cost estimating,
- scheduling,
- performance measurement,
- configuration management,
- integrated logistic support,

Table I-3 LANL Activity Summary Schedule

ADS No.	Operable Unit Description	Start of Work Date
1049	Canyons Assessment	10/89
1062	Interim Remedial Measures Assessment	10/89
1063	Interim Remedial Measures Remediation	10/89
1106	TA-21 Assessment	10/89
1122	TA-33 Assessment	10/89
1127	TA-35 Waste Oil Storage Pit Closure/Remediation	10/89
1147	TA-50 Assessment	10/89
1153	TA-51, 54 Assessment	10/89
2106	Program and Information Remediation Management	10/89
2107	Program and Information Assessment Management	10/89
1150	TA-54 Area L Waste Oil Storage Tans Closure/Remediation	04/90
1066	NEPA Documentation Assessment	05/90
1067	RCRA Mixed Waste Storage and Disposal Facility	06/90
1071	TA-0, 19, 26, 73, 74 Assessment	10/90
1078	TA-1 Assessment	10/90
1079	TA-10, 31, 32, 45 Assessment	10/89
1111	TA-6, 7, 22, 40, 58, 62 Assessment	10/90
1129	TA-4, 5, 35, 42, 48, 52, 55 Assessment	10/90
1144	TA-49 Assessment	10/90
2110	Environmental Analytical Chemistry Facility	10/90
2115	TA-54 Area L Closure/Remediation	10/90
1082	TA-11, 13, 16, 24, 25, 28, 37 Assessment	10/91
1086	TA-15 Assessment	10/91
1093	TA-18, 27, 65 Assessment	10/91
1098	TA-2, 41 Assessment	10/91
1114	TA-3, 59, 60, 61, 64 Assessment	10/91
1130	TA-36, 67, 71 Assessment	10/91
1132	TA-39 Assessment	10/91
1140	TA-46 Assessment	10/91
1157	TA-8, 9, 23, 69 Assessment	10/91
1085	TA-12, 14, 65 Assessment	10/92
1100	TA-20, 53, 72 Assessment	10/92
1136	TA-43 Assessment	10/92
1154	TA-57 Assessment	10/92

- test and evaluation, and
- systems engineering.

Table I-4 is a numbered outline of the WBS applied by the DOE/UC's ER Program. The actual WBS numbering system may be modified in the near future to be consistent with the upper-level WBS nomenclature currently being developed by DOE. The fundamental units of the WBS are the OUs, management, closure, and other activities listed in Table I-3. Each one consists of one or more of the Activity Data Sheets (ADSs) contained in the current five-year plan. The ADS serves as DOE/EM's tool for projecting costs and schedules and requesting budget allocations.

The following documents describe the policy for managing DOE work and are pertinent to the use of the WBS:

- OMB Circular A-109, Major System Acquisitions
- DOE Order 4700.1, Project Management System
- DOE Order 5700.1A, Major System Acquisitions
- DOE Order 5700.3, Major System Acquisition Procedures
- DOE Order 5700.4, Project Management System
- DOE Order 4240.1A, Designation of Major System Acquisitions
- DOE Order 2250.1, Department of Energy (DOE) Cost and Schedule Control Systems Criteria for Contract Performance Measurement
- DOE Order 1332.1, Uniform Reporting System for Contractors.

6.0 ENVIRONMENTAL RESTORATION PROGRAM SCHEDULE

To develop realistic baseline and subsequent forecast dates, it is necessary to have relevant information from the completed and approved CMS. Such information will enable the determination of specific corrective measures that can be applied to feasible schedule objectives. In addition, funding availability, or the lack thereof, will significantly affect the timely implementation of any scheduled interim action.

Specific milestones, however, have been identified for the RFI/CM

- complete RFI work plan,

TABLE I-4. DOE/UC'S ER PROGRAM WBS

1. ENVIRONMENTAL MANAGEMENT
    - 1.1 MANAGEMENT
    - 1.2 WASTE OPERATIONS
    - 1.3 TECHNOLOGY DEVELOPMENT
    - 1.4 ENVIRONMENTAL RESTORATION
        - 1.4.1 MANAGEMENT
        - 1.4.2 INSTALLATIONS
            - 1.4.2.1 RESERVED
            - 1.4.2.2 LOS ALAMOS
                - 1.4.2.2.1 Management
                - 1.4.2.2.1.1 Remediation Management (2106)
                - 1.4.2.2.1.2 Assessment Management (2105, 2107)
                - 1.4.2.2.1.3 Quality Assurance
                - 1.4.2.2.1.4 Technical Data Management
                - 1.4.2.2.2 Health and Safety
                - 1.4.2.2.3 Community Relations
                - 1.4.2.2.4 Installation
                - 1.4.2.2.4.1 Five-Year Plan
                - 1.4.2.2.5 Assessment Tasks (ADS No.)
                - 1.4.2.2.5.1 Canyons Assessment (1049)
                - 1.4.2.2.5.2 Interim Remedial Measures Assessment (1062)
                - 1.4.2.2.5.3 NEPA Documentation Assessment (1066)
                - 1.4.2.2.5.4 TA-0, -19, -26, -73, -74 Assessment (1071, 1072, 1073, 1096, 1112)
                - 1.4.2.2.5.5 TA-1 Assessment (1078)
                - 1.4.2.2.5.6 TA-10, -31, -32, -45 Assessment (1079, 1117, 1119, 1138)
                - 1.4.2.2.5.7 TA-11, -13, -16, -24, -25, -28, -37 Assessment (1082, 1083, 1084, 1092)
                - 1.4.2.2.5.8 TA-12, -14, -67 Assessment (1085)
                - 1.4.2.2.5.9 TA-15 Assessment (1086, 1088, 1089)
                - 1.4.2.2.5.10 TA-18, -27, -65 Assessment (1093, 1094, 1095)
                - 1.4.2.2.5.11 TA-2, -41 Assessment (1098, 1099)

1.4.2.2.5.12 TA-20, -53, -72 Assessment (1100, 1049)

1.4.2.2.5.13 TA-21 Assessment (1106, 1107, 1108)

1.4.2.2.5.14 TA-6, -7, -22, -40, -58, -62 Assessment (1111, 1155, 1156)

1.4.2.2.5.15 TA-3, -59 Assessment (1114, 1115, 1116)

1.4.2.2.5.16 TA-33 Assessment (1122, 1125, 1126)

1.4.2.2.5.17 TA-4, -5, -35, -42, -48, -52, -55, -63, -66 Assessment (1129, 1134)

1.4.2.2.5.18 TA-36, -68, -61 Assessment (1130, 1131)

1.4.2.2.5.19 TA-39 Assessment (1132)

1.4.2.2.5.20 TA-43 Assessment (1136)

1.4.2.2.5.21 TA-46 Assessment (1140, 1141, 1142)

1.4.2.2.5.22 TA-49 Assessment (1144, 1145)

1.4.2.2.5.23 TA-50 Assessment (1147)

1.4.2.2.5.24 TA-51, -54 Assessment (1148, 1153)

1.4.2.2.5.25 TA-57 Assessment (1154)

1.4.2.2.5.26 TA-8, -9, -23, -69 Assessment (1157, 1158)

1.4.2.2.6 Remediation Tasks, C/R (Activity Data Sheets)

1.4.2.2.6.1 Interim Remedial Measures Remediation (1063)

1.4.2.2.6.2 RCRA Mixed-Waste Storage/Disposal Facility (1067)

1.4.2.2.6.3 TA-1 Remediation (1077)

1.4.2.2.6.4 TA-21 Remediation (1101, 1103, 1105)

1.4.2.2.6.5 TA-0, -19, -26 Remediation (1113)

1.4.2.2.6.6 TA-10, -31, -32, -45 Remediation (1118)

1.4.2.2.6.7 TA-33 Remediation (1121, 1123, 1124)

1.4.2.2.6.8 TA-4, -5, -35, -48, -52, -53 Remediation (2111)

1.4.2.2.6.9 TA-49 Remediation (2112)

1.4.2.2.6.10 TA-50 Remediation (2113)

1.4.2.2.6.11 TA-51, -54 Remediation (2114)

1.4.2.2.7 Closure/Remediation Tasks, R (Activity Data Sheets)

1.4.2.2.7.1 TA-35 Waste Oil Storage Pit Remediation (1027)

1.4.2.2.7.2 TA-54 Area L Waste Oil Remediation (1150)

1.4.2.2.7.3 TA-54 Area L Closure/Remediation (2115)

- complete RFI,
- complete RFI report,
- complete CMS plan,
- complete CMS, and
- complete CMS report.

These milestones are to be applied individually to each OU, not to the ER Program as an entity. As more information becomes available from the RFI/CMS and any associated investigations concerning the specific OUs, detailed achievable schedule scenarios will be developed and refined to meet project requirements and regulatory due dates. Specific schedule dates for the CMI phase of the ER Program have yet to be established.

DOE/UC do not believe that the health and environment risks associated with any of the Laboratory's SWMUs warrant a DOE/UC risk-based prioritization; therefore, OUs are scheduled in the Order listed in the HSWA Module. The HSWA Module requires that DOE/UC complete RFI work plans for 10% of the SWMUs in Table A of the HSWA Module and 20% of the SWMUs in Table B by May 23, 1991, one year after the effective date of the Module. In the second year (ending May 23, 1992), plans must be completed for an additional 25% and 35%, respectively; in the third year (ending May 23, 1993), 20% and 45%; and the remaining SWMUs in the fourth year (ending May 23, 1994).

The Laboratory schedule for each OU includes 1 year for the RFI work plan, 5 years for the RFI, and 2 years for the CMS. DOE/UC has scheduled 11 years to accomplish these actions. The HSWA Module currently requires that the RFI/CMS be completed within 10 years. However, the 10-year schedule was based on the 603 SWMUs listed in the HSWA Module, not on the total number that need to be addressed under the 24 OUs. With EPA's approval, DOE/UC will address all SWMUs listed in the SWMU data base report submitted to EPA in November 1990 over an 11-year schedule for completing the CMS. If sufficient resources prove to be unavailable over the course of the ER Program, DOE/UC may request further extensions of the schedule under the provisions of the HSWA Module. Major resource constraints that may impact implementation include insufficient budget allocations, as well as unavailable manpower and analytical facilities for RFIs.

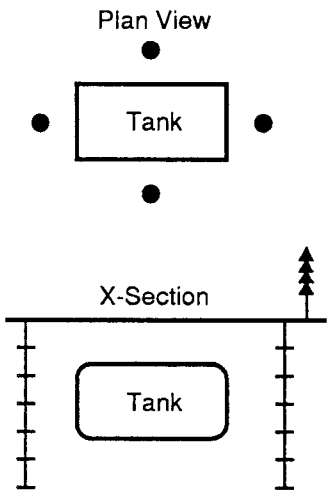


Figure I-4. Discrete units:

Assumed for discrete underground structures such as tanks, sumps, and pits

Sampling points placed adjacent to all sides of the structure

Sample from surface to total depth as follows:

- 5-ft intervals from surface to 30 ft
- 10-ft intervals from 30 ft to total depth

Total depth of sampling points based on waste form, geology, hydrology, and period of use

Groups of discrete units (e.g., tank farm) will be sampled around the perimeter of the group of structures at 20-ft spacing

Screening techniques, as appropriate.

The schedules are based on the technical scope for the RFI, CMS, CMI, and stipulations of the HSWA Module. OU planning and schedule information is presented in Appendix S.

7.0 RESOURCE PLANNING

7.1 COST OVERVIEW

The total estimated cost (TEC) of the ER Program cannot be determined until the RFI/CMS is completed and the scope of the corrective measures is determined. The TEC of the ER Program will require modification as the RFI is completed, corrective measures are identified, and conceptual designs are approved.

The TEC of the ER Program may increase as a result of federal factors such as weather delays, reduced federal funding (which may cause the Program to be extended), enactment of more stringent regulations, and results from the RFI/CMS. Every effort will be made to prevent cost increases. Such activities as enhanced sampling strategies, more efficient analytical systems, structured decision making, and corrective measure pilot studies will aid in controlling costs. Also, the ER Program staff will pursue educational and technological exchanges with other DOE facilities or institutions that may have developed more technologically advanced or more cost-effective solutions to current problems at DOE installations. Staying abreast of the rapid technological advances being made in the ER field will remain a top priority of the ER Program and is fundamental to achieving cost-effective remedial actions.

7.2 COST ESTIMATING

Cost estimating is the process of projecting financial requirements to complete a specified project. Cost estimates provide baseline budgets for actual versus estimated cost comparisons made during the life of a project. Current projected costs of the Laboratory's ER Program are presented in Appendix S.
The principal elements of cost estimating are

- defining the planning and estimating scope,
- selecting the estimating structure for preparing cost data,
- collecting, evaluating, and applying the necessary cost, and cost-related data,
- applying the proper estimating methods, and

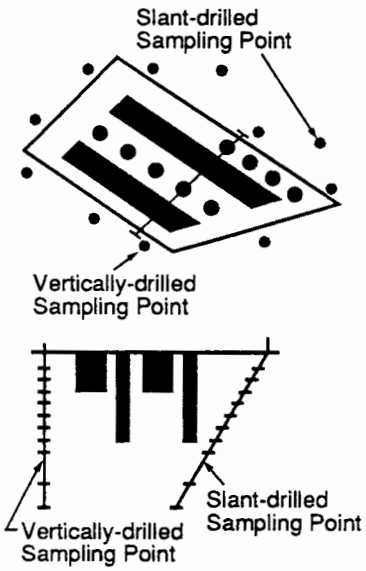


Figure I-5. Perimeter sampling:

Assumed for sites where the planned remedial action is in-place stabilization

Phase 1 sampling:

- Sampling points placed at 100-ft spacing around perimeter of area
- Sample at 10-ft intervals from surface to total depth

Phase II sampling: 30% of Phase I samples for further investigation

Total depth of sampling points based on waste form, geology, hydrology, and period of use.

Screening, as appropriate

Alternate vertical and slant-drilled sampling points to sample directly below unit.

- documenting the estimate in enough detail that it can be reviewed, evaluated, and implemented in the decision-making process.

Cost estimating at the Laboratory will be done in accordance with DOE Order 4700.1 (DOE 1987). Preparation of a cost estimate requires a description of the basis on which the estimate is made. The following cost estimates will be performed during the various phases of each project in the ER Program:

- planning/feasibility study,
- budget or conceptual design,
- title I design,
- title II design,
- government or engineers,
- current work, and
- independent cost.

Individual definitions and applicabilities are presented in Part D of DOE Order 4700.1(DOE 1987). Additionally, the "Cost Estimating Handbook for Environmental Restoration" may be used as guidelines.

The DOE/UC are in the early stages of the RFI/CMS process at the Laboratory. Therefore, site-specific experience for projecting the costs for each element is limited. The cost projections in Appendix S are based on assumptions in two areas: (1) preparing plans, studies, and reports and (2) carrying out RFI field investigations. Estimates for preparing plans, studies, and reports are based on a fully burdened average cost of $122 /hr for effort on generic-size class of the OU, and on best professional judgment of the effort needed to address each size class of OU (Table I-5). Costs for RFI field investigations are derived from generic sampling strategies for each of eight categories of SWMUs listed above (Figures I-4 through I-11) and estimates of the number of samples for each SWMU and sampling costs. Table I-6 presents the estimate for the average cost per sample.

The generic OUs, sampling strategies, and sample costs serve as tools for preliminary cost projections to enhance planning. DOE/UC's approach to cost projection has been validated as a reasonable approach by independent experts in remediation from DOE, EPA, and their contractors. As DOE/UC gains experience and knowledge through implementation of the ER Pro-

TABLE I-5. LANL ER PROGRAM WORK PLAN, RFI, AND CMS COST ESTIMATE

	Very Large OU (100 Areas of Concern and/or SWMUs)	Large OU (75 Areas of Concern and/or SWMUs)	Medium OU (50 Areas of Concern and/or SWMUs)	Small OU (25 Areas of Concern and/or SWMUs)	Very small OU (10 Areas of Concern and/or SWMUs)
Work Plan					
Intro	$50,000	$37,500	$25,000	$12,500	$5,000
Sampling Plan	$2,125,000	$1,593,750	$1,062,500	$531,250	$212,500
Tech Data Mgmt Plan	$75,000	$56,250	$37,500	$18,750	$7,500
QA Plan	$75,000	$56,250	$37,500	$18,750	$7,500
H&S Plan	$125,000	$93,750	$62,500	$31,250	$12,500
Community Relations Work Plan	$50,000	$37,500	$25,000	$12,500	$5,000
Subtotal	**$2,500,000**	**$1,875,000**	**$1,250,000**	**$625,000**	**$250,000**
RFI Report					
Data Analysis	$2,500,000	$1,875,000	$1,250,000	$625,000	$250,000
Baseline Risk Assessment	$1,750,000	$1,312,500	$875,000	$437,500	$175,000
Report Prep.	$750,000	$562,500	$375,000	$187,500	$75,000
RFI Subtotal	**$5,000,000**	**$3,750,000**	**$2,500,000**	**$12,250,000**	**$500,000**
CMS Report					
Alternative Analysis	$2,500,000	$1,875,000	$1,250,000	$625,000	$250,000
Risk Assessment	$1,750,000	$1,312,500	$875,000	$437,500	$175,000
Report Prep	$750,000	$562,500	$375,000	$187,500	$75,000
CMS Report Subtotal	**$5,000,000**	**$3,750,000**	**$2,500,000**	**$1,250,000**	**$500,000**
Task Total	**$12,500,000**	**$9,375,000**	**$6,250,000**	**$3,125,000**	**$1,250,000**

TABLE I-6. LABORATORY ESTIMATED FULLY LOADED

Cost Per Sample

Costing Category	Cost
Field Labor	$ 250
Sampling Equipment	150
Drilling	700
Location Surveying	300
Sample Archiving (Five Years)	50
Geophysics (Surface and Borehole)	100
Health and Safety Screening (Radiation, Volatiles, Explosives)	300
Packing/Shipping	50
TCL Volatiles (not Appendix IX)	750
TCL Semivolatiles (not Appendix IX)	1500
Explosives	1000
Radionuclides (^{238}Pu, ^{239}Pu; ^{234}U, ^{235}U, ^{238}U; ^{137}Cs, ^{3}H, ^{241}Am)	1800
TAL Metals	500
Totals[a]	$ 7500

[a]If Appendix IX or TCLP is required, add $2000 to $3000.

Laboratory Cost per Average Sample	
Assuming 20% of estimated samples require partial analysis	$3750
Assuming the remaining 80% of samples require full analysis	$7500
Cost of "average" sample	$6750

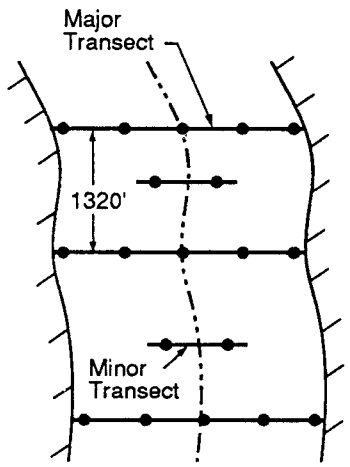


Figure I-6. Canyon:

Sample on "major" and "minor" transects across the canyon

Major transects are located every 1,320 ft along the length of the canyon:

- Average 5 samples on any transect
- Minimum of 2 samples on any transect
- 10-ft intervals from 30 ft to total depth

Minor transects are located midway between major transects

- 2 samples per transect
- 5-ft intervals from surface to 30 ft
- 10-ft intervals from 30 ft to total depth
- Total depth of sampling points based on average depth of alluvium in the canyon
- Screening techniques as appropriate.

gram, cost projections will become more refined. Use of generic sampling design to project costs does not imply that these approaches will actually be used at specific SWMUs. Specific sampling strategies will be identified in the RFI work plans for each OU.

7.2.1 Methods of Determining RFI Sampling Assumptions

The sampling assumption methodologies are derived from the major types of SWMUs found at Los Alamos. The Laboratory has a 45-year history of producing various waste streams and has used different methods for disposal. As a result, eight categories of sites have been identified, and a separate approach to sampling has been developed for each:

- discrete units,
- perimeter sampling,
- canyons,
- outfall areas,
- active firing sites,
- inactive firing sites,
- drainlines, and
- randomly sampled areas .

Each sampling assumption includes sampling depths, sampling point spacings, and assumptions germane to the physical setting.

7.2.2 RFI Sampling Sheets

The appropriate sampling assumption methodology is applied to each area of concern and each SWMU. Each specific sampling assumption sheet includes an ADS number, location description, planned remedial action, sampling point designation, sampling depth, sample analysis (inorganics, organics, metals, explosives, or radionuclides), QA sample requirements, and investigation-derived waste characterization sample quantity. The ER Program Office is preparing a report that describes sampling and cost assumptions in detail.

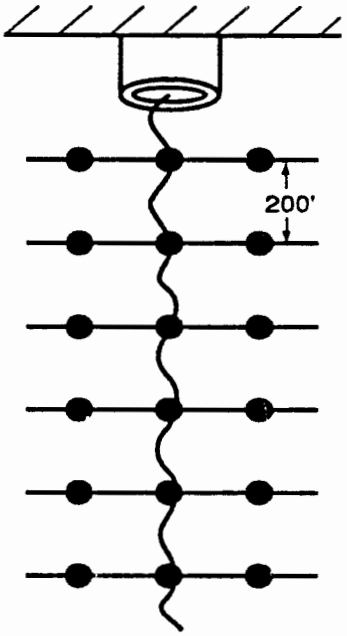


Figure I-7. Outfall areas:

Sample on transects across outfall area

Transects spaced 200 ft apart along length of outfall to maximum of 1,000 ft

Three sampl ng points per transect

Phase I: Sample outfall on transects spaced 200 ft apart; three sampling points per transect; collect samples as follows:

- Composite the surface sample interval from three sampling points
- Composite the 24-in. sample interval from three sampling points
- Composite the 36-in. sample interval from three sampling points

One discrete sample from each depth for VOC analysis

Phase II: One sampling point per transect; three sample depths: surface, 24 in., and 36 in.

Phase III: 30% of Phase I and II samples for further investigation

Screening techniques, as appropriate.

7.2.3 RFI Cost Methodology

A sample analysis/handling unit cost was derived by performing a study to compare sampling costs provided by three outside contractors and costs provided by the Laboratory's Health and Environmental Chemistry (HSE-9) laboratory. The cost methodology applied by the ER Program is comprehensive and addresses volatiles, semivolatiles, pesticides/herbicides, PCBs, and various radionuclides in the analytical section. All samples are assumed to be mixed waste samples. The unit cost also accounts for such factors as logistics, surface topography, vegetation, subsurface geology, waste constituents, and health and safety.

The sample unit cost factor is multiplied by the specific sample number to derive the RFI cost for each SWMU and area of concern. The estimated costs are then aggregated by OU to give the OU RFI cost estimate (Figures I-4 through I-11 and Tables I-5 and I-6).

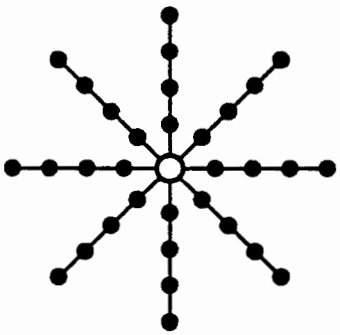
7.2.4 RFI Work Plan and CMS Report Cost Estimates

Costs for the RFI work plan, the RFI report, and the CMS were divided into five categories (Table I-5):

- very large OU (100 SWMUs and areas of concern),
- large OU (75 SWMUs and areas of concern),
- medium OU (50 SWMUs and areas of concern),
- small OU (25 SWMUs and areas of concern), and
- very small OU (10 SWMUs and areas of concern).

7.2.5 Cost Estimates for the Environmental Restoration FY93 Five-Year-Plan

The cost-estimating process described above is adjusted for the FY93 Five-Year Plan as follows. The number of samples required for each OU is reduced by 33%. It is assumed that this reduction can be achieved because some sites currently scheduled for investigation will, with EPA approval, require no further action (NFA) and will never be sampled. Other sites will require minimal investigation before EPA grants NFA approval. Additionally, use of the common-sense (or observational) approach and statistically based sampling designs should help reduce the number of samples. Finally, improved analytical procedures should reduce analytical costs.



Active Firing Sites

Figure I-8. Active firing sites:

Sampling efforts intended to define SWMU unit boundaries, not to establish remedial actions

Samples of eight lines radiating from site

Length of lines estimated based on

- Historic shot size
- Field investigation data
- Configuration of site (open or contained)

Sampling point spacing is 200 ft

One sample per sampling point

Screening techniques as appropriate.

7.2.6 Cost Estimating for Future Environmental Restoration Five-Year Plans

Cost estimating in the future will be based on RFI work plans and the results of the RFI/CMS process. The uncertainty associated with cost estimates will decrease as the Laboratory's ER Program matures.

7.3 ESTIMATING THE WORK FORCE

Sufficient personnel resources be available to ensure effective management and implementation of ER Program objectives. The accuracy of work force projections is expected to improve as approval through the RFI/CMS is obtained, as planned work is authorized each year, and as experience is gained from the conduct of RFI/CMS activities.

7.4 CONTINGENCY

At present, the RFI/CMS contains no provision for contingency costs. As the ER Program and individual OUs mature, contingency needs will be assessed in the RFI/CMS and construction projects, as appropriate.

8.0 MANAGEMENT CONTROL SYSTEMS

The Laboratory will develop, implement, and maintain a system to provide monthly variance analysis and corrective action planning as part of the UC MCS consistent with DOE requirements. Variance analysis applies to cost, schedule, and performance levels that have exceeded established thresholds.

8.1 DEPARTMENT OF ENERGY/HEADQUARTERS

Cost, schedule, and performance variances for DOE tracking purposes will be reported if thresholds established by the DOE are exceeded. DOE Order 4700.1 provides details concerning specific project types and associated limits.

8.2 DEPARTMENT OF ENERGY/ALBUQUERQUE

Cost, schedule, and performance variance control will be accomplished through the approval and oversight of the Change Control Board. DOE/AL will establish conformance standards using the thresholds and variance-reporting requirements outlined in DOE Order 4700.1.

8.3 UNIVERSITY OF CALIFORNIA

The deputy division leader of HSE Division working with the ER Program manager, will establish thresholds at the start of each project. Cost, schedule, and performance variances for internal UC reporting purposes, as

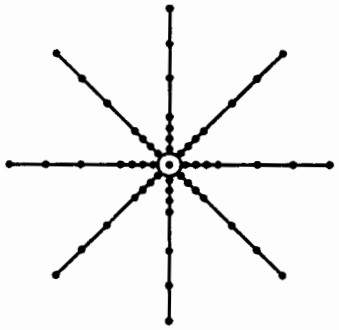


Figure I-9. Inactive firing sites:

Sample on eight lines radiating from site

Length of lines estimated based on

- Historic shot size

Field investigation data

- Configuration of site (open or contained)

Phase I sampling point spacing increases away from site center as follows:

- 50-ft spacing from site center to 200 ft; two sample depths—surface and 2 ft

- 100-ft spacing from 200 ft to end of line; one sample from the surface-to-1-ft interval

- One sampling point in center of site

Phase II sampling: 10% of Phase I samples

Screening techniques, as appropriate.

appropriate to the ER Program, will be reported if thresholds established by the ER Program manager are exceeded.

9.0 REPORTING

9.1 REQUIREMENTS

The development and implementation of reporting requirements for the ER Program are mandated by DOE and by the regulatory agencies through the DOE/UC's RCRA operating permit, including the HSWA Module. DOE/LAAO and UC as copermittees, must sign the following certification for each deliverable to EPA including monthly, quarterly, and technical progress reports.

> I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

All reporting data and documentation requirements will conform to DOE Order 4700.1, applicable guidance from DOE/HQ, DOE/AL, DOE/LAAO, and internal UC criteria. The documentation requirements for the Laboratory's ER Program are shown in Table I-7.

9.2 PROGRESS REPORTS

DOE HQ and DOE/AL reporting requirements and regulatory reporting requirements are presented in the Environmental Restoration On-Site Remediation Program Management Plan (DOE 1990c).

9.2.1 DOE Requirements

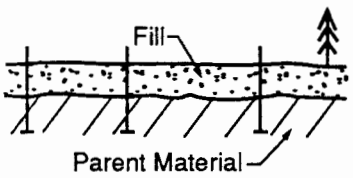
Monthly reports required by DOE/HQ, which cover only those milestones that DOE-HQ has identified for tracking purposes, will be submitted by UC through DOE/LAAO to DOE/AL for transmittal to DOE/HQ. Additionally, the quarterly reports required by DOE/HQ, which cover DOE/HQ-identified milestones, will be submitted by UC through DOE/LAAO to DOE/AL before submittal to DOE/HQ.

TABLE I-7. LABORATORY ER PROGRAM DOCUMENTATION REQUIREMENTS

Type	Frequency	Due Date To DOE/AL	UC	DOE/LAAO	DOE/AL	Regulatory Agency
I. DOE Planning Documents						
DOE/AL Field Office Management Plan	0	NA	IN	IN	P/MA	NA
DOE/AL Field Office Program and Implementation Plan	A	Sept 15	IN	IN	P/MA	NA
DOE/AL Field Office Budget Request Summary	A	NA	IN	IN	P	NA
DOE/AL Five-Year Plan	A	2nd Qtr FY	IN	IN	P	R
DOE/AL Site-Specific Plan	A	1st Qtr FY	P	AP	AP	R
DOE/AL Current-Year Work Plan	A	September	P	AP	AP	R
II. DOE Status Reports						
Installation Monthly Status Report	M	10th	P	R	AP	NA
DOE/AL Monthly Field Office Status Report	M	13th	IN	IN	P	NA
III. Primary Regulatory Agency Documents						
Laboratory Installation Work Plan	A	NA	P	R	R	AP
RFI OU Work Plans	NA	NA	P	R	R	AP
RCRA Closure Plans	NA	NA	P	R	R	AP
RFI Reports	NA	NA	P	R	R	AP
CMS Plan	NA	NA	P	R	R	AP
CMS Reports	NA	NA	P	R	R	AP
Interim Measures Plans	NA	NA	P	R	R	AP
Monthly Management Reports	M	20th	P	R	R	AP
Quarterly Technical Progress Reports	NA	NA	P	R	R	AP

Key: O = one-time or as required, NA = not applicable, IN = input, P = prepare, MA = DOE/AL manager approval, A = annual, M = monthly, R = review, AP = approve.

X-Section



Decommissioned Drainlines

Figure I-10. Drainlines:

In-place drain lines

- Cleanup at the time of removals; verification sampling before backfilling excavation; no cost estimate for RFI/CMS

Decommissioned drain lines

- One sample depth at interface of fill and parent material

- Sampling point spacing as follows

Outside Laboratory boundaries:

Phase I: Sampling points along former location of drain line spaced at 100-ft intervals; one sample depth at interface of fill and parent material

Phase II: 40% of Phase I samples for further investigation

Inside LANL boundaries:

Phase I: Sampling points along former location of drain line spaced at 100-ft intervals; one sample depth at interface of fill and parent material

Phase II: 10% of Phase I samples for further investigation

Screening techniques, as appropriate.

TABLE I-8 FACILITY SUBMISSION SUMMARY

Facility Submission Requirements	Due Date
Written notification of newly iidentified SWMUs	Fifteen (15) calendar days after discovery
Written notification of newly discovered releases	Fifteen (15) calendar days after discovery
Verbal notification of newly discovered releases	Twenty-four (24) hours after release discovery
Monthly Management Reports	Monthly, no later than sixty (60) calendar days after effective date of permit
Task I Preliminary Report Description of Current Condition Installation Work Permit	November 19, 1990
SWMU Assessment Plan for newly identified SWMUs	Ninety (90) calendar days after receipt of request
Revised SWMU Assessment Plan	As determined
SWMU Assessment Report	Sixty (60) calendar days after completion of implementation of SWMU Assessment Plan
Task II Installation RFI Work Plan for SWM'J(s)	November 19, 1990
OU Work Plans	As specified in Inatallation RFI Work Plan
RFI Preliminary Report	According to schedule in RFI Work Plan
Revised RFI Work Plan	As determined by Administrative Authority usually within 30 days of receipt of NOD
RFI Report and Summary Report	Sixty (60) calendar days after completion of RFI
Technological Progress Report	Quarterly, no later than one hundred eighty (180) days from effective date of permit
Revised RFI and Summary Reports	Thirty (30) calendar days after notification of deficiency
Interim Measures Plan for interim measures required after permit issuance	Thirty (30) calendar days after notification of deficiency

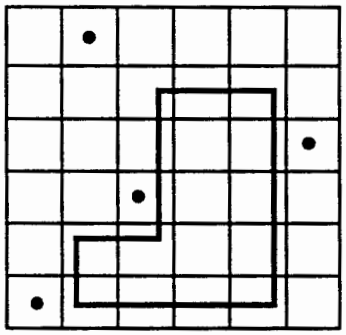


Figure I-11. Randomly sampled areas:

Assumed for sites where the planned remedial action is clean to acceptable risk-based criteria

Sample a percentage of an area with a 5 x 5 ft grid; grid size will be increased up to 100 x 100 ft, depending on the size of the site

Percentage of the grid sampled based on:

- Heterogeneity of waste
- Distribution of waste

Stratified simple random sampling assumed for sites with known structures and expected waste distribution

Simple random sampling assumed for sites where waste is evenly distributed at site

Sampling points will be sampled from surface to total depth; limited to near-surface sampling, as appropriate

- 5-ft intervals from surface to 30 ft
- 10-ft intervals from 30 ft to total depth

Total depth of sampling points based on waste form, geology, hydrology, and period of use.

TABLE I-8 FACILITY SUBMISSION SUMMARY (CONT.)

Revised Interim Measures Plan	As determined
CMS Plan	Ninety (90) calendar days after notification of requirement to perform CMS
Relvised CMS Plan	As determined
CMS Report	Sixty (60) calendar days after completion of CMS
Revised CMS Report	Thirty (30) calendar days after notification of deficiency

9.2.2 REGULATORY REQUIREMENTS

Monthly and quarterly reports will be submitted to EPA, NMEID, and DOE.

9.3 TECHNICAL REPORTS

The technical report requirements set forth in the HSWA Module (i.e., the facility submission summary) are presented in Table I-8. All reports will be submitted to EPA, NMEID, AND DOE.

ASME (American National Standards Institute/American Society of Mechanical Engineers) 1989. "Quality Assurance Requirements for Nuclear

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QUALITY PROGRAM PLAN IDENTIFICATION FORM

Document Title:	Quality Program Plan for the Environmental Restoration Program
Document Control Number:	
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Telephone:	505-667-1691

Approval for Implementation:

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   TITLE: HSE Deputy Division Leader, Los Alamos National Laboratory

SIGNATURE:_____**DATE:**_____

2. **NAME:** Robert Vocke
   TITLE: ER Program Manager, Los Alamos National Laboratory

SIGNATURE:_____ **DATE:**_____

3. **NAME:** Larry Maassen
   TITLE: Quality Program Project Leader, ER Program, Los Alamos National Laboratory

SIGNATURE:_____**DATE:**_____

4. **NAME:** Robert Forrest
   TITLE: Chief of Office of Quality Assurance, Region VI, Environmental Protection Agency

SIGNATURE:_____**DATE:**_____

■ QUALITY PROGRAM PLAN

1.0 INTRODUCTION

This Quality Program Plan (QPP) describes the requirements for activities as they relate to and affect quality control as performed by the Los Alamos National Laboratory (Laboratory) Environmental Restoration (ER) Program. The focus of the ER Quality Program is directed toward producing reports, environmental measurement data, and documentation of the quality controls used. Quality assurance (QA) serves both as a guideline and as a management tool to ensure that all activities are performed in an appropriate, well-regulated manner that generates reliable, scientifically valid, and thoroughly documented data.

1.1 SCOPE

The scope of the Quality Program is broad because of the wide variety of activities involved in undertaking the ER Program. The requirements of this QPP apply to specific projects and activities managed by the ER Program Office. These projects and activities include, but are not limited to,

■ Resource Conservation and Recovery (RCRA) facility investigations (RFIs), to identify, confirm, and quantify contamination; corrective measures studies , (CMSs); and corrective action design/corrective action implementation (CMI);

■ National Environmental Policy Act (NEPA) compliance documentation; and

■ design, construction, and operation of the proposed Mixed Waste Storage and Disposal Facility;

The amount of QA applied to these activities varies according to the importance of the activity.

1.2 POLICY STATEMENT

It is the University of California's (UC) policy to conduct all activities related to the ER Program in accordance with the QA standards or requirements provided by the Environmental Protection Agency (EPA) and US Department of Energy (DOE). UC is committed to providing the resources necessary to ensure development and implementation of the ER Quality Program. These resources are obtained through the DOE as part of the DOE's ER budgeting process.

UC's goals are to generate and produce data that are valid, complete, traceable, and defensible and to ensure that data quality objectives (DQOs)

are met. The ER Program will implement the QA practices necessary to obtain a clean, safe environment. Employees are responsible for the quality of their own work, which means knowing and understanding the requirements of each task undertaken, doing the job right the first time, and initiating action to change requirements that are inappropriate or unattainable.

2.0 ORGANIZATION

The intent of the Quality Program is to implement applicable requirements and to verify that activities affecting quality are performed according to established quality procedures and controls. QA personnel will have sufficient authority, access to work areas, and organizational freedom to identify quality-related problems; to recommend, initiate, or effect solutions through designated channels; and to verify implementation of the solutions to ensure that unsatisfactory conditions are corrected. These QA personnel will also have direct access to responsible management at a level where the appropriate authority and organizational freedom, including sufficient independence from cost and schedule, can effect an appropriate action.

This section describes the organization structure of the ER Program and key QA responsibilities associated with the Environmental Quality Program. The ER Program organization is shown in Figure II-1.

2.1 RESPONSIBILITIES OF THE HEALTH, SAFETY, AND ENVIRONMENT DEPUTY DIVISION LEADER

The deputy division leader is responsible for directing the organization units conducting the ER Program.

2.2 RESPONSIBILITIES OF THE ENVIRONMENTAL RESTORATION PROGRAM MANAGER

The program manager (PM) is responsible for the overall management of the ER Program, including

- ensuring that Laboratory ER activities are consistent with the goals and objectives of the deputy division leader, DOE, EPA, and the New Mexico Environmental Improvement Division (NMEID);

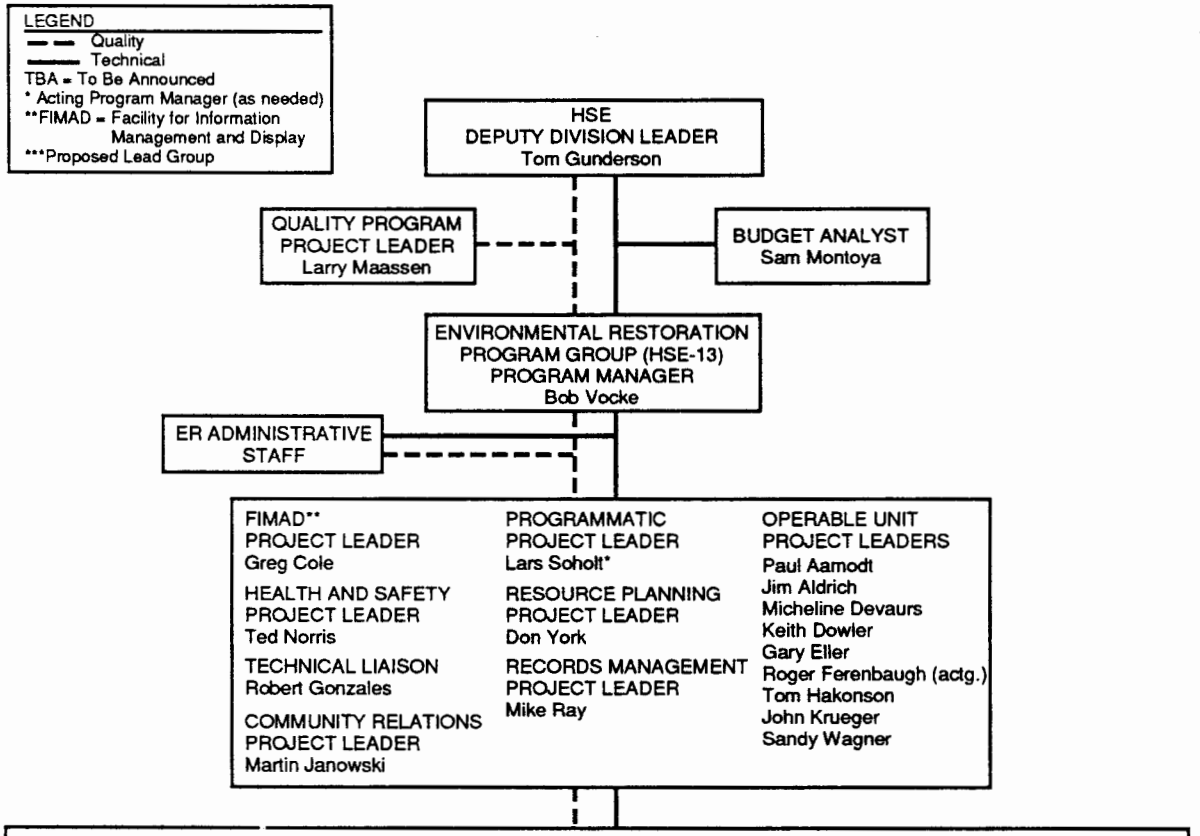
- ensuring compliance with HSWA Module;

- ensuring compliance with change control procedures;

- costing, scheduling, and measuring performance;

- submitting monthly and quarterly reports to DOE;

- tracking deliverables and milestones established by the DOE, EPA, and NMEID; and



TECHNICAL TEAMS	GROUPS/ DIVISIONS	TECHNICAL TEAM LEADER	QA REPRESENTATIVE	ER PROGRAM OFFICE TECH. TEAM COORDINATOR
Analytical Chemistry/Sample Coordination	HSE-9***, CLS, INC	Chuck Rzeszutko	TBA	Wagner
Analytical Chemistry Instrumentation Dev.	HSE-9***, CLS, ERA, INC	Craig Leasure	TBA	Wagner
Geochemistry	INC***, CLS, EES, HSE-9	Dave Curtis	TBA	Wagner
Geology, Geophysics, Drilling	EES***, HSE, MEE-13	Bill Laughlin	TBA	Aamodt
Project Health & Safety	ER***, HSE-1, 2, 3, 5, 10, 11	Ted Norris	TBA	Norris
Community Relations	PA-3***, PA-1	Martin Janowski	TBA	Janowski
FIMAD**	EES, HSE-9	Greg Cole	TBA	Cole
Records Management	EES-1***	Mike Ray	TBA	Ray
Statistics	A-1***, EES-1, UCLA	Kathy Campbell	TBA	Soholt
Decision Analysis	A-1***	Elizabeth Kelly	TBA	Devaurs
Cost Estimating	MEE-4***	Bob Gillis	TBA	Aamodt
Cost Benefit	A-4***	Linda Trocki	TBA	Devaurs
Hydrology	EES***, HSE, N-6, MEE-13	Micheline Devaurs (actg.)	TBA	Devaurs
Site Assess. and Remediation Tech. Devel.	HSE***, ERA, EES, MEE, INC	Harry Ettinger	TBA	Aamodt
Document Preparation	IS-9, 11, 12, OS-6	Lars Soholt (actg.)	TBA	Soholt
Environmental Assessment	HSE-8, EES-2	Doris Garvey	TBA	Aamodt
Corrective Action Imp. (Remediation)	ENG***, HSE-7	Chris Loggains	TBA	Soholt
Interim Remedial Measures	ER***, ENG, HSE-8	Robert Gonzales	TBA	Gonzales
Mixed Waste Storage/Disposal Facility	MEE***, ENG, HSE-7	Dean Nelson	TBA	Aamodt
Quality Assurance	ER***, MEE-9	Larry Maassen	TBA	Maassen
Engineering (Conceptual - Title II)	ENG***, MEE	Chris Loggains	TBA	Krueger
Regulatory Compliance	HSE-8	Dave McInroy	TBA	Krueger
Planning/Scheduling/Reporting	ER, HSE-DO	Don York	TBA	York
Solid Waste Management Unit Data Base	ER	Robert Gonzales	TBA	Gonzales
Air Quality	HSE-8***, EES-5	Craig Eberhart	TBA	Soholt
Risk Assessment	ER***, EES, HSE-1, 5, 8, 10, 11, A, UCLA	Lars Soholt (actg.)	TBA	Soholt

Figure II-1. Organization of the Environmental Restoration Program at Los Alamos National Laboratory.

- ensuring the establishment, implementation, and support of the QA, health and safety (H&S), records management, and community relations programs.

2.3 RESPONSIBILITIES OF PROJECT LEADERS

2.3.1 Programmatic Project Leader

The responsibilities of the programmatic project leader are to

- serve as acting PM during the PM's absence;

- work with the PM and deputy division leader to provide overall program planning coordination, oversight, and direction; and

- assist in interfacing with personnel and programs external to the ER Program Office, both internally and externally.

2.3.2 Operable Unit Project Leaders

Operable unit (OU) project leaders (PLs) are responsible for

- overseeing day-to-day operations, including planning, scheduling, and reporting technical and related administrative activities;

- ensuring preparation of scientific investigation planning documents and procedures;

- preparing monthly and quarterly reports for the PM;

- overseeing subcontractors, as appropriate;

- coordinating with technical team leaders;

- conducting technical reviews of the milestones and final reports;

- interfacing with the UC's Quality Program project leader (QPPL) to resolve quality concerns and to coordinate with the QA staff for audits;

- complying with the ER Program H&S, records management, and community relations plans; and

- complying with the Laboratory's technical and QA requirements for the ER Program.

2.3.3 Quality Program Project Leader

The QPPL is responsible for directing and managing the ER quality program, including

- ensuring that independent organizations adequately and effectively evaluate the quality program;
- verifying the implementation of the quality program by UC and its subcontractors;
- resolving disputes regarding quality;
- overseeing a QA staff;
- assisting PLs in developing quality assurance project plans (QAPjPs);
- reviewing and approving all QP plans, QAPjPs, and implementing procedures;
- ensuring that QA audits are conducted;
- issuing stop-work orders;
- serving as liaison between the Laboratory's ER Quality Program and the EPA's Regional Office of Quality Assurance; and
- preparing monthly reports for the ER Program Manager.

The QPPL will function and be funded independently from the technical projects undergoing QA review. The QPPL will not be assigned duties that preclude full attention to QA responsibilities or that conflict with the reporting and resolution of QA issues and problems. The QPPL reports directly to the ER PM.

2.3.4 Health and Safety Project Leader

The H&S PL is responsible for

- preparing and implementing the ER Program H&S plan;
- reviewing site-specific H&S plans prepared by subcontractor or Laboratory personnel;

- interfacing and coordinating with Laboratory personnel to use resources appropriate for the ER H&S Program;

- ensuring compliance of the ER Program with applicable environmental regulations, DOE orders, UC policy, and applicable New Mexico laws and regulations,

- overseeing the maintenance of the H&S data base for the ER Program in such areas as worker training and medical surveillance,

- preparing monthly reports for the ER PM.

2.3.5 Community Relations Project Leader

The community relations PL

- prepares the community relations program plan and implements its provisions;

- interfaces and coordinates with program personnel to ensure resources for the community relations program;

- ensures that the community relations program meets the requirements of the HSWA Module;

- serves as the primary interface between the public and the ER Program Office; and

- prepares monthly reports for the ER PM.

2.3.6 Project Leader for the Facility for Information Management and Display

The Facility for Information Management and Display (FIMAD) supports all of the electronic information needs of the ER Program at Los Alamos. The PL for the FIMAD is responsible for

- the development and continued operation of the FIMAD;

- continued systems analyses of information-processing needs and incorporation of the analyses in the development of the FIMAD;

- testing, evaluating, and purchasing requisite hardware and software;

- determining staffing needs, reviewing personnel qualifications, and providing training, guidance, instruction, and supervision for the FIMAD;

- developing quality-implementing procedures and configuring management for the FIMAD;

- initiating and maintaining an active collaborative effort with local universities; the National Center for Geographic Information and Analysis; industry; and other government organizations (foreign and domestic) in professional training, research, and applied technology;

- assisting in technical projects at the FIMAD such as developing graphical user interfaces, system integration and networking; developing operating system tools for back-up, security, and disaster recovery; and developing applications software to support two- and three-dimensional modeling, integration of raster and vector graphics, and still-video archival and retrieval across a network; and

- preparing monthly reports for the ER PM.

2.3.7 Project Leader for Records Management

The PL for records management will

- develop and implement a records management plan (RMP);

- serve as contact for project participants with respect to matters regarding records and technical data;

- coordinate the flow of records to the FIMAD;

- ensure that records management procedures comply with regulatory guidelines and requirements;

- standardize documentation controls to ensure the integrity of the data and records;

- initiate and oversee development of QA procedures for implementing the RMP;

- assist with identifying reporting requirements (including reporting frequency, formats, and types of information);

- serve as primary interface with Communications and Records Management Division to ensure compliance with Laboratory records policy;

- collaborate closely with key ER Program personnel on records management issues; and

- prepare monthly reports for the ER PM.

2.3.8 Project Leader for Resource Planning

The Resource Planning PL's responsibilities include

- developing a master logic network (schedule) for the ER Program,
- integrating the schedule with the work breakdown structure (WBS),
- projecting near- and long-term resource needs of the ER Program, and
- assisting other project leaders in resource planning and scheduling.

2.4 RESPONSIBILITIES OF TECHNICAL TEAM LEADERS

Technical team leaders are responsible for

- coordinating team activities with PLs,
- issuing programmatic guidance to team members,
- ensuring independent reviews of team deliverables,
- ensuring quality and completeness of deliverables, and
- designating QA representatives, as appropriate.

2.5 QUALITY ASSURANCE REPRESENTATIVE

The technical teams will be represented on the ER Program Quality Council (Section 20). The QA representative is the primary source of information on QA policy for the team and will serve as a member of the ER Program Quality Council. The QA representatives

- recommend and review proposals for improvements in QA policies and procedures,
- prepare and review QA procedures and plans,
- evaluate potential quality problem areas,
- consult on matters of QA specific to their organizations,
- serve as a source of information on QA matters and help to implement

the ER Quality Program within their organization,

- help with the coordination of audits,
- participate in audits of other areas, and
- assist in preparing procurement requests.

3.0 QUALITY ASSURANCE PROGRAM

This QPP states the QA requirements applicable to the UC's ER Program. Activities will be planned, implemented, and maintained as required by this QPP.

The requirements established in this QPP will be implemented by ER Program personnel through written documents such as QAPjPs; quality administrative procedures (QPs); and standard operating procedures (SOPs). The QPP describes what will be controlled and the planned approaches for implementing these QA controls. The QPs, QAPjPs, and SOPs describe in detail how QA controls will be implemented.

Figure II-1 identifies all of the major organizational units that are required to participate in the ER Quality Program. The figure also identifies the QA representative (QAR) at each organizational level. Subcontractors to the ER Program are accountable PLs or organizational units and are subject to the same or equivalent QA requirements as those defined in this QPP.

This plan is prepared in accordance with the EPA guidelines for QPPs as outlined in QAMS-005/80, Interim Guidelines and Specifications for Preparing Quality Assurance Program Plans (EPA 1980) and NQA-1, Quality Assurance Requirements for Nuclear Facilities (ANSI/ASME 1989), as specified in DOE Order 5700.6B. Table II-1 is a matrix that lists the ER Quality Program control elements based on NQA-1 in the first column and on the QAMS-004/80 control elements in the second column.

The intent of this QPP is to present a comprehensive, coherent, QA program compatible with QA standards of both DOE (NQA-1) and EPA (QAMS). The approach taken seeks to satisfy the QA requirements of both groups and to serve the basic intent of all quality programs; i.e., to ensure that appropriate controls are applied to a program, project, or activity; that the quality of the results is known and documented; and that the effectiveness of the controls, as implemented, can be evaluated.

Quality is defined as conformance to valid, mutually agreed-upon requirements.

TABLE II-1 QUALITY ASSURANCE CONTROL ELEMENTS CROSS-REFERENCE MATRIX

ER Quality Program Control Elements	QAMS 004/80 Control Elements
Identification Form	1. Identification
1.0 Introduction	2. Introduction
	3. Policy Statement
2.0 Organization	4. Quality Assurance Management
3.0 Quality Assurance Program	5. Personnel Qualifications
	6. Data Quality Assessment
4.0 Design Control	7. Data Generation
5.0 Procurement Document Control and Control of Purchased Items and Services	6. Facilities, Equipment, and Services
6.0 Instructions, Procedures, Plans, and Drawings	7. Data Generation
7.0 Document Control	4. Quality Assurance Management
8.0 Identification and Control of Items and Samples	9. Data Quality Assessment
9.0 Control of Processes	8. Data Processing
10.0 Inspection	
11.0 Test Control	
12.0 Control of Measuring and Test Equipment	6. Facilities, Equipment, and Services
13.0 Handling, Storage, and Shipping	8. Data Processing
14.0 Inspection, Test, and Operating Status	
15.0 Control of Nonconforming Items	
16.0 Corrective Action	10. Corrective Action

17.0 Records	8. Data Processing
18.0 Audits and Surveillance	4. Quality Assurance Management
19.0 Software Quality Assurance	
20.0 Quality Improvement	

3.1 PERSONNEL QUALIFICATIONS AND TRAINING

3.1.1 Qualifications of Environmental Restoration Program Personnel

3.1.1.1 Position Descriptions

Position descriptions will be written for positions affecting quality. At a minimum, position descriptions will include the position title, the responsibilities of the position, and the minimum education and experience required.

3.1.1.2 Documentation of Qualifications

ER Program positions that affect quality will be performed by qualified individuals. Documentation of their qualifications will include their relevant education, experience, and training. A brief statement of ER personnel qualifications is presented in Appendix R.

3.1.1.3 Evaluation of Qualifications of Environmental Restoration Program Personnel

Supervisors will periodically review documentation of personnel qualifications to ensure that it is adequate.

3.1.2 Training

Individuals assigned to perform activities affecting quality will receive, at a minimum, orientation to familiarize them with the purpose, scope, methods of implementation, and applicability of the following documents as they relate to the individual's work:

- QPPs,
- QAPjPs, and
- QA implementing procedures, SOPs, and work plans.

Training may be implemented through a mandatory reading list, classroom presentations, video presentation, or other methods of instruction. Supervisors should identify the training needs of their employees at least annually.

3.2 ASSESSMENT OF QUALITY PROGRAM

All projects and activities will be subject to periodic external QA reviews or audits of performance. Systems and performance audits will be conducted as arranged by the PL, QAR, and QPPL. Audits assess the adequacy of, and adherence to, the ER QPP, QAPjPs, and implementing procedures. Audits will be performed in accordance with written plans and check lists; they are further addressed in Section 18 of this QPP.

3.3. DATA QUALITY OBJECTIVES

Most, if not all, ER Program projects and activities rely upon the ability to obtain environmental data of known and documented quality to meet objectives and to determine overall success. To ensure that adequate environmental measurement data are obtained, DQOs are established and documented at the onset of each project. To ensure that reliable data are obtained, tight quality controls are built into project designs and are documented in QAPjPs and associated design documents.

DQOs for data collection describe the uncertainty that a decision maker is willing to accept in results derived from environmental data. This uncertainty is used to specify the quality of the measurement data required, usually in terms of precision, accuracy, representativeness, comparability, and completeness. The DQOs will be defined and approved by UC, DOE, and EPA before field and laboratory work is initiated. The field and laboratory organizations performing the work should be aware of the DQOs so that they may make informed decisions to attain those DQOs during the course of the project. Development of DQOs is described in Data Quality Objectives for Remedial Response Activities (EPA 1987). DQOs are further discussed in the QAPjP.

Data quality should not be confused with data usability; the two are closely related, but only data users determine usability. In general, determining usability is a qualitative decision process, whereas determining data quality is a quantitative verification process.

3.4 ASSESSMENT OF DATA QUALITY

The quality of the measurement data generated and processed will be assessed to determine whether DQOs have been met. Aspects of data

quality to be addressed are precision, accuracy, representativeness, completeness, and comparability.

EPA-approved and/or the best available methodology will be used for assessing data quality. For many measurements and analyses conducted by the ER Program, suitable methodology must be developed and verified. Aspects of data quality to be addressed are discussed in the following subsections.

3.4.1 Precision

SOPs will contain a mechanism for demonstrating the reproducibility of each measurement process. Examples of activities to assess precision are listed below.

3.4.1.1 Standard Reference Materials

Analytical data from standard reference material will be within prescribed acceptance limits.

3.4.1.2 Instrument Checks

Each measurement device will be checked routinely to demonstrate that variables are within predetermined acceptance limits. Examples of checks include zero, noise level, drift, flow rate, linearity, and daily performance checks.

3.4.2 Accuracy

SOPs will contain mechanisms for demonstrating the relationship of the reported data compared with the "true" value(s).

3.4.2.1 Traceability of Instruments

A unique identification number will be assigned to each measurement device. Documentation will identify the specific measurement device, where and when it was used, maintenance performed, and the equipment and standards used for calibration.

3.4.2.2 Traceability of Standards

Each standard and measurement device will be calibrated against a standard of known and higher accuracy, when possible. All calibration standards will be traceable to available National Institute of Standards and

Technology (NIST). If NIST standards do not exist, other validated (primary) standards will be used or the basis for calibration will be documented.

3.4.2.3 Traceability of Samples

At the time each sample is collected, it will receive a unique identification number. Documentation will identify sampling time, place, and action taken on each sample in accordance with the procedure for sample chain of custody.

3.4.2.4 Traceability of Data

Data will be documented to allow complete reconstruction from initial field records through retrieval from the data storage system .

3.4.2.5 Reference, Spiked, or Blind Samples

Recoveries of reference, spiked, or blind samples will be within predetermined acceptance limits.

3.4.3. Representativeness, Comparability, and Completeness

Where appropriate, statements on representativeness, comparability, and completeness will be included.

4.0 DESIGN CONTROL

Identifying and documenting design criteria for ER activities and projects involves establishing the performance and quality objectives that a project or activity must achieve. Selection and definition of appropriate functional criteria and other design inputs are necessary to ensure that correct bases are established for engineering design. Controls will be established for engineering design activities to ensure that engineering designs and design data comply with functional design criteria and other specified requirements.

Planning will be documented to provide early and adequate assurance that the specified requirements can and will be met. Procedures will be used to specify design activities, including analyses, calculations, and the preparation and control of drawings and documents. Procedures will be developed to verify that the products of engineering design comply with functional design criteria and meet specified requirements.

Laboratory facilities that are designed, engineered, or constructed specifically for the ER of laboratory areas or solid waste management units (SWMUs) are exempt from these design controls. Design control requirements for these facilities are addressed in the Laboratory Quality Manual for Engineering and Construction (Facilities Engineering Division).

5.0 CONTROL OF PROCUREMENT DOCUMENTS AND PURCHASED ITEMS AND SERVICES

The procurement of items and services will be controlled to ensure conformance with the requirements listed below. The extent to which controls are applied depends on the importance and complexity of the item or service and the need to control an activity to ensure the quality of the item or service. In general, commercial, off-the-shelf items and equipment are exempt from stringent procurement requirements.

Procurement documents will contain the following information, as appropriate:

- description of the scope of work,
- technical requirements for the work,
- Quality Program requirements,
- a right-of-access provision,
- subcontracting requirements (including having subcontractors pass through appropriate QA requirements),
- documentation requirements, and
- applicable design bases.

Acceptance of services performed requires documentation of audits, a technical review of data generated, or other objective evidence of satisfactory performance.

Methods of acceptance for items include

- supplier certificate of conformance,
- a source verification,
- a receiving inspection,
- a postinstallation test at the facility site, or
- a combination of the above.

6.0 INSTRUCTIONS, PROCEDURES, PLANS, AND DRAWINGS

A method for initiating, preparing, reviewing, and approving instructions, procedures, and drawings for ER Program QA and technical activities will be established and maintained. Activities that typically require approved, detailed procedures include, but are not limited to, audits, records and document control, data assessment, and field and laboratory operations.

6.1 QUALITY ASSURANCE PROJECT PLANS

All projects that generate environmental data mandated by the Hazardous and Solid Waste Amendments (HSWA) Module require a QAPjP. DOE/UC has prepared a generic QAPjP applicable to its site investigation activities (Appendix T). Task-specific QAPjPs may incorporate the generic QAPjP by reference, as appropriate.

A QAPjP must be prepared according to the Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans (EPA 1980) and the Regional Technical Assistance for Preparing Quality Assurance Project Plans (EPA 1985); it should also reference approved SOPs whenever possible. The level of detail of a QAPjP will depend on the requirements of the OU work plan and other special considerations. Each QAPjP must address the following 16 elements. If an element does not apply, an explanation must be included in the corresponding subsection of the QAPjP. Some modifications to the plan may be necessary during the course of the project.

Each QAPjP must include the following items:

- title page with provision for approval signatures;
- table of contents;
- project description;
- project organization and responsibility;
- DQOs for measuring the precision, accuracy, completeness, comparability, and representativeness of data;
- sampling procedures;
- chain-of-custody requirements;
- calibration procedures and their frequency;

- analytical procedures;
- data reduction, validation, and reporting;
- internal quality control checks and their frequency;
- performance and system audits and their frequency;
- QA reports to management;
- preventive maintenance procedures and schedules;
- specific routine procedures to assess precision, accuracy, representativeness, completeness, and comparability of data; and
- corrective action.

6.2 STANDARD OPERATING PROCEDURES

SOPs describe standard operations, analyses, or actions commonly accepted as the usual or normal method of conducting repetitive or routine work. SOPs are detailed documents describing who does what, when, where, how, and why, in a stepwise manner. They will be sufficiently complete and detailed enough to ensure that

- data of known quality are generated to meet measurement objectives and
- minimal loss of data results from out-of-control conditions.

SOPs will be

- adequate to establish traceability of standards, instrumentation, samples, and environmental data;
- consistent with sound scientific and engineering principles; and
- consistent with the instrument manufacturers' instruction manuals.

Documentation for SOPs will include

- a record of the performance of all tasks and their results;
- an explanation of the cause of missing data; and

- a validation of data each time they are recorded, calculated, or transcribed.

To accomplish these objectives, SOPs will address the following areas, as applicable:

- sampling and analytical methodology;
- special precautions, such as holding times and preservation;
- federal reference, equivalent, and alternate test procedures;
- selection and use of instrumentation;
- calibration and standardization;
- preventive and remedial maintenance;
- replicate sampling and analysis;
- blind and spiked samples;
- quality control procedures such as inter- and intralaboratory or field activities;
- documentation;
- sample custody and handling procedures;
- sample transportation;
- data-handling and evaluation procedures;
- precision, accuracy, completeness, representativeness, and comparability; and
- document control.

Measurement activities will adhere to established EPA regulations and guidelines and ER Program SOPs. Deviations will be justified and documented in field and/or laboratory notebooks and/or logbooks. Adherence to approved SOPs will be determined during systems audits. SOPs will be revised as necessary. SOPs covering H&S are covered in the ER Program H&S plan (Annex III).

6.3 QUALITY ADMINISTRATIVE PROCEDURES

QPs will describe the methods for performing and implementing the quality requirements identified in this QPP (e.g., requirements for records management, corrective action, procedure preparation).

7.0 DOCUMENT CONTROL

Documents that prescribe activities affecting quality (such as work plans, procedures, instructions, and directives) will be prepared, revised, reviewed, and issued in accordance with written procedures. These procedures will use logs, registers, transmittals, acknowledgments, or other control measures to determine the status of documents and to describe how documents, including changes thereto, are reviewed and coordinated before approval and issuance.

Changes to documents, other than those defined as minor changes, will be controlled by the same measures (or their equivalent) used to control the original document. They will be reviewed and approved by the organizations that originally reviewed the documents and approved the changes, unless other organizations are specifically designated. The reviewing organization will have access to pertinent background data or information upon which to base its reviews.

Changes that do not alter a document's intent, objectives, or quality requirements will be considered minor and will not be subject to the requirements of this section. Minor changes that can be made or authorized by the preparer of the document include typographical errors, punctuation, and other minor editorial corrections.

8.0 IDENTIFICATION AND CONTROL OF ITEMS AND SAMPLES

Procedures for identifying and controlling samples, analytical standards, and data will be established to ensure that these items are accurately and correctly marked and maintained. Procedures for field and laboratory sample identification and field and laboratory chain of custody will be established to maintain the identity and integrity (authenticity) of all samples and sample data. Procedures for traceability of standards will be developed to ensure that working standards may be traced to primary standard reference materials. The specific methods used for identifying and controlling samples, standards, and data will be described in detail in written procedures.

8.1 IDENTIFICATION OF FIELD SAMPLES

The specific procedures for identifying field samples will be referenced in the QAPjP for each project. The method of identifying field samples depends on the type of sample collected and analyses to be performed. Examples of specific logbook formats, sample labels, and chain-of-custody forms are included in written procedures.

8.2 CHAIN OF CUSTODY

Chain-of-custody procedures ensure that samples are maintained from collection to completion of analysis under continuous possession or are stored in secure areas. These procedures are necessary for demonstrating sample authenticity in legal proceedings.

A sample is considered to be in an individual's custody if

- it is in his or her possession; or
- it is in his or her view after being in his or her possession; or
- it was in his or her possession and he or she locked it up; or
- it is in a designated secure area.

8.3 SAMPLE TRANSFER

Transferring possession of samples will be documented in a chain-of-custody document. Specific procedures and documents used for performing and documenting sample transfer are described in written procedures.

Laboratory approval for receipt of samples is documented when the designated representative of an internal or contractor laboratory signs the chain-of-custody document.

Transfer of samples off the site must be done in a manner that ensures the physical and evidentiary integrity of the samples. Samples should be transferred according to approved shipping procedures and in conformance to Department of Transportation (DOT) regulations and applicable UC requirements.

8.4 LABORATORY CHAIN-OF-CUSTODY AND SAMPLE IDENTIFICATION PROCEDURES

Laboratory chain-of-custody and sample identification procedures are established to ensure that samples are under custody while in a laboratory, that sample custody is documented and traceable, and that laboratory sample identification numbers are cross-referenced to field sample numbers.

8.5 TRACEABILITY OF ANALYTICAL STANDARDS

Analytical standards are used to calibrate analytical instruments and to verify the accuracy of the results. Analytical standards are traceable to primary standard reference materials. Limited-life items will be controlled to discourage use beyond their expiration dates. Vendor-established dates may be evaluated to determine their validity and may be modified (extended or reduced) based on the experience of professional analysts. The best available standards of a known concentration are used to verify calibrations. Documentation is provided for all standards preparations and standards used.

9.0 CONTROL OF PROCESSES

9.1 DATA COLLECTION

The QAPjP will address the methods to be used to eliminate or avoid errors during the data collection process. Collection of data may be manual or electronic and may have many different sources ranging from historical data to direct field measurements. Where field measurements or observations are made, the data collected will be entered in field logbooks or notebooks. Bench records will be maintained for laboratory data. Data that may be collected include monitoring data, values, date and time of activity, site conditions, field calculations, engineering analyses, and any other pertinent information.

9.2 VALIDATION

Data validation is defined as the process whereby data are filtered and accepted or rejected based on a set of predetermined criteria. Data validation consists of reviewing data for compliance with method acceptance criteria and then evaluating the usability and validity of the data. All calculations and records will be examined, quality control sample results will be checked, and the data set will be qualified.

The quality of sample analyses will be controlled and verified by established acceptance criteria to ensure that process parameters are controlled and that specified environmental measurement conditions are maintained. Acceptance criteria will be established for each analytical method. Acceptance criteria for analytical parameters are typically documented by maintaining control charts; however, records demonstrating that acceptance criteria have been achieved are an acceptable substitute.

Laboratories performing sample analyses for the ER Program will be responsible for maintaining quality control charts. Analysts are responsible for documenting all process acceptance criteria and updating control charts in a timely and orderly manner. Separate control charts will be maintained for each instrument and analyst.

Data outside the upper and lower bounds for acceptance will be qualified and reported to the PL, who will decide whether the data collection or analysis must be repeated. Validation of data collection and reduction is assured through regular evaluations that include checking results for errors in computer entry, data transmission, and transcription during data processing. Data validation will be performed using established guidelines so that consistent reviews are obtained.

10.0 INSPECTION

Activities associated with scientific investigations relating to site characterization do not ordinarily require that engineering inspections be made to verify conformance of an item or activity to specified requirements. Other activities that will require inspection-related activities (such as acceptance of received materials, technical reviews, document compliance, and project auditing) are covered in this QPP.

All engineered/fabricated items used for hazardous and/or radioactive waste containment or other means of remediation as part of the ER Program will be inspected. Inspection of design activities will be conducted by specialists who are independent of primary design activities. Inspections can be conducted to review any aspect of design activities. Quality inspections of design efforts include a review of activities and independent verification performed as part of the design process.

Inspections related to construction will be conducted by the construction contractor or by Facilities Engineering Division staff at the Laboratory according to approved procedures. Before construction begins, the inspector will review design drawings and specifications. Materials inspections include comparison with purchase requisitions and purchase orders in a manner commensurate with their impact on quality.

11.0 TEST CONTROL

As defined by NQA-1, a test is a measurement against a known standard. In the scientific investigation process for site characterization, such tests are made only in the sense of calibration of equipment (Section 12).

Tests of all engineered and fabricated items used for containing hazardous and/or radioactive waste will be described in specific test plans. These plans will be reviewed by an independent specialist to ensure that the tests are appropriate. The tests include soils tests for foundation suitability, strength, soil consistency, and unconfined compressive strength. Materials tests may also be needed to verify liner performance, concrete mixes, etc.

12.0 CONTROL OF MEASURING AND TEST EQUIPMENT

General laboratory and field equipment must be appropriate for its intended use and must be available in sufficient quantities and condition to generate and process environmental data that result in documented quality and integrity.

12.1 EQUIPMENT IDENTIFICATION

Each piece of analytical equipment will be uniquely identified either by the manufacturer's model and serial number or by a UC property number. For each piece of equipment used, there will be a permanent record containing service, maintenance, and records of calibration and periods of use.

12.2 MAINTENANCE AND CALIBRATION OF MEASURING AND TEST EQUIPMENT

Permanent records of the maintenance histories of measuring and test equipment (including detailed descriptions of adjustments made and parts replaced) will be kept in bound notebooks or logbooks and will be signed and dated.

All equipment used for monitoring, measuring, or testing must have an established calibration and preventive maintenance procedure. This procedure will be outlined in an equipment-specific SOP. Equipment will be calibrated against known standards or with procedures outlined by the manufacturer. Where applicable, service agreements for the equipment may be obtained and used. Routine calibration services are provided by the Electronic Vacuum Maintenance Group (MEC-9) at the Laboratory.

If a piece of equipment is found to be out of calibration, previous measurements or test results will be reviewed. Equipment that is out of calibration will be immediately removed and will not be used again until it can be recalibrated. If calibration cannot be maintained, the equipment must be replaced or repaired.

Calibration and control measures may not be required for rulers, tape measures, levels, and other such devices if normal commercial equipment provides adequate accuracy.

13.0 HANDLING, STORAGE, AND SHIPPING

Procedures for handling, field storage, custody transfer, shipping, receiving, and laboratory storage of samples; laboratory identification and security of samples; tracking of samples; and data file assembly for ER Program samples and associated analytical data will be specified and controlled to prevent contamination, damage, or loss and to minimize the deterioration of samples and standards. Personnel involved in handling, shipping, or storing samples will be trained in performing the specific procedures used.

14.0 INSPECTION, TEST, AND OPERATING STATUS

The requirements of this section apply to engineered items. Because site characterization activities do not produce engineered items, the requirements of this section do not apply to site characterization.

For engineered facilities that are used for hazardous and/or radioactive waste containment, this criterion refers to the operational readiness of the facility and to the operating status of support systems, such as environmental sampling and monitoring systems and waste inspection and handling systems. Activities demonstrating the operational readiness of such a facility will be identified. The facility's design and construction records will be reviewed. The results of tests, inspections, surveillances, audits, and corrective actions will be reviewed. All identified nonconformances will be resolved before determining that the construction task has been completed and that the facility is operable.

15.0 CONTROL OF NONCONFORMING ITEMS

Nonconforming items can be related to materials, operating equipment, test equipment, analytical equipment, unacceptable reports, or unacceptable construction work. In all cases, nonconforming items will be clearly identified (by label or by designation) and will be removed from service or otherwise controlled until a resolution has been completed and documented.

16.0 CORRECTIVE ACTION

A corrective action procedure will be developed to provide an effective method for identifying and correcting deficiencies that are adverse to quality. All personnel are responsible for identifying adverse conditions.

An effective corrective action program contains the following requirements:

- Conditions that adversely affect quality will be promptly investigated to determine the cause and to initiate corrective action to prevent recurrence.

- Documentation of the cause and corrective action required to mitigate the adverse problems will be performed and reported to the appropriate levels of management.

- Actions that must be taken to ensure the verification of corrective actions will be identified.

Corrective action procedures will have guidelines for determining when a corrective action is necessary, provisions to inform management of the need for a corrective action, and provisions for following up the corrective action to determine its success.

17.0 RECORDS

Adequate precautions will be taken during the reduction, manipulation, and storage of data to prevent the introduction of errors or the loss or misinterpretation of data. Data processing consists of collection, validation, storage, transfer, and reduction. The RMP (Annex IV) addresses the programmatic needs for all stages of technical data, program records, technical literature, and other support documentation.

All records generated by UC and its subcontractors for the ER Program are the property of the ER Program Office.

17.1 DATA COLLECTION, VALIDATION, AND REDUCTION

EPA guidance documents will be followed in the development of procedures for sample collection and analysis, data reduction, and data validation.

17.2 DATA AND RECORDS MANAGEMENT

A records system to identify and classify project records will be established. The records system will be defined and implemented in accordance with written procedures, which will specify how records are identified, classified (lifetime or nonpermanent), indexed, reviewed (inspected), stored, protected, and retrieved.

The FIMAD will be the ultimate repository for data and records. Records that document evidence of quality will be specified, prepared, and maintained in accordance with appropriate QPs and will comply with DOE Order 1324.2A, Records Disposition (DOE 1988). The records will be legible, identifiable, and retrievable and will be protected against damage, deterioration, or loss.

18.0 AUDITS AND SURVEILLANCE

QA audits and surveillances will be performed to verify compliance of ER Program activities with all aspects of the Quality Program. Audits will be conducted by qualified, certified audit staff in accordance with written plans and check lists. Audits will be scheduled to provide coverage of and coordination with ongoing QA activities and will be conducted at a frequency commensurate with the importance of the audited activity. Audit teams will have at least one individual who has technical expertise in the activity to be audited if the activity is part of a scientific investigation activity.

Surveillances will be performed by ER Program QA personnel, or their designated representatives, who have the qualifications, experience, training, or expertise relevant to the project or activity under surveillance. Surveillances are conducted on an ad hoc basis and do not require formal scheduling; however, notification of an impending surveillance is normally provided in writing to the affected organization(s).

19.0 SOFTWARE QUALITY ASSURANCE

Controls will be established over the development, modification, acquisition, and use of software in accordance with DOE Order 1330.1C Computer Software Management (DOE 1990). Newly developed or modified software will receive an independent technical review. Software will be verified, and validated when required, through testing. Records of software configuration will be maintained. Software will be protected against uncontrolled changes and against loss or damage. Software applications will be documented, and application problems will be documented and resolved.

20.0 QUALITY IMPROVEMENT

A quality council will be formed consisting of representatives from the technical teams. This council will recommend and review proposals for improving the Quality Program. The council will focus on continuously improving the program and preventing problems to produce results that continuously meet or exceed requirements.

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■ HEALTH AND SAFETY PROGRAM PLAN

1.0 INTRODUCTION

In March 1990, the US Environmental Protection Agency (EPA) issued the Hazardous and Solid Waste Amendments (HWSA) Module of the Resource Conservation and Recovery Act (RCRA) permit for operating Los Alamos National Laboratory (the Laboratory). This Health and Safety (H&S) plan fills the requirement in the HSWA Module for such a plan and includes relevant information about the entire Environmental Restoration (ER) Program to allow review by H&S experts.

The purpose of this H&S plan is to provide a safe environment for workers at the Laboratory and the public by setting forth the procedures that will be followed throughout the ER Program at the Laboratory. The plan addresses applicable H&S regulations but does not discuss specific hazards that are likely to be encountered at each investigative site; detailed analysis of hazards at specific sites will be presented in the H&S sections of the work plan's specific RCRA facility investigations (RFIs) and corrective measures studies (CMSs) that will be prepared for operable units (OUs) for corrective action at the Laboratory. The H&S plans for specific OUs will address site-specific concerns as outlined in this H&S program plan.

2.0 HEALTH, SAFETY, AND ENVIRONMENTAL PROTECTION REGULATIONS

The University of California (UC) is committed to performing ER work in ways that provide for (1) the health and safety of workers at ER sites, (2) the health and safety of the people in the surrounding areas, and (3) the protection of the environment. This work will be done in compliance with all applicable federal, state, and local laws and regulations, with all applicable Department of Energy (DOE) orders and H&S standards, and with UC health, safety, and environment standards for the Laboratory. This H&S plan, as well as the work to be performed under the HSWA Module, is governed by the requirements shown in Table III-1.

The DOE's policy is to ensure that operations at its facilities are conducted in a manner that limits risks to the health and safety of the public and employees and that adequately protects property and the environment (DOE Order 5480.1B). This policy is implemented through developing H&S programs for contractors and systematically reviewing operations and facilities.

The DOE has implemented its health, safety, and environmental protection requirements in orders from headquarters and, for the Laboratory, from the DOE's Albuquerque Operations Office (DOE/AL). In addition, the DOE has adopted as its policy the health and safety standards of the American Conference of Government Industrial Hygienists, the American National

TABLE III-1. REQUIREMENTS GOVERNING THIS HEALTH AND SAFETY PLAN

EPA REQUIREMENTS

Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities (National Institute of Occupational Health and Safety 1985)
EPA Order 1440.2, Health and Safety Requirements for Employees Engaged in Field Activities
EPA Order 1440.3, Respiratory Protection
Approved Installation Contingency Plan
EPA Operating Safety Guide
OSHA regulations, particularly those in 29 CFR 1910 and 1926
State and local regulations
Other EPA guidance as provided

DOE REQUIREMENTS REQUIRED BY DEPARTMENT OF ENERGY

DOE Order 1540.2, Hazardous Material Packaging for Transport Administrative Procedures
DOE Order 5000.3A, Occurrence Reporting and Processing of Operations Information
DOE Order 5480.1B, Environment, Safety, and Health Program for Department of Energy Operations
DOE Order 5480.3, Safety Requirements for the Packaging and Transportation of Hazardous Materials
DOE Order 5480.4, Environmental Protection, Safety, and Health Protection Standards
DOE Order 5480.10, Contractor Industrial Hygiene Program
DOE Order 5480.11, Radiation Protection for Occupational Workers
DOE Order 5481.1B, Safety Analysis and Review System
DOE Order 5482.1B, Environment, Safety, and Health Appraisal Program
DOE and AL Orders 5483.1A, Occupational Safety and Health Program for DOE Contractor Employees at Government-Owned Contractor-Operated Facilities
DOE and AL Orders 5484.1, Environmental Protection, Safety, and Health Protection Information Reporting Requirements
DOE Order 5500.2, Emergency Planning, Preparedness, and Response for Operations
DOE Order 5500.3, Reactor and Nonreactor Nuclear Facility Emergency Planning, Preparedness, and Response Program for DOE Operations
DOE Order 5500.4, Public Affairs Policy and Planning Requirements for Emergencies

OTHER FEDERAL REGULATIONS

40 CFR 300, National Oil and Hazardous Substances Pollution Contingency Plan
49 CFR 172-174, Transportation of Hazardous Materials

LABORATORY REQUIREMENT

Compliance with Environment, Safety, and Health Manual

Standards Institute, and the Occupational Safety and Health Administration (OSHA).

3.0 BRIEF DESCRIPTION OF ENVIRONMENTAL RESTORATION SITES, THEIR LOCATIONS, AND POTENTIAL HAZARDS

The Laboratory originated in 1943 as a weapons development facility to design and produce atomic bombs as part of the World War II effort. The work performed in this mission and in research and development activities since World War II has resulted in the deposition of hazardous materials at a large number of locations around the Laboratory. Many of these locations meet the definition of solid waste management units (SWMUs) in the HSWA Module. The contents of these disposal and discharge areas reflect the diverse operations at the Laboratory. Some areas contain nonhazardous solid wastes, some contain hazardous wastes, some contain radioactive materials, and some contain combinations of these three materials (Table III-2). The general locations of the SWMUs are shown in Figure III-1.

Workers at ER sites may encounter conditions that result in injuries or illnesses from chemical, radiological, physical, or biological hazards. For workers at sites containing chemical and radiological materials, the most likely pathways are inhalation, ingestion, and dermal absorption. Engineering and administrative controls will be used whenever possible to minimize risks. Workers will be required to wear appropriate respiratory protection as needed to eliminate the hazards of inhaling hazardous materials. Smoking, eating, and drinking will be prohibited in locations where workers might ingest hazardous or radioactive materials. Outer garments that are appropriate for the work being done will be provided to protect workers' skin and personal clothing against dermal absorption or contamination with hazardous materials. Disposable, chemically resistant outer garments generally will be worn to protect the workers' bodies and personal clothes, and they will wear gloves to protect their hands.

Another chemical hazard at certain ER sites is the possible presence of explosive materials. A field monitoring program will determine whether explosives are present, and workers will be thoroughly trained in safety procedures for working with explosive materials.

The physical hazards likely to be encountered by workers often will depend on the weather conditions and topography where the work is being done. Weather-related hazards include hypothermia in cold weather; heat stress in hot weather; the possibility of lightning strikes; and falls on surfaces made slippery by water, ice, snow, or hail. Topographic features at some ER sites include steep surfaces or cliffs and other rugged terrain. Both weather-related and topographic hazards will be discussed with workers during pre-entry safety meetings.

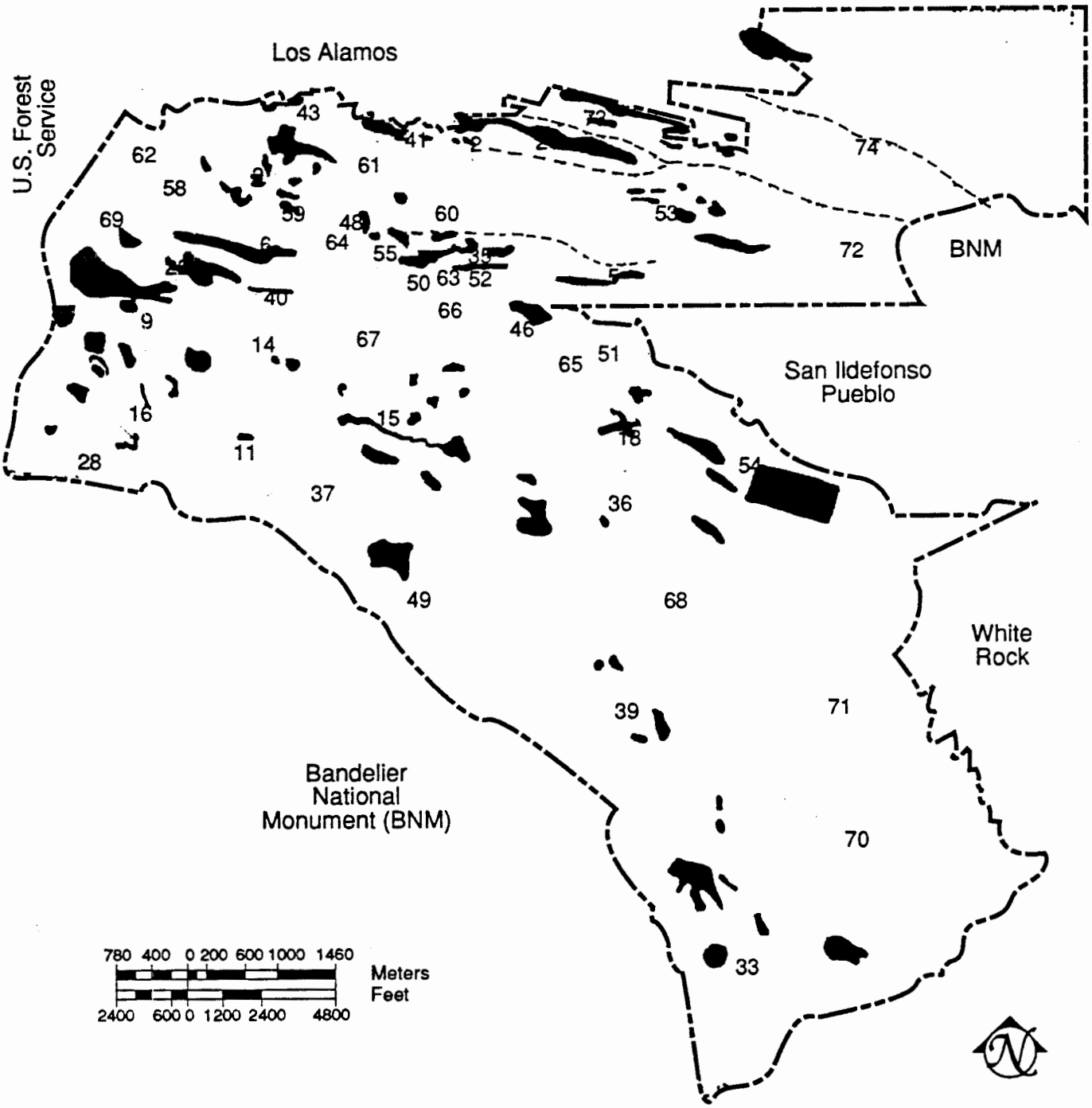

Figure III-1. Potential contaminated areas.

TABLE III-2. SUMMARY LIST OF SOLID WASTE MANAGEMENT SITES AND PRINCIPAL POTENTIAL CONTAMINANTS

Operable Unit ID No.	Operable Unit Title	Principal Potential Contaminants	Types of Release Site
1049	Canyons TA-33	Radionuclides/Hazardous Waste Radionuclides/Solvents/Metals including Beryllium, Mercury, Lead, Uranium	Contaminated Sites Contaninated Areas/ Firing Sites/Burn Pit/ Material Disposal Areas D, E, and K/Septic Systems/ Outfalls
1071	TA-0, 19, 26, 73, 74	Radionuclides/Petroleum Products/ High Explosives/Lead/Uranium	Contaminated Areas/ Incinerator/Firing Range/ Landfill/Underground Storage Tanks
1077	TA-10, 31, 32, 45	Radionuclides/Metals/Solvents/ Acids/High Explosives	Contaminated Areas/ Landfill/Septic System
1078	TA-1	Radionuclides/Metal/Organics Waste Lines/Septic Systems/ Disposal Areas	Contaminated Areas/Acid
1082	TA-11, 13, 16, 24, 25, 28, 37	High Explosives/Photoprocessing Chemicals/Plating Wastes/ Beryllium/Acids/Organics	Contaminated Areas/Septic Systems/Landfills/Burn Pits/ Material Disposal Area R
1085	TA-12, 14, 67	Radionuclides/High Explosives/ Metals Including Beryllium, Aluminum, Copper, Lead	Contaminated Areas/ Firing Sites/Burn Areas/ Landfill
1086	TA-15	Radionuclides/Metals Including Beryllium, Cadmium, Mercury, Lead/Chromates/Acids/Petroleum Products	Contaminated Areas/Burn Pits/Shafts/Sumps/Septic Systems Material Disposal Areas N and Z
1093	TA-18, 27, 65	Radionuclides/High Explosives/ Metals, Including Beryllium and Mercury/Acids/Solvents	Contaminated Areas/Firing Pits/Septic Systems/Landfills /Underground Storage Tanks

1098	TA-2, 41	Radionuclides/Organics/Metals Including Beryllium and Mercury/ Potassium Dichromate/Solvents/ PCB-Contaminated Oil	Contaminated Areas/ Outfalls/Septic Systems/ Sumps/Burn Pits/Oil Storage
1100	TA-3, 59, 60, 61, 64	Radionuclides/Metals Including Beryllium, Chromium, Mercury/ Solvents/Petroleum Products	Contaminated Areas/Septic Systems/Underground Storage Tanks/Sumps/ Outfalls/Landfills
1100	TA-20, 53, 72	Radionuclides/High Explosives/ Metals Including Beryllium and Nickel/Corrosion Inhibitors	Contaminated Areas/Disposal Pits/Firing Sites/Lagoons/ Outfalls
1106	TA-21	Radionuclides/Metals Including Beryllium/Nitric Acid/Fluorine/ Various Chemicals	Contaminated Areas/ Underground Storage Tanks/ Liquid Waste Wells/ Landfills/Material Disposal Areas A, B, T, U, and V
1111	TA-6, 7, 22, 40, 58, 62	Radionuclides/High Explosives/ Metals Including Beryllium, Cadmium, Mercury, Lead/Solvents/ Water Treatment Chemicals	Contaminated Areas/Disposal Pits/Firing Sites/Septic Systems/Sumps/Underground Storage Tanks/Material Disposal Area F
1127	TA-4, 5, 35, 42, 48, 52, 55, 63, 66	Radionuclides/High Explosives/ Waste Oil/Heavy Metals/Solvents	Contaminated Areas/Septic Systems/Outfalls/Firing Point
1130	TA-36, 68, 71	Radionuclides/High Explosives/ Nitric Acid/Metals Including Aluminum, Copper, Silver/Organics Including Nitrobenzene	Contaminated Areas/ Firing Sites/Burn Pits/ Drop Tower/Material Disposal Area AA
1132	TA-39	Radionuclides/Metals/High Explosives/Photoprocessing Chemicals	Contaminated Areas/Firing Sites/Landfills/Septic Systems/Material Disposal Area Y
1136	TA-43	Radionuclides/Hazardous Waste/ Corrosion Inhibitors	Contaminated Areas/ Outfalls
1140	TA-46	Radionuclides/Acids/Organics/ Various Chemicals/Petroleum Products/Metals	Contaminated Areas/Outfalls/ Septic Systems/Sumps/ Landfill/Stabilization Pit

1144	TA-49	Radionuclides/Metals Including Beryllium and Lead/Solvents/Acids	Contaminated Areas/ Septic System Leach Fields/ Burn Area/Material Disposal Area AB
1147	TA-50	Radionuclides/Waste Oil/Heavy Metals/ Acids/Solvents	Contaminated Areas/ Septic Systems/Material Disposal Area C
1148	TA-51, 54	Radionuclides/High Explosives/ Hazardous Wastes	Contaminated Areas/ Material Disposal Areas G, H, J, and L
1154	TA-57	Radionuclides/Hazardous Waste	Contaminated Areas/ Disposal Area
1157	TA-8, 9, 23, 69	Radionuclides/High Explosives/ Organics/Asbestos/Photoprocessing Chemicals	Contaminated Areas/ Firing Sites/Burn Areas/ Landfills/Septic Systems/ Material Disposal Areas M and Q

Another occupational hazard is noise. If sound levels exceed 90 dBA, feasible engineering or administrative controls will be used to reduce exposure to noise. Hearing protection, such as ear plugs or ear muffs, will be required, as appropriate, if noise exposures still exceed 90 dBA. Workers who operate equipment in the vicinity of electrical power lines will be required to conform to OSHA standards.

Biological hazards may include bites from poisonous snakes, bites from ticks that can cause Rocky Mountain spotted fever, and bites from fleas that carry bubonic plague. For proper medical care workers bitten by a rodent or a snake will report that fact immediately to the site safety officer. First aid supplies will be available.

A detailed discussion of the known hazards and an evaluation of the risks to workers and to others will be prepared as part of the H&S section of the site-specific plans that address each operable unit.

4.0 ACCESS TO SOLID WASTE MANAGEMENT UNITS

All areas addressed by the ER Program are located near paved or dirt roads. Access to some sites, however, can be impeded by rugged canyon terrain.

Throughout most of the year, almost all SWMUs can be reached by two-wheel-drive vehicles. However, after some snowstorms in the winter and some heavy rainstorms in the summer, access to a few of the sites requires the use of four-wheel-drive vehicles. Four-wheel-drive vehicles are available for use, if necessary.

The Los Alamos Medical Center (LAMC) is the only hospital near the Laboratory. Both the staff and the facilities at the LAMC are able to handle and treat injuries involving radioactivity or hazardous materials. Medical treatment facilities are maintained at three locations on the Laboratory site. These facilities are staffed by the Occupational Medicine Group (HSE-2) and are equipped to provide treatment for minor injuries and initial medical treatment for patients en route to LAMC. HSE-2 is well trained in recognizing and treating toxicologic and radiologic injuries and illnesses.

The maximum distance by road from an ER site to LAMC is about 20 mi, although most sites are much closer. Normally, injured people are transported by road. Because of the terrain, fixed-wing aircraft cannot be used for medical transport. The closest helicopters available for medical evacuations are based in Albuquerque, 60 mi south of Los Alamos. Usually, ill or injured workers can be transported more quickly to LAMC by ground transportation than to Albuquerque by helicopter.

The utilities available at each ER site vary with location. Many of the sites have telephone, electric power, and water lines nearby; some do not. The availability of utilities at each SWMU will be discussed in the H&S plans for each operable unit.

When telephone service is not readily available, the primary means of rapid communication to off-site locations is self-contained, ultrahigh-frequency radio transmitter and receiver units. The Laboratory has numerous base stations for such transmission, but transmissions to and from some canyon locations can present problems and will be dealt with appropriately.

5.0 RESPONSIBILITIES

The Laboratory's Environment, Safety, and Health Manual (LANL 1990) sets forth policy for management and employee responsibilities and for the safety of contract personnel and visitors.

The following paragraphs are policy statements quoted from this manual.

- Management Responsibility

The primary responsibility for employee health and safety on the job, as well as for environmental protection from UC operations at the Laboratory, rests with line management; this responsibility will be given first priority before Laboratory operations are approved or carried out. Supervisors are expected to recognize and anticipate potential hazards, to inform employees of risks associated with their work, to specify protective measures, and to ensure that their employees receive appropriate training. Supervisors also will establish and maintain a system to ensure that appropriate consideration is given to significant changes made in operations, procedures, materials, or equipment that could affect the safety of an activity, including environmental impact.

- Employee Responsibility

Employees are often in the best position to evaluate health and safety risks that might result in harm to themselves and their co-workers. Therefore, UC employees are responsible for observing applicable health, safety, and environment procedures; for using prescribed personal protective equipment; for promptly reporting accidents, injuries, and unsafe conditions; and for participating in required medical and biological monitoring programs.

- Safety of Contract Personnel and Visitors

A safe work environment will be provided for contract personnel and visitors. This includes certain health protection services provided by the Health, Safety, and Environment (HSE) Division. The Laboratory's health, safety, and environment rules will be enforced for everyone visiting or working at the Laboratory.

Implementing these policies in the UC's ER Program requires that the primary responsibility for safety in the field reside with the project leaders in the division who perform or oversee the field work. The responsibility for environment, safety, and health concerns must continue through line management to each supervisor in the field.

Each field team will have a site safety officer and a person designated as the field team leader. The site safety officer will work with the field team leader to ensure that work is carried out safely. Administratively, the field team leader will not have authority to overrule the site safety officer in matters of health and safety. The organizational relationships for field work are shown in Figure III-2.

The site safety officer has a key role for the health and safety of workers at a hazardous or potentially hazardous site, for the safety of visitors, and for the safety of people off the site. The responsibilities of the site safety officer include

- evaluating the potential hazards at a site,
- being informed about the results of sample analysis pertaining to health and safety as the ER site investigation and remediation work progress,
- concurring with the field team leader about the location of exclusion area boundaries,
- presenting safety briefings to workers,
- determining protective clothing requirements for workers,
- determining personal dosimetry requirements for workers,

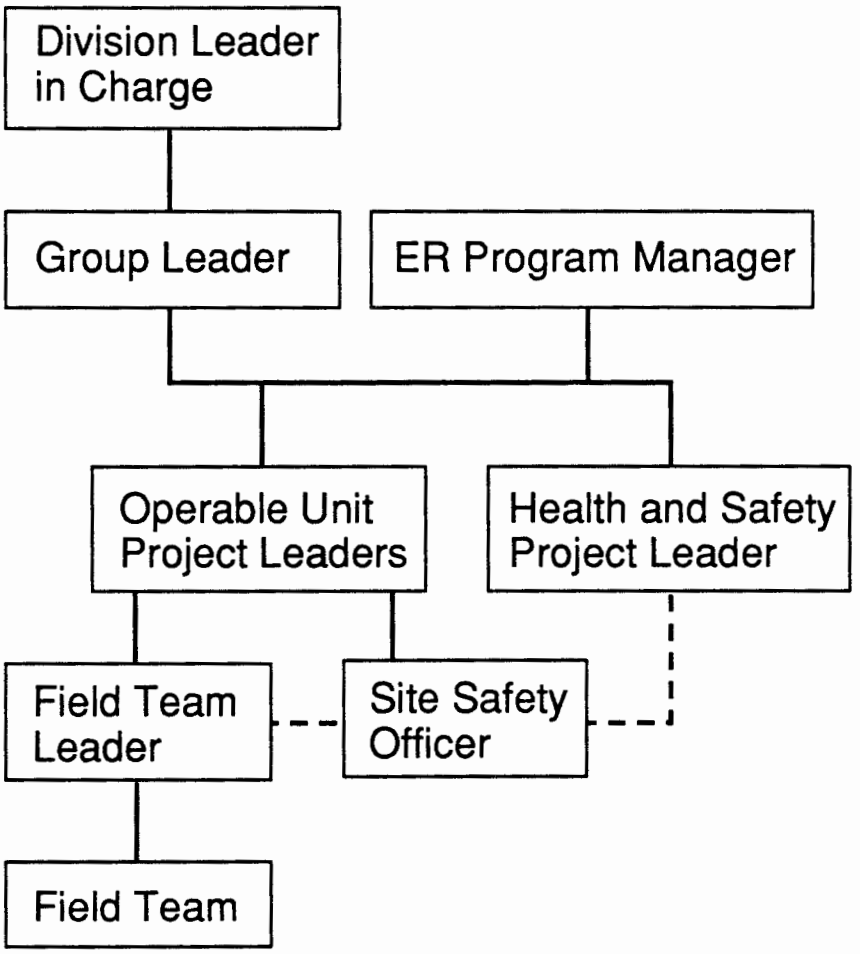

Figure III-2. Field work organization showing health and safety responsibility.

- maintaining a current list of telephone numbers for emergency situations,

- having an operating radio transmitter/receiver in case telephone service is not available,

- maintaining an up-to-date copy of the H&S plan for work at the site,

- maintaining an up-to-date copy of the emergency plan and procedure for the site,

- establishing the safety requirements to be followed by visitors,

- providing visitors with a safety briefing,

- maintaining a logbook of workers and visitors within the exclusion area at a site, and

- determining whether workers can perform their jobs safely under prevailing weather conditions.

The site safety officer will be trained in first-aid procedures and in cardiopulmonary resuscitation. The site safety officer will ensure that first-aid supplies are available at the site and will be informed about the locations of facilities for emergency medical care for injuries, including those for injuries that might involve contamination by radioactive materials or hazardous chemicals.

6.0 EMERGENCY PROCEDURES

The UC is committed to emergency planning at the Laboratory. The process of both analyzing the actions needed to respond appropriately to emergencies and of developing plans to deal with those emergencies is an important aspect of emergency preparedness. Emergency responses will be considered for each ER site and will be included with the H&S plan for each operable unit.

The Laboratory's Environment, Safety, and Health Manual discusses emergency response levels and the criteria for determining the appropriate response when toxic materials are involved. The American Industrial Hygiene Association's guidelines, which are based on the maximum concentration of toxic material that can be tolerated for up to one hour, have been adopted. Three emergency response planning guideline (ERPG) concentrations are defined below.

■ ERPG-1 The maximum airborne concentration of a toxic material below which it is believed that nearly all individuals could be exposed for up to one hour without experiencing other than mild, temporary adverse health effects or without perceiving a clearly defined, objectionable odor.

■ ERPG-2 The maximum airborne concentration of toxic material below which it is believed that nearly all individuals could be exposed for up to one hour without experiencing or developing irreversible or other serious health effects or symptoms that could impair an individual's ability to take protective actions.

■ ERPG-3 The maximum airborne concentration of a toxic material below which it is believed that nearly all individuals could be exposed for up to one hour without experiencing or developing life-threatening health effects. Concentrations at these levels require protective measures.

Four emergency response levels are defined in the Environment, Safety, and Health Manual: unusual event, site alert, site emergency, and general emergency. For the unusual event and site alert levels, the on-scene commander (the first emergency response person to arrive at the site) may elect to form an on-scene control group (OSCG), depending on the situation. For the site emergency and general emergency levels, authority for mitigating the emergency is transferred to the Laboratory's Emergency Operations Center (EOC), and the OSCG takes command at the scene. Actions at these four levels are described in the following sections.

6.1 RESPONSE TO AN UNUSUAL EVENT

This response is to an event that has occurred or is in progress that normally would not be considered an emergency but that could reduce the safety of the facility. In this situation, no potential exists for significant releases of radioactive or toxic materials to non-Laboratory lands. Activation of response organizations to emergencies outside the Laboratory is not expected, and emergency responses are limited to areas within Laboratory boundaries.

6.1.1 Employee Actions

The following actions should be taken by employees.

■ Protect the health and safety of employees and the public and reduce the possibility of further damage.

■ Notify appropriate emergency response personnel, such as the fire de-

partment, the protective force, Emergency Management Group (OM-1), and others, as required.

- Notify supervisory personnel.

6.1.2 Management Actions

The following actions should be taken by line management.

- Ensure that the environment and the health and safety of employees and the public are protected.

- Ensure that OM-1, division management, HSE Division management, and others, depending on the nature of the incident, have been notified.

- Investigate the cause of the incident and take corrective actions.

6.2 RESPONSE TO A SITE ALERT

The site alert is a response to an event that has occurred or is occurring or that could substantially reduce the safety level of the facility. In this situation, limited off-site release of radioactive materials may occur. Off-site releases of toxic materials are not expected to exceed the concentrations defined in ERPG-1. [Questions about materials that do not have an established ERPG should be addressed to the Industrial Hygiene Group (HSE-5).] The alert level ensures that on-site and off-site emergency response personnel are promptly advised and are available if needed, that monitoring is initiated as required, and that the responsible Laboratory organizations are notified of emergency conditions.

6.2.1 Employee Actions

The following actions should be taken by employees.

- Sound the appropriate alarm (fire, immediate evacuation, or announcement on the public address system).

- Protect the health and safety of employees and the public and reduce the possibility of further damage.

- Notify appropriate emergency response personnel, such as the fire department, the protective force, OM-1, and others as necessary.

- Notify supervisory personnel.

- Evacuate, if necessary.

6.2.2 Management Actions

The following actions should be taken by line management.

- Ensure that the environment and the health and safety of employees and the public are protected.

- Ensure that evacuation (if necessary) is complete.

- Ensure that personnel have been accounted for.

- Ensure that OM-1, division management, HSE Division management, and others, depending on the nature of the incident, have been notified.

- Report to the OSCG upon the arrival of the emergency management on-scene commander.

- Provide guidance and technical support for emergency mitigation and recovery.

6.3 RESPONSE TO A SITE EMERGENCY

This response is to an event that has occurred or is occurring and that involves actual or likely major failures of facility functions needed to protect on-site personnel, public health and safety, and the environment. In this situation, off-site releases of radioactive material not exceeding protective response recommendations are likely or are occurring. Off-site releases of toxic materials may exceed the concentrations described in ERPG-2. (Questions about materials that do not have an established ERPG should be addressed to HSE-5). The site emergency level response ensures that the emergency operation center is manned, appropriate monitoring teams are dispatched, personnel required for determining on-site protective measures are at duty stations, predetermined protective measures for on-site personnel are initiated, current information is provided to the DOE, and off-site officials and organizations are consulted.

6.3.1 Employee Actions

The following actions should be taken by employees.

- Sound the appropriate alarm (fire, immediate evacuation, or announcement on the public address system).

- Protect the health and safety of employees and the public and reduce the possibility of further damage.

- Evacuate the area, if possible.

- Notify appropriate emergency response personnel such as the fire department, the protective force, OM-1, and others, as necessary.

- Notify supervisory personnel.

6.3.2 Management Actions

The following actions should be taken by line management.

- Ensure that the environment and the health and safety of employees and the public are protected.

- Ensure that evacuation (if possible) is complete.

- Ensure that personnel have been accounted for.

- Ensure that OM-1, division management, HSE Division management, and others, depending on the nature of the incident, have been notified.

- Report to the OSCG upon arrival of the emergency management on-scene commander.

- Provide guidance and technical support for emergency mitigation and recovery.

6.4 RESPONSE TO A GENERAL EMERGENCY

This response is to an event that has occurred or is in progress and that substantially interferes with the functioning of facility safety systems. In this situation, off-site releases of radioactive material exceeding protective response recommendations are likely to occur or are occurring. Off-site releases of toxic materials are likely to occur or are occurring and exceed the concentrations described in ERPG-3. (Questions about materials that do not have an established ERPG should be addressed to HSE-5). The general emergency level initiates predetermined protective measures for on-site personnel, public health and safety, and the environment. It also provides continuous assessment of emergency conditions and permits exchange of

information both on and off the site. Declaring a general emergency will activate DOE-wide resources to deal with emergency conditions and to ensure protection of on-site personnel, the public, and the environment.

6.4.1 Employee Actions

The following actions should be taken by employees.

- Sound the appropriate alarm (fire, immediate evacuation, or announcement on the public address system).

- Protect the health and safety of employees and the public and reduce the possibility of further damage.

- Evacuate the area, if possible.

- Notify appropriate emergency response personnel such as the fire department, the protective force, OM-1, and others, as necessary.

- Notify supervisory personnel.

6.4.2 Management Actions

The following actions should be taken by line management.

- Ensure that the environment and the health and safety of employees and the public are protected.

- Ensure that evacuation (if possible) is complete.

- Ensure that personnel have been accounted for.

- Ensure that OM-1, division management, HSE Division management, and others, depending on the nature of the incident, have been notified.

- Report to the OSCG upon arrival of the emergency management on-scene commander.

- Provide guidance and technical support for emergency mitigation and recovery.

An H&S plan will be prepared as part of each OU work plan. In addition, for each ER site, an emergency plan will be prepared that will include procedures specific to various types of emergencies. A copy of these plans

must be available at the work site at all times. Personnel entering the exclusion zone must be familiar with the procedures. The plans will designate emergency contacts on a form such as the one shown in Figure III-3. Criteria for evacuation will be listed, as well as the type of alarm device that will signal an evacuation. Evacuation routes will be detailed, and the location of a visible windsock will be noted to allow upwind escape routes to be determined.

If any accident occurs in which off-site personnel must be notified to protect public health, the call lists referenced in the Laboratory's Environment, Safety, and Health Plan will be used to designate key response personnel and their alternates. The Laboratory's ER Program community relations coordinator and program manager will also be notified to help prepare emergency-specific information for the public.

7.0 CONTROL OF SITE ACCESS

To protect employees and the general public from unnecessary exposure to toxic materials or radiation and to prevent the spread of contamination, control zones will be established as necessary at sites with hazardous materials or potentially hazardous materials. The control or exclusion zone will be delineated by the field team leader with the concurrence of the site safety officer. The boundary of an exclusion zone will be defined based on the nature, magnitude, and extent of contamination; the potential for contaminant migration; and hazards at the site, such as high explosives or ordnance, flammable materials, use of mechanical equipment, possible impacts of projectiles from operational activities at nearby firing sites, the presence of electrical lines or other utilities, structures, tanks, pits, trenches, surface impoundments, and the presence of steep banks or cliffs. Different exclusion zones with different protective requirements may be established for a single site. Decontamination may be required for personnel, equipment, and vehicles moving from one zone to another. Furthermore, exclusion zone boundaries may be changed as operations progress. All changes will be designated by the field team leader, with the concurrence of the site safety officer.

A contamination reduction zone will generally surround the exclusion zone(s). A contamination reduction corridor through the contamination reduction zone will be established, the size of which will depend on the number of stations required for decontamination activities. The corridor should be located in a direction that is generally upwind from the exclusion zone.

Figure III-3. Typical emergency contact form.

EMERGENCY CONTACTS

Site Safety Officer

Name _____ Call _____

Environmental Restoration Health and Safety Officer

Name _____ Call _____

24-hr LANL Health/Safety Coordinator

Call _____

FIRE Call _____

AMBULANCE
Call _____

POISON CENTER
Call _____

SECURITY
Call _____

POLICE
Call _____

YOU ARE LOCATED AT

_____

THE NEAREST TELEPHONE IS LOCATED AT

_____

THE NEAREST EMERGENCY MEDICAL SERVICES ARE LOCATED AT

_____

_____

Additional control zones may be established for safety considerations other than contamination, such as hard-hat, steel-toed shoes, eye protection, and ear protection zones.

8.0 FIELD MONITORING EQUIPMENT

Field monitoring equipment will be used (1) to help determine the hazards at a site so that plans can be made for conducting work in a manner that minimizes personnel exposures to hazardous or radioactive materials and (2) to ensure that decontamination procedures are effective. The following guidelines set forth hazard-specific monitoring procedures:

- Explosivity—Continuous readings of combustible gas levels (explosivity) at ground, waist, and head levels will be obtained in confined areas or where the presence of explosive gases is suspected. The meter will be calibrated for the vapor that is present. If readings approach or exceed 10% of the lower explosive limit (LEL), extreme caution will be exercised in continuing the investigation. If readings approach or exceed 25% of the LEL, all personnel will be immediately evacuated from the site. Before resuming any on-site activities, project personnel should consult with fire protection experts and/or the local fire department and then develop explosion prevention procedures for safely conducting site work.

- Oxygen Deficiency—Confined spaces will be monitored for oxygen deficiency. Oxygen deficiency readings should be taken at ground, waist, and head levels. Any area with an oxygen level of less than 19.5% oxygen will require the use of a self-contained breathing apparatus or a supplied-air respirator. Under no circumstance should an air-purifying respirator be used for entry or work in a confined space or oxygen-deficient atmosphere. Because explosivity meters will not function properly in oxygen-deficient environments, areas with oxygen-deficient atmospheres should be treated as potentially explosive.
- Chemical Hazards—When it is necessary to work in an environment with the potential for organic chemical vapors, vapor concentrations will be monitored using a photoionization or flame ionization detection instrument. No respiratory protection equipment is necessary if the chemical constituents are known and the concentrations do not exceed the threshold limit values (TLVs). Air-purifying respirators may be worn when vapor concentrations do not exceed 5 parts per million (ppm) for a 5-min time-weighted average period. If vapors exceed 5 ppm or if the vapor does not have an odor that would warn of breakthrough, a self-contained breathing apparatus must be worn. If atmospheric concentrations exceed 500 ppm, the site will be evacuated, and appropriate health and safety personnel will be contacted to find out what additional personnel protective equipment or safety precau-

tions are required for continued site work. Areas in which high levels of vapors are encountered should be avoided, if possible.

■ Radiation—Radiation monitoring will be conducted at sites where radioactive materials may be present. If radiation levels approach 10.0 mR/hr, a detailed radiological site survey will be conducted. If radiation levels are greater than 10.0 mR/hr, the assistance of a radiation health physicist will be obtained before the site is entered.

Because resuspension of radioactively contaminated soil can result in radiation exposures and inhalation of radioactive particles, air monitoring will be conducted during activities in which airborne particles of contaminated soil may be a hazard to workers, and respiratory protection will be used, as appropriate.

Radiation exposures will be monitored through the use of thermoluminescent dosimeters (TLDs), other personal radiation dosimeters, radiation survey meters, and air monitoring as required by DOE Order 5480.1 Ch. XI. Radiation exposures will always be kept as low as can be reasonably achieved.

Administrative limits will be used to ensure that employees do not receive occupational exposures that exceed the quarterly or annual limits specified in DOE Order 5480.1 Ch. XI (Appendix A). If administrative limits or standards are exceeded, employees exposed to the elevated levels of radiation will be placed on work restrictions until the end of the period of concern. Employees under the age of 18 will neither be employed in, nor allowed to enter, controlled areas in which they may receive radiation exposures above background levels.

■ Noise—US Air Force Prescribed Standard AF 161-35 identifies the TLV for personnel exposure to noise. Protective hearing equipment and noise-suppression devices will be mandatory for levels above the TLV and will be encouraged for levels below the TLV.

9.0 PROTECTION LEVELS, PROTECTIVE CLOTHING, PROTECTIVE EQUIPMENT, AND GENERAL SAFETY PRACTICES

9.1 PROTECTION LEVELS

The EPA has established four levels of protection for personnel entering potentially hazardous sites. The four EPA protection levels and requirements for protective clothing are summarized below.

Additional control zones may be established for safety considerations other than contamination, such as hard-hat, steel-toed shoes, eye protection, and ear protection zones.

8.0 FIELD MONITORING EQUIPMENT

Field monitoring equipment will be used (1) to help determine the hazards at a site so that plans can be made for conducting work in a manner that minimizes personnel exposures to hazardous or radioactive materials and (2) to ensure that decontamination procedures are effective. The following guidelines set forth hazard-specific monitoring procedures:

- Explosivity—Continuous readings of combustible gas levels (explosivity) at ground, waist, and head levels will be obtained in confined areas or where the presence of explosive gases is suspected. The meter will be calibrated for the vapor that is present. If readings approach or exceed 10% of the lower explosive limit (LEL), extreme caution will be exercised in continuing the investigation. If readings approach or exceed 25% of the LEL, all personnel will be immediately evacuated from the site. Before resuming any on-site activities, project personnel should consult with fire protection experts and/or the local fire department and then develop explosion prevention procedures for safely conducting site work.

- Oxygen Deficiency—Confined spaces will be monitored for oxygen deficiency. Oxygen deficiency readings should be taken at ground, waist, and head levels. Any area with an oxygen level of less than 19.5% oxygen will require the use of a self-contained breathing apparatus or a supplied-air respirator. Under no circumstance should an air-purifying respirator be used for entry or work in a confined space or oxygen-deficient atmosphere. Because explosivity meters will not function properly in oxygen-deficient environments, areas with oxygen-deficient atmospheres should be treated as potentially explosive.
- Chemical Hazards—When it is necessary to work in an environment with the potential for organic chemical vapors, vapor concentrations will be monitored using a photoionization or flame ionization detection instrument. No respiratory protection equipment is necessary if the chemical constituents are known and the concentrations do not exceed the threshold limit values (TLVs). Air-purifying respirators may be worn when vapor concentrations do not exceed 5 parts per million (ppm) for a 5-min time-weighted average period. If vapors exceed 5 ppm or if the vapor does not have an odor that would warn of breakthrough, a self-contained breathing apparatus must be worn. If atmospheric concentrations exceed 500 ppm, the site will be evacuated, and appropriate health and safety personnel will be contacted to find out what additional personnel protective equipment or safety precau-

tions are required for continued site work. Areas in which high levels of vapors are encountered should be avoided, if possible.

■ Radiation—Radiation monitoring will be conducted at sites where radioactive materials may be present. If radiation levels approach 10.0 mR/hr, a detailed radiological site survey will be conducted. If radiation levels are greater than 10.0 mR/hr, the assistance of a radiation health physicist will be obtained before the site is entered.

Because resuspension of radioactively contaminated soil can result in radiation exposures and inhalation of radioactive particles, air monitoring will be conducted during activities in which airborne particles of contaminated soil may be a hazard to workers, and respiratory protection will be used, as appropriate.

Radiation exposures will be monitored through the use of thermoluminescent dosimeters (TLDs), other personal radiation dosimeters, radiation survey meters, and air monitoring as required by DOE Order 5480.1 Ch. XI. Radiation exposures will always be kept as low as can be reasonably achieved.

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9.0 PROTECTION LEVELS, PROTECTIVE CLOTHING, PROTECTIVE EQUIPMENT, AND GENERAL SAFETY PRACTICES

9.1 PROTECTION LEVELS

The EPA has established four levels of protection for personnel entering potentially hazardous sites. The four EPA protection levels and requirements for protective clothing are summarized below.

■ Hard Hats—Hard hats may be required for some work operations and may be worn with any level of protective clothing.

■ Safety Shoes—Steel-toed safety shoes and boots may be required for many field activities and may be worn with any level of protective clothing.

■ Hearing Protection—Ear muffs or ear plugs may be required when operating in areas with high noise levels. Care should be taken to ensure that hearing protection devices do not interfere with the ability to hear and respond to emergency warning signals.

■ Safety Glasses—Safety glasses or other eye protection will be required whenever there may be hazards to the eyes.

The site safety officer will determine what protective clothing will be worn by workers and visitors at a site. In all cases in which self-contained breathing apparatus is required, two persons will be suited up for entry and a third person will be suited as appropriate for back-up. For other types of work, the buddy system will be the standard.

9.3 PROTECTIVE EQUIPMENT

A variety of safety equipment may be used to protect personnel from safety hazards and to minimize exposures to hazardous chemicals and radionuclides during field investigations. In areas with potentially hazardous environments, ambient and portable monitors, meters, and alarms will be used to monitor exposures and to measure air concentrations of contaminants, explosive materials, and oxygen, as appropriate. Instruments will be selected for maximum reliability, sensitivity, selectivity, and safety in the field. Although specific safety-monitoring equipment needs will be identified in individual site H&S plans, a generic list of some of the safety equipment that might be used is briefly described below.

■ Portable oxygen indicator—A portable oxygen indicator is used to measure ambient oxygen concentrations in confined spaces or areas with high concentrations of gases other than air. The most useful indicators are those that measure from 0 to 25% oxygen. Oxygen indicators should be corrected for the elevation at the site.

■ Combustible gas indicator (CGI)—A combustible gas indicator is used to measure the concentrations of flammable vapors or gases. The indicator usually shows the concentration in terms of the percent of the LEL of the calibration gas. The LEL represents the lowest concentration (by volume) in air that can explode, ignite, or burn in the presence of an ignition source. The oxygen concentration will affect the accuracy of the CGI.

- Photoionization and flame ionization detection meters—Photoionization and flame ionization (organic vapor analyzer—OVA) detection meters can be used to indicate the approximate air concentration of many organic vapors. The response of the instruments depends on what gases have been used in calibration. In general, the instruments are more sensitive to complex organic compounds than to simple ones.

- Direct-reading colorimetric indicator tubes—Colorimetric indicator tubes may be used to quickly measure the approximate concentration of a vapor or gas. The tubes are made of glass and are packed with an indicator (reactive) chemical. Different tubes are needed for different gases. A specified amount of air is drawn through the tube to give an approximation of the concentration.

- High- and low-volume air samplers—Various types of high- and low-volume air samplers are available to measure ambient and personal breathing zone concentrations of particulates, vapors, and gases. Different filter sizes can be used to separate particulates into size categories.

- Radiation survey meters—A variety of radiation survey meters is available for measuring alpha particles, beta particles, gamma rays, and x-rays. Instruments include ion detection tubes, proportional counters, Geiger-Mueller (GM) counters, and scintillation detectors.

- TLDs—These dosimeters are used to measure absorbed ionizing radiation. They can be used both for ambient monitoring and for personnel dosimetry.

Other safety equipment will be available and used as needed. Safety devices, such as safety harnesses, belts and lines, and safety ladders and cherrypickers, will be used as appropriate to provide safe access and to protect workers from falls. Emergency equipment (fire extinguishers, first-aid kits, blankets, showers, and eye wash stations) will also be available for immediate response and emergency treatment. Emergency equipment will be clearly marked, and its locations will be shown on the site-specific H&S plan maps.

9.4 GENERAL SAFETY PRACTICES

Some hazards can be minimized by implementing specific procedures, using special equipment, training personnel, or ensuring availability of emergency response equipment in the event of an accident. The following general requirements must be observed during all ER RFI.

■ Eating, drinking, smoking, chewing gum or tobacco, and applying make-up or cosmetics is prohibited in any area designated as contaminated. The hands and face must be washed upon leaving a contaminated work area and before eating, drinking, smoking, or chewing gum or tobacco.
■ Decontamination procedures should be planned before a site is entered, performed as close to the contaminated areas as possible, and followed by personnel shower as soon as possible.

■ Facial hair that interferes with the mask-to-face seal on respirators is not allowed on personnel entering respiratory protection areas.

■ Contact with contaminants should be minimized as far as can be reasonably achieved. Unnecessary personnel should not enter contaminated areas, and personnel in contaminated areas should avoid unnecessary contact with contaminated surfaces.

■ High explosives and ordnance—All field investigation activities in areas potentially contaminated with high explosives and/or ordnance will be reviewed and approved by UC explosives safety personnel. Personnel entering sites potentially contaminated by explosives will be trained to recognize and avoid hazards.

■ Flammable materials and fire—A fire and explosion prevention and control program will be established at sites with flammable and reactive materials. Good housekeeping practices and proper storage of flammable and combustible materials will be required. In the event of a fire, personnel will evacuate the area and contact the fire department immediately. Fire extinguishers will be available for control of small fires by personnel who have been trained to use fire extinguishers.

10.0 DECONTAMINATION

Personnel, equipment, and vehicles that have been in contaminated areas may become contaminated and require decontamination. Specific decontamination procedures will be written for each aggregation of sites, based on the likely hazards expected at that aggregation of sites. The guidelines for decontamination procedures are provided below.

■ Decontamination stations will be set up to reduce contamination as personnel move toward the end of the contamination reduction corridor. The system will be set up to wash and rinse, at least once, all protective equipment worn. A sequential doffing of protective equipment will be conducted, starting with the most heavily contaminated items at the first station and progressing to the least contaminated items at the final station. The stations will be far enough apart to minimize cross-contamination.

- All personnel entering an exclusion zone in which personnel decontamination is required must follow the specified decontamination procedures. Personnel who are not required to wear the maximum level of protective gear may by-pass the decontamination stations for gear they are not wearing.

- Emergency decontamination procedures will be established for persons who must evacuate the site under emergency conditions or because of injury. If decontamination activities may aggravate or cause more serious health effects to an injured person or if prompt life-saving first aid and/or medical treatment is required, decontamination procedures will be omitted and life-saving care initiated without delay. The outer garments will be removed whenever practical (or if necessary because the victim has been contaminated with a life-threatening material). However, if the outer contaminated garments cannot be safely removed, the individual should be wrapped in plastic, rubber, or blankets to help prevent contaminating medical personnel and/or the interior of the ambulance. Contaminated garments can then be removed at the medical facility. Whenever possible, emergency response personnel will accompany contaminated victims to the medical facility to advise on matters involving decontamination.

- Personnel assisting in decontamination activities will be attired in clothing that protects them from the contamination released during the decontamination process. Protection levels for decontamination workers will be identified in the site-specific H&S plans.

- Periodically, swipes will be taken to determine the presence of chemical and radioactive contamination. The swipes will be analyzed in a laboratory to assess the effectiveness of decontamination or to estimate permeation through protective clothing and personnel exposure.

- A personnel contamination log will be maintained to record contamination levels, and decontamination measures will be taken.

- All equipment and vehicles used in the exclusion zone will require the same level of decontamination. Reusable clothing and respirators will be sanitized after decontamination.

- Audits will be conducted to ensure compliance with decontamination procedures.

11.0 WORKER TRAINING

ER Program workers at hazardous sites will receive training in accordance with the OSHA regulations in 29 CFR 1910.120 and DOE Order 5480.11. Most workers will be expected to have completed a 40-hr hazardous worker course before they start field work. A certificate of successful course completion, or the equivalent, will provide appropriate documentation. Workers not required to have the 40-hr course will need to successfully complete a 24-hr course. All workers will have an annual 8-hr refresher course. Field supervisors will take an 8-hr course pertaining to their work. Project leaders are required to have the 40-hr hazardous worker training course, or equivalent, an annual 8-hr refresher course, and an 8-hr supervisor training course.

On-site training is also required for workers. Those with the 24-hr off-site training are required to have 8 hr of supervised training on an ER site. Those workers with the 40-hr off-site training are required to have 24 hr of supervised on-site training.

Workers who have to wear respirators or self-contained breathing apparatus will require training for such activities. Respirator training must be equivalent to that specified in EPA Order 1440.3. A minimum of 6 hr of training will be provided initially, and 2 to 4 hr annually thereafter. This training can be a part of occupational health and safety training provided for other reasons, and it can count as credit for both programs. Records of training and fitness testing will be maintained by the worker's supervisor. The Laboratory's Safety and Risk Assessment Group (HSE-3) will arrange for radiation safety training required by DOE Order 5480.11.

Additional training for workers will be provided in the following areas, as appropriate: (1) recognition of high-explosive materials and ordnance, (2) first aid, (3) cardiopulmonary resuscitation, (4) decontamination procedures, (5) emergency response, and (6) fire extinguisher training.

12.0 EMPLOYEE MEDICAL MONITORING PROGRAM

All ER Program personnel engaged in field work at hazardous or potentially hazardous sites will participate in a medical monitoring program designed to determine baseline conditions before starting field work, to check for harmful effects of toxic substances at regular intervals, and to provide emergency medical care for symptoms indicative of toxicological or radiological health problems. The physicians in HSE-2 will provide

medical examinations of ER Program workers employed by the Laboratory and its integrated contractors.The physicians will be supplied with information about possible toxic materials at ER sites. Subcontractors who operate their own employee medical programs will be required to provide a level of employee protection at least equivalent to that provided by HSE-2.

13.0 RECORDS AND REPORTING REQUIREMENTS

13.1 TRAINING AND MEDICAL RECORDS

The training and medical records of all ER Program workers at ER sites are important documents. The ER Program Office will assign a unique identification number to each worker and will maintain a file that lists the dates of completion of pertinent training and medical examinations.

The training and medical records will not be maintained in the ER Program Office. However, the locations of the records will be retained in the ER Program Office files for the convenience of anyone who may need access to the records. Subcontractors will provide the ER Program Office with the same information about workers at ER sites as provided by other organizations at the Laboratory. The organizational entities with the original records will maintain them in a manner that complies with OSHA and DOE requirements.

13.2 UNUSUAL OCCURRENCE REPORTS

All unusual occurrences at the Laboratory must be reported to the ER Program Office and to other organizations, as specified in the Laboratory's Environment, Safety, and Health Manual, and to the US Department of Energy/Los Alamos Area Office (DOE/LAAO) in accordance with the requirements of DOE Order 5484.1B and AL Order 5000.34. An occurrence is defined as "any deviation from the planned or expected behavior or course of events in connection with any DOE or DOE-controlled operation if the deviation has environmental protection, safety, or health protection significance" (DOE Order 5484.1). Reportable unusual and off-normal occurrences include

- any substantial degradation of a barrier designed to contain radioactive or toxic material or any substantial release of radioactive or toxic material;

- loss of control of hazardous or radioactive materials;

- accidents involving the transport of radioactive or toxic materials;

- any fire or explosion that affects the integrity of the site or project;

- any condition resulting from natural events or man-made activities that substantially affects or threatens performance, reliability, or safe operation (e.g., site flooding, wind damage, soil stability problems, equipment malfunction, and personnel operation errors that create hazardous conditions);

- any release of contamination outside the controlled area; and

- any incidence of breach of access control by unauthorized personnel;

- any acts of vandalism or major theft occurring at a site;

- any contamination or injury to personnel.

In addition to the DOE reporting system, any subcontractors involved in unusual occurrences will be responsible for any reporting requirements to OSHA under the Occupational Safety and Health Act or any other reporting requirements directly applicable to them.

13.3 EMPLOYEE INFORMATION

DOE Form F-5480.2, "Occupational Safety and Health Protection" (a poster outlining contractor responsibilities to provide safety and health protection) and DOE Form F-5480.4, "Occupational Safety and Health Complaint Form" (a form to be used in reporting violations) will be posted in prominent locations at the workplace (but not necessarily at the field site.

■ REFERENCES

DOE and AL Orders 5483.1A, Occupational Safety and Health Program for DOE Contractor Employees at Government-Owned Contractor-Operated Facilities

DOE and AL Orders 5484.1, Environmental Protection, Safety, and Health Protection Information Reporting Requirements

DOE Order 5500.2, Emergency Planning, Preparedness, and Response for Operations

DOE Order 5500.3, Reactor and Nonreactor Nuclear Facility Emergency Planning, Preparedness, and Response Program for DOE Operations

DOE Order 5500.4, Public Affairs Policy and Planning Requirements for

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■ **RECORDS MANAGEMENT PROGRAM PLAN**

1.0 INTRODUCTION

This document describes the Records Management Plan (RMP) for the Environmental Restoration (ER) Program activities at Los Alamos National Laboratory (the Laboratory). The program is being implemented by the Department of Energy (DOE) and the University of California (UC). Because the ER Program is in a relatively early stage of development, certain aspects of the RMP are still being defined and are referenced as future goals. The plan is intended to establish general guidelines for records management, including technical data sets. The specific methods and details of protecting record packages will be implemented through quality administrative procedures (QPs) and standard operating procedures (SOPs) developed in cooperation with the Quality Program staff.

1.1 ORGANIZATION OF RECORDS MANAGEMENT PLAN

The RMP is organized to interface with the Installation Work Plan (IWP) and is divided into seven major sections. This introduction presents the organization, regulatory mandate, purpose, objective, and terminology of the RMP. Section 2 describes a three-fold approach to records management and how it will be implemented. The Record-Processing Facility (RPF) and the Facility for Information Management, Analysis, and Display (FIMAD) are described in Section 3. Sections 4 through 7 describe how the RMP will be coordinated with the Quality Program, the Health and Safety (H&S) Program, and resource planning and community relations activities.

1.2. REGULATORY MANDATE

The development and implementation of this plan are mandated by the Hazardous and Solid Waste Amendments (HSWA) Module of the DOE/UC permit to operate the Laboratory under the Resource Conservation and Recovery Act (RCRA). General requirements for data management are presented in Task II, Section B (p. 7) of the HSWA Module, but many other references to technical data are made throughout the document. The manner in which records of work performed under the permit are managed is of primary importance in ensuring the integrity and intended function of the data and documentation contained in the record packages submitted to the Environmental Protection Agency (EPA).

1.3 PURPOSE

The purposes of the RMP are to

- meet requirements for protecting and managing records and technical data as specified in the HSWA Module;

- provide an ongoing tool to support the technical efforts of UC and its ER Program contractors; and

- function as a support system for management decisions throughout the life of the program.

The RMP addresses programmatic needs for all forms of technical data, program records, technical literature, and other documentation. The records will be collected, organized, indexed, stored, and protected with the goal of providing efficient use and retrievability by a diverse group of users. This goal applies to both manual and automated activities for handling records. A properly implemented RMP will enhance interactions with the local community, adjacent communities, the State of New Mexico Environmental Improvement Division (NMEID), the EPA Region VI, the DOE, and other parties who may have an interest in the ER effort at the Laboratory.

1.4 OBJECTIVE

The objective of the RMP is to establish the general guidelines for managing records, regardless of their physical form or characteristics, generated and/or used by the ER Program at the Laboratory. It is important that the RMP be consistently implemented to provide an auditable and legally defensible system for records management.

Coordination with other aspects of the ER Program, (such as the Quality and H&S programs) is important for achieving useful program-wide guidelines for records management and especially technical data, which, in some cases, may not be reproducible.

1.5 TERMINOLOGY

Common terminology is important to ensure that information is correctly conveyed to the reader of this RMP. There are varied and rigorously debated definitions for records, technical data, information, and similar terms. To ensure consistent terminology in the RMP, the statutory definition for "records" (44 USC 3301) is used. "Records" are defined as "...books, papers, maps, photographs, machine readable materials, or other documentary materials, regardless of physical form or characteristics, ...appropriate for preservation... because of the informational value of the data in them." Thus, the term "records" includes technical data and is used in this document to reflect the broader scope of protecting all ER Program records. This usage is also consistent with the General Records Schedules for environmental records, as defined by the National Archives and Records Administration.

2.0 DESCRIPTION AND IMPLEMENTATION OF THE RECORDS MANAGEMENT PROGRAM

The general challenge addressed by the RMP is summarized in the following question:

How will the ER Program's records be handled to ensure

- the integrity and protection of information,
- efficient and cost-effective access, and
- legal and technical defensibility?

2.1 PLAN DESCRIPTION

The RMP incorporates a threefold approach based on records control and total commitment to Quality Program guidelines. This approach includes the following precepts:

- Structured work flow for record packages—Records control will be maintained through a structured work flow and processing scheme for record packages.

- Use of approved procedures—Accountability to Quality Program requirements will be maintained through the documented use of approved procedures accompanied by relevant training.

- Referable information base—"Essential" ER Program records will be submitted to a referable information base available to ER Program participants for data access while providing records protection through a documented process of change control.

2.2 PLAN IMPLEMENTATION

2.2.1 Structured Work Flow for Record Packages

In the recent past, records were generally maintained at the various locations of ER Program participants; therefore, no formal submittal of record packages was required. As quality guidelines evolved, the need for centralized protection of program records became apparent. Development of a computerized system was already under way when the ER Program Office obtained space for the RPF, which also functions as an interim repository for records during processing.

2.2.1.1 Submittal of Records Packages

Participants are required to review their records as they are generated to determine whether the information represents an ER Record as defined in Section 5.1 of the Procedure for LANL ER Records Management (LANL-ER-QP-17.1, R0, in review). This determination can be made in two ways:

- ER records are those specifically identified in QPs, SOPs, or ER Program plans.

- ER records are those identified by ER Program personnel. Records identified in this manner are prepared at the discretion of the participant and should be records that are considered essential to the program. Essential records are those required for the continued functioning and/or interests of the ER Program.

Record package submittal will be documented by completing the ER Record Package Transmittal Form consistent with the Laboratory's procedure for ER records management (LANL-ER-QP-17.1, R0). All technical data, including raw data, must be submitted as a record package to the RPF for processing and eventual delivery to FIMAD.

The submittal of records from analytical teams, technical teams, and contractors should be in hard copy (i.e., paper, logbooks, or similar media) and, whenever possible, also on machine-readable electronic media. Requirements, formats, and constraints on transferring electronic records to the FIMAD are defined in Attachment 3 of the ER records management procedure.

2.2.1.2 Records Flow

Figure IV-1 is a conceptual diagram of the flow of records as it now occurs contrasted with the work flow planned for the near future. As shown in this figure, the primary change for record packages in the future will be the long-term storage at Communications and Records Management (CRM) Division facilities of the original record package after it is entered into the FIMAD.

Figure IV-2 is a diagram showing a detailed overview of records flow in the ER Program. The model represents a top-down analysis of the general types of records, showing how they will proceed through processing from the time of generation by the originator to final disposition of the record.

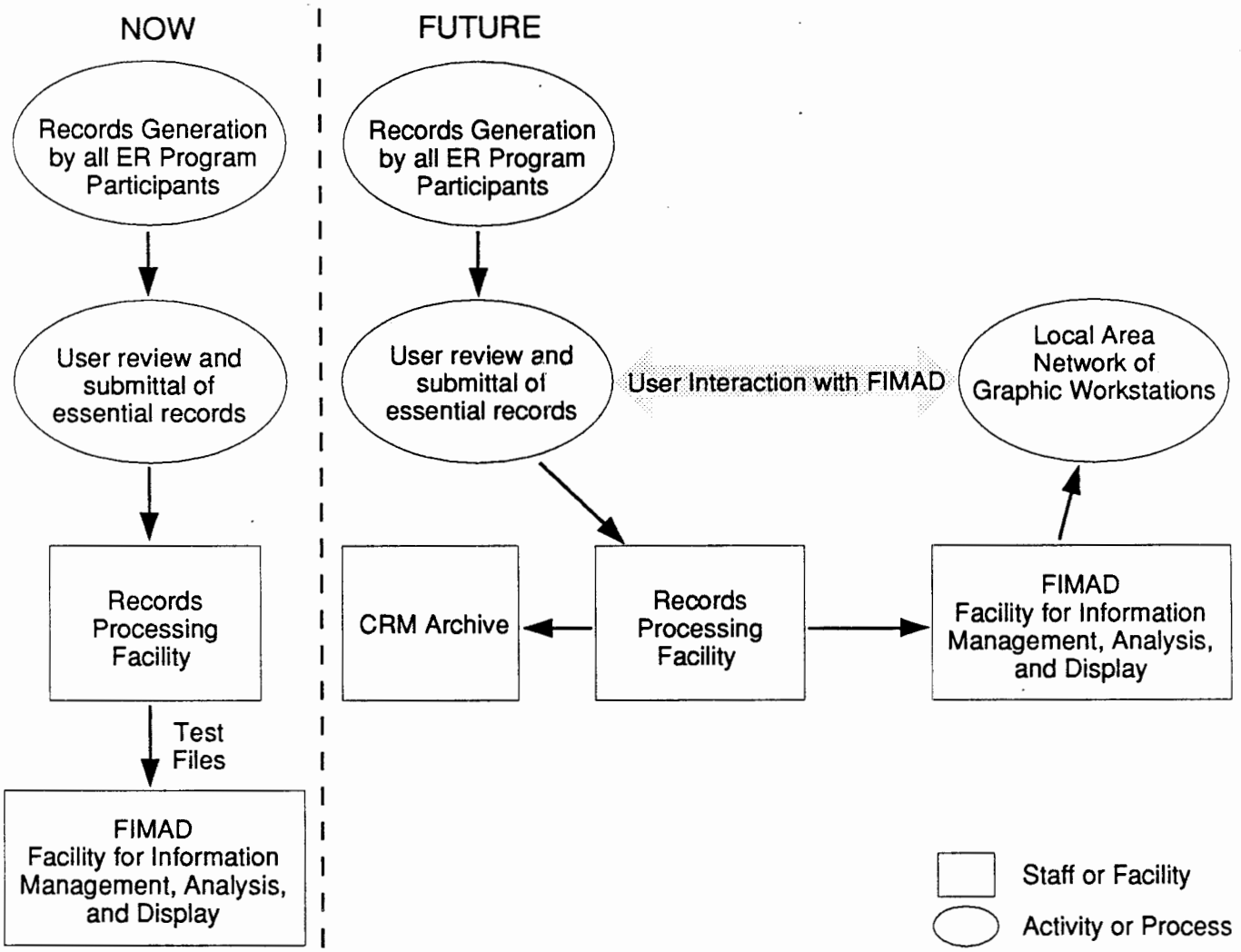


Figure IV-1. Flow of records as it now occurs contrasted with the work flow planned for the near future.

2.2.2 Use of Approved Procedures

Quality-approved procedures will be used for all steps of records handling. The primary elements to be covered by these procedures are listed in Appendix T. Personnel involved in the handling of records will be trained to use applicable procedures. Figure IV-3 shows the work flow for processing record packages and delineates the entire sequence of steps for processing a record package as defined in the records management procedure.

2.2.3 Referable Information Base

Records will be captured by the process of submitting a record to the FIMAD through the RPF. Record packages transferred to the RPF and the

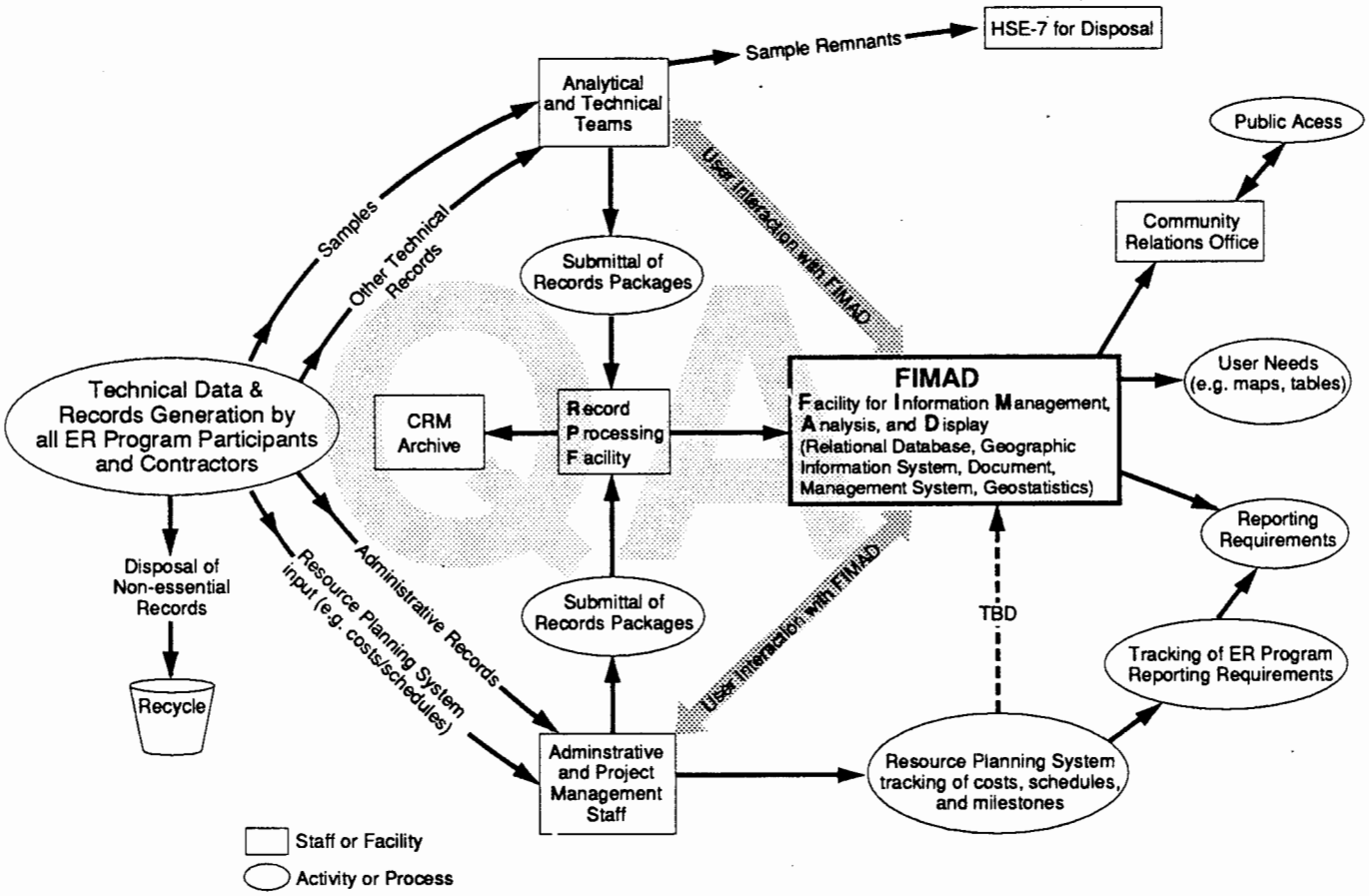
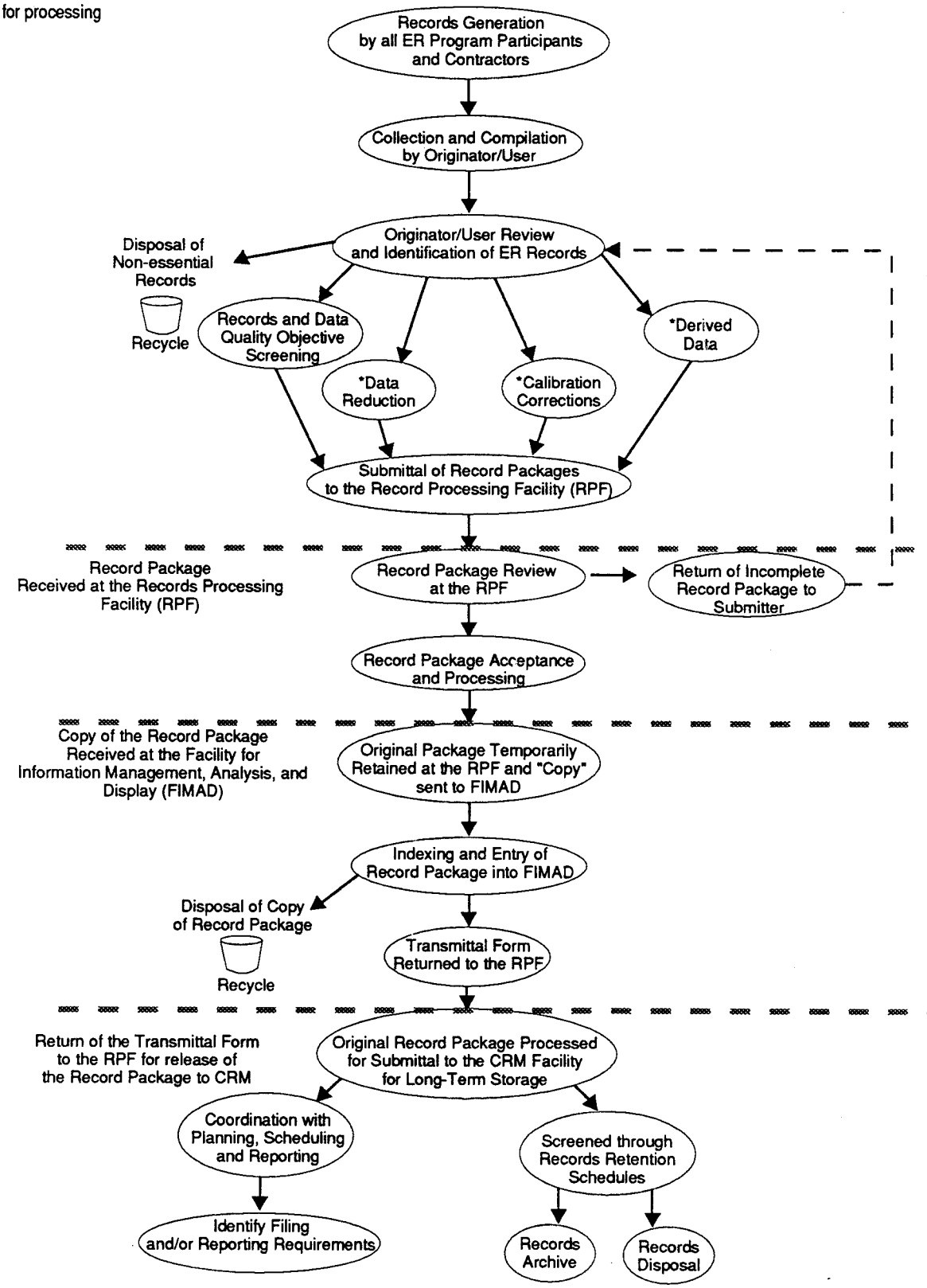


Figure IV-2. Overview of records flow in the ER Program.

FIMAD will provide a base of information to which all program participants can refer. It will include record packages documenting ER Program activities at the Laboratory, as well as certain records originating outside the Laboratory ER Program, that have been submitted in accordance with the records management procedure.

All record packages protected in the referable information base of the RPF and FIMAD will be subject to documented correction requests when the originator needs to change a record. This procedure will ensure that users of the ER Program have the latest version of the record. Because records that have been superseded will be disposed of, correction requests should be carefully considered.

Figure IV-3. Work flow for processing record packages.



*This activity may or may not be applicable to a Record Package, or may be relevant at a different stage in processing the Record Package.

2.3 SPECIAL TOPICS

2.3.1 Operable Unit Work Plans

The RMP annex of the IWP should be considered as reference for general guidance in developing operable unit (OU) work plans. The QPs and SOPs used in OU work will define documentation requirements for technical activities, which will typically include such information as assignment of sample and measurement codes, survey locations, and measurement types. Participants should duly protect the resulting records to protect raw data and field records until they are submitted to the RPF in accordance with records management procedure.

2.3.2 Technical Data

2.3.2.1 Data Validation

Data validation may be needed to consider replicate measurements, to identify outlying values, and to report results determined to be below detection limits. These conditions should be handled as directed in ER program SOPs and RCRA facility investigation guidance (EPA 1989), or later revisions, if applicable. Similar means for handling the inherent inconsistencies of data may be developed by the user as long as they are documented, reproducible, and technically defensible. Any reduction of data must be documented in accordance with relevant SOPs.

2.3.2.2 Data Analysis

Once the analyses of technical data have been submitted to the FIMAD, they are used at the discretion of the technical teams. The FIMAD will provide the necessary capability for tabular and two- and three-dimensional graphical displays of data, generation of maps, statistical analyses, sorting of data according to various parameters, and similar requirements as specified in the ER program SOPs and the RCRA Corrective Action Plan (EPA 1989).

2.3.3 Records Working Group (Ad Hoc)

Periodically, a team of program participants may need to meet to resolve special issues related to records and technical data sets. The group will comprise program participants with appropriate expertise and will be selected and activated as needed by the ER Program Manager (or designee).

3.0 DESCRIPTION OF FACILITIES FOR RECORDS MANAGEMENT PROGRAM

3.1 RECORDS-PROCESSING FACILITY

The RPF is the site for receiving and processing ER Program record packages to prepare them for delivery to the FIMAD. The RPF is located at 2101 Trinity Drive in the town of Los Alamos. The RPF currently houses records used in compiling site histories for solid waste management units (SWMUs). These and subsequent record packages submitted to the RPF will be processed for delivery to the FIMAD. During processing activities, original record packages are to be retained at the RPF in 1-hr fire-rated equipment as defined in the Standard for the Protection of Records of the National Fire Protection Association, Inc. (1986). After processing has been completed, paper copies of records will be scanned into the FIMAD and then recycled. The original documents will be sent to the CRM archives to ensure compliance with NQA-1 (ANSI/ASME 1989) requirements for retention and protection.

The RPF will serve two purposes: it will be a library that contains information for which capture at the FIMAD is either not feasible or not desirable or for which only occasional reference may be required (e.g., a large, multiple-volume, bound report from EPA). All hard-copy records not retained at the RPF will be sent to CRM Division for long-term archival storage, as appropriate.

3.2 FACILITY FOR INFORMATION MANAGEMENT, ANALYSIS, AND DISPLAY

The ER Program Office has established the FIMAD in Building SM 215, TA-3, to provide the hardware and software necessary for data capture, display, and analysis. This information will be readily accessible to participants through a network of work stations.

The eventual network will comprise "miniclusters" distributed throughout Laboratory facilities to allow users, including ER Program contractors, access to the FIMAD. Each minicluster may include a graphics work station, possibly several X-terminals or diskless node work stations, and other necessary hardware. The satellite facilities will have no data input capabilities so that quality controls on data entry can be implemented at a single location.

3.2.1 System Capabilities

The system will be capable of executing numerous tasks using X-11 windows in the UNIX environment. The planned capabilities are listed below:

- geographic analysis using the ARC/INFO-ORACLE Geographic Information System (GIS) and the GEOEAS geostatistics package;

- records management (RM) using the ORACLE Relational Data Base Management System (RDBMS);

- management of documents;

- management of large-scale documents (e.g., drawings and maps);

- management of video images;

- two- and three-dimensional graphics support for modeling;

- storage, compression, and conversion support for certain types of data ;

- data integration of various types of information; and

- possible resource planning (RP) system support.

3.2.2 System Configuration

The development of the Local Area Network (LAN) is based on the concept of "open systems" with adherence to existing standards and protocols. Figure IV-4 shows the system configuration for the development phase of the FIMAD. Commercially available software has been selected whenever possible to address Quality Program concerns about code modification and to ensure the best use of limited resources. The initial system includes all of the RISC-based UNIX work stations, which provide a good port to the ARC/INFO/ORACLE software. This software package is considered to be a critical component of the FIMAD to provide consistency with EPAs software.

Figure IV-5 shows the proposed production configuration. The actual configuration may change as new information is obtained during the development phase of the FIMAD.

3.2.3 Configuration Management

Configuration management will be implemented as a means of accounting for, controlling, and reporting the planned and actual design of components for the FIMAD. Configuration management ensures that there is always an approved and accessible last version of the whole computer system.

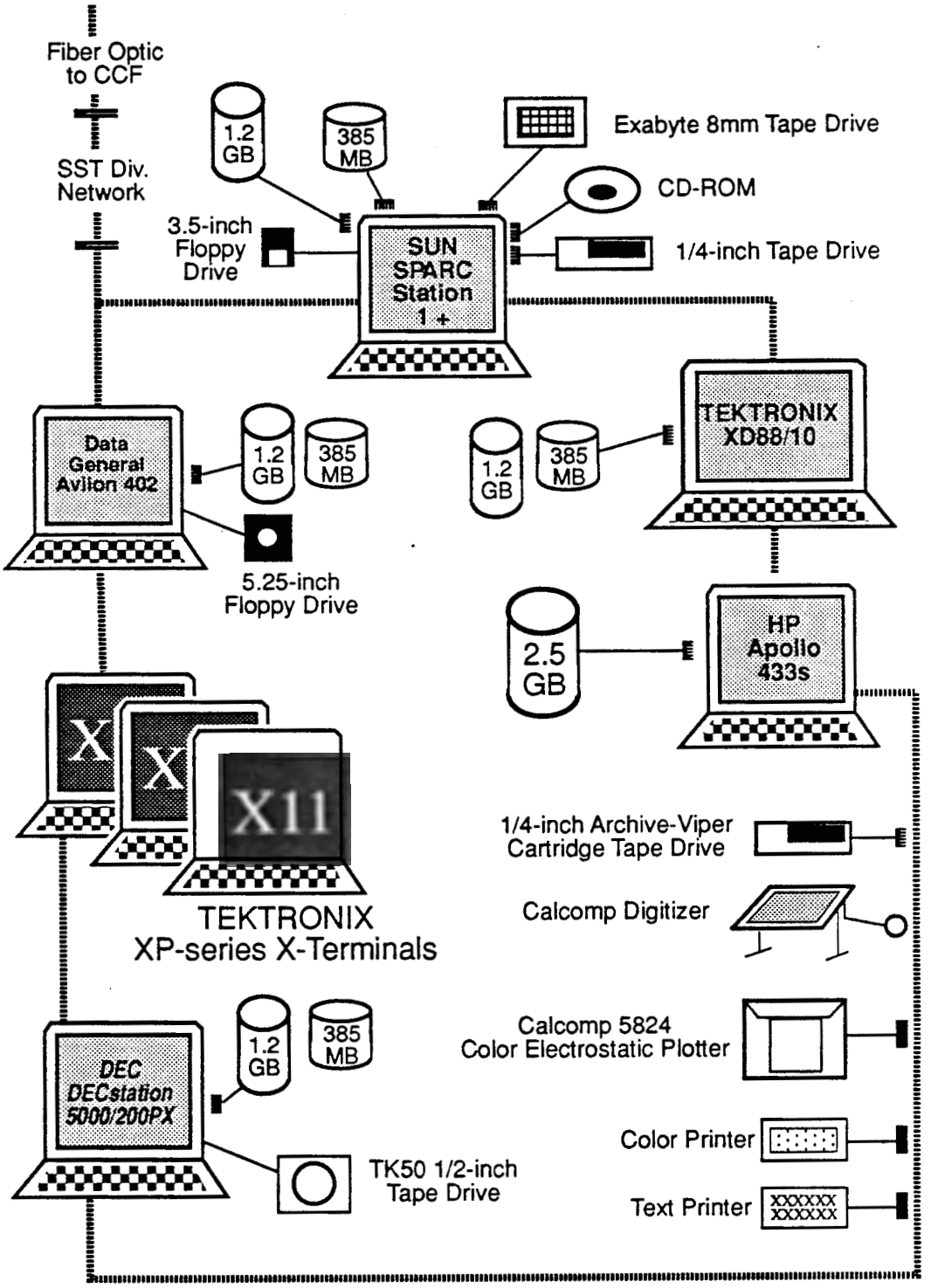


Figure IV-4. System configuration for the development phase of the FIMAD.

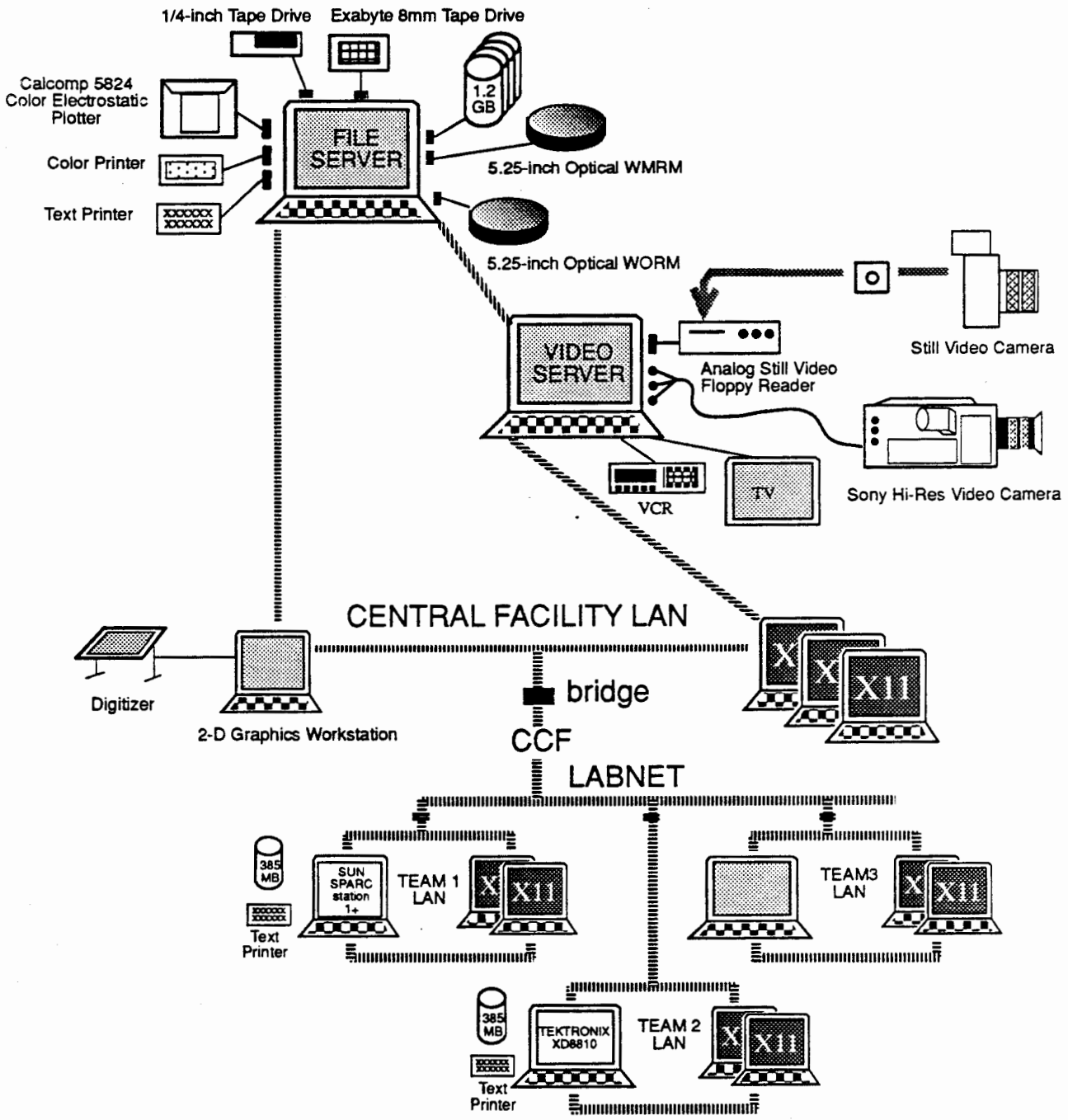


Figure IV-5. Proposed production configuration.

Configuration management will purposely be simple and flexible during system development. The end product will be documentation of the process of systems development to permit identification of the relevant configuration at any given time in the life of the ER Program. The documentation should follow accepted practices for design and development of information systems.

3.2.4 Solid Waste Management Unit Data Base Conversion

Archive records have been examined for key information entered in the SWMU data base, which is contained on a personal computer (PC) system. A conversion of the SWMU data base from PC to the ORACLE relational data base in the FIMAD is planned. This conversion will provide compatibility for reporting to the Waste Information Network (WIN) data base maintained for the DOE by Martin-Marietta Energy Systems at Oak Ridge, Tennessee. During the development of the FIMAD, test files are being introduced to the UNIX-based system, and SWMU data will eventually be entered on a routine basis.

3.2.5 Optical Storage

Optical storage systems will be used in records management activities wherever possible. They consist of hardware and software that convert the hard-copy documents into digital form for program activities. Because optical systems reduce enormous volumes of paper records, this method of storing records is becoming widely accepted throughout government agencies and private industry. The defensibility of using optical records will be provided by the use of specified procedures, training, and documentation that the specified procedures were used and by keeping a copy of the original records at a separate location.

3.2.6 Microfilm

Because microfilming is reliable and widely accepted, this technology may be used for certain types of records. The readability of a record on microfilm accommodates the lack of hardware standards in some components of optical archive systems. Microfilm standards and legal defensibility are well established. Microfilm may also be used to transmit color graphics information.

3.2.7 File Standards and Compatibility

The computer systems currently used by the ER Program represent multiple operating systems, including MS-DOS, Apple UNIX, and VMS. The problem of file compatibility is neither unique to the ER Program nor is it

simple. The RMP endorses using open systems with adherence to existing standards and protocols for exchanging information.

3.2.8 Progress in Technology

The changes in hardware and software technology are frequent and substantial and demand that attention be given to industry standards. Some products may influence decisions on the selection of media and how they fulfill regulatory requirements for records retention, data access, and legal defensibility. Personnel assigned to operate and maintain the FIMAD will keep abreast of industry trends and will recommend conversions and/or modifications to the system, as necessary, to keep it a viable component of the ER Program.

Requirements for retaining certain records may extend well beyond the typical life systems currently used. In these cases, the requirements will be met by retaining hard copy of the record package.

4 .0 COORDINATION WITH THE QUALITY PROGRAM

Written procedures approved by the Quality Project Leader will be used for managing program records. Procedures will be written in accordance with LANL-ER-QP-06.1, R0, Preparation, Review, and Approval of Quality Administrative Procedures (LANL 1990). The procedures, which contain most of the elements identified in Appendix T, will be applied uniformly throughout the ER Program to achieve the objectives of the RMP and to fulfill the obligations defined in the approved HSWA Module.

4.1 RECORDS PROTECTION BEFORE SUBMITTAL

Records will be generated during most ER Program activities. Participants should carefully manage the resulting records, documentation, and technical data. The protection given by the originator until the record packages are submitted to the RPF in accordance with the records management procedure should be commensurate with the value of the information.

4.2 RECORDS PROTECTION DURING SUBMITTAL

Record packages submitted to the RPF will be processed in accordance with the records management procedure. The processing steps are summarized below.

The record package is sent with an ER Record Package Transmittal Form completed by the originating organization.

- The record package is processed; a copy of the form and the original package are retained at the RPF in 1-hr fire-rated equipment as defined in the Standard for the Protection of Records of the National Fire Protection Association, Inc.

- The original form and a copy of the package are forwarded to the FIMAD.

4.3 RECORDS PROTECTION AFTER SUBMITTAL

After the record package has been received at the FIMAD, the following steps will be taken:

- The records processor at the FIMAD makes an electronic copy of the record package and also information from the transmittal form for retention at the FIMAD.

- A copy of the transmittal form is sent to the originator.

    - The original transmittal form is returned to the RPF.

    - A copy of the record package is returned to the RPF for retention.

    - The original record package, which has been temporarily storedat the RPF, will then be forwarded to CRM-1 for long-term storage, and pertinent copies of the forms will be stored at the RPF and the FIMAD.

5.0 COORDINATION WITH THE HEALTH AND SAFETY PROGRAM

Certain health and safety records that are to be included in the FIMAD have been identified in the H&S plan. This information pertains to safety training and medical surveillance of each person working at an SWMU. Because of the confidential nature of certain types of medical information, many records will appropriately be maintained in the Occupational Medicine Group's (HSE-2's) data base or by participating contractors. For convenience, training records will be maintained by the Safety and Risk Assessment Group (HSE-3) or by the contractors, and the FIMAD will only contain information about the completion of training, the dates of required refresher training, and the location of the training records. The information fields to be included in the FIMAD are

- a unique identifier for each worker,
- employer,
- dates of work at each hazardous waste site,
- dates of completion of required training,
- dates of medical surveillance examinations,
- locations of training and medical examination records, and
- dates of required refresher training.

6.0 COORDINATION WITH THE RESOURCE PLANNING SYSTEM

The RP system will monitor costs, schedules, and deliverables for the ER Program. The software has the necessary capability for monitoring the ER Program reporting requirements. All reporting requirements for the ER Program will be integrated into the RP system (as milestones or deliverables) to be monitored and disseminated to ER Program staff at regular intervals so the ER Program obligations are met. Specific regulatory requirements for reporting, including data types and report frequency, will be delineated and integrated with the development of formal records retention schedules. Any special reporting requirements and applicable restrictions on data type and format [e.g., cost and schedule control systems criteria (CSCSC) or major systems acquisition (MSA)] will also be identified during that process.

The Work Breakdown Structure (WBS) developed in the RP effort is being integrated into the indexing scheme for records as an option for querying records. Concerns about WBS changes are legitimate and justify not using WBS numbers as primary indices for record packages.

7.0 COORDINATION WITH THE COMMUNITY RELATIONS PROGRAM

RCRA requires that records be made available to the public. Two complementary approaches to enable the community to access data are being considered. However, because protection of the data is imperative, system security for protecting records will be weighted heavily in determining the optimal solution.

7.1 HARD COPY

Hard copies of relevant records will be retained in a reading room accessible to the public. Hard-copy files will supplement electronic records.

7.2 ELECTRONIC ACCESS

A work station or optical reading device may be chosen to allow public access to relevant records. It has not yet been determined if this is the best balance between public access to the data and protecting the data base. If a work station is the option selected, there may be significant cost associated with a data link.

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■ **COMMUNITY RELATIONS PROGRAM PLAN**

1.0 OVERVIEW OF COMMUNITY RELATIONS PROGRAM PLAN

In accordance with the Resource Conservation and Recovery Act (RCRA) as amended by the Hazardous and Solid Waste Amendments (HSWA), the Environmental Protection Agency (EPA) has granted the Department of Energy (DOE) and University of California (UC) a permit to operate Los Alamos National Laboratory (the Laboratory) as a hazardous waste treatment and storage facility. Module VIII of the permit (HSWA Module) requires that the Laboratory prepare a Community Relations Program Plan (CRPP) as part of its Installation Work Plan (IWP). This CRPP fulfills that requirement.

In accordance with guidance received during development of the HSWA Module, this CRPP is written in the format of a community relations plan, prepared in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) EPA (1988). The CRPP incorporates the general requirements listed in Part D of the HSWA Module. These requirements can be summarized as follows:

- provide information about technical activities in the Laboratory's Environmental Restoration (ER) Program in a timely manner;

- respond to communities' concerns about the ER Program in a manner that encourages two-way communication between the interested parties and the Laboratory;

- provide to the public opportunities for education about the various technical and regulatory processes associated with ER in a manner that assists public understanding and participation in the process; and

- provide opportunities within the regulatory framework for timely public comment on ER activities.

Because of the complexity of the Laboratory and of the tasks to be performed under the ER Program, the public must have one central contact point to meet its information needs. For the purposes of this CRPP, the public includes all groups and individuals outside the program, the DOE, the EPA, or the New Mexico Environmental Improvement Department (NMEID). The information provided to the public must be timely, consistent, and credible. Therefore, all information concerning ER Program activities will originate with, or be provided to the public through, the community relations project leader, who is

Martin J. Janowski
Community Relations Coordinator
Environmental Restoration Program
Los Alamos National Laboratory
P.O. Box 1663, MS K-481
Los Alamos, New Mexico 87545
(505) 665-2127

2.0 SITE HISTORY AND DESCRIPTION

2.1 INSTALLATION DESCRIPTION

The Laboratory is managed by the UC for the DOE. The principal mission of the Laboratory is the design, development, and testing of weapons for the nation's nuclear arsenal. This effort is supported by extensive research programs in nuclear physics, hydrodynamics, conventional explosives, chemistry, metallurgy, radiochemistry, and biology. In addition to the weapons program, Laboratory personnel are involved in medium-energy physics; space nuclear systems; controlled thermonuclear fusion; laser research; geothermal, solar, and fossil energy research; nuclear safeguards; biomedical research; and space physics.

The Laboratory is located in north-central New Mexico on the Pajarito Plateau (Figure V-1), a volcanic shelf on the eastern slope of the Jemez Mountains at an approximate elevation of 7,000 ft. The Pajarito Plateau is cut by a number of steeply sloped, deeply eroded water drainage canyons, which have formed isolated, finger-like mesas running west to east. Surface water flow crossing the Laboratory is intermittent or ephemeral and reaches the Rio Grande only during significant periods of runoff from snowmelt or thunderstorms. The main aquifer lies 600 to 1,200 ft below the surface and is separated from the surface by unsaturated tuff, a volcanic ash. There is no known hydrological connection between the surface and the main aquifer from which the municipal water supply for the Laboratory and Los Alamos is obtained.

The Laboratory is situated on approximately 27,500 acres (43 mi^2) of DOE land, 24,000 acres (87%) of which are located in Los Alamos County. The location and spacing of the 37 active technical areas reflect historical development patterns, topography and functional relationships (Figure V-2). At present, the Laboratory's on-site population (including both employees and contractors) is approximately 12,000 people, who are housed in some 1,500 buildings encompassing about 7,000,000 ft^2.

The surrounding area, including all of Los Alamos County and large portions of Sandoval, Rio Arriba, and Santa Fe counties, remains largely

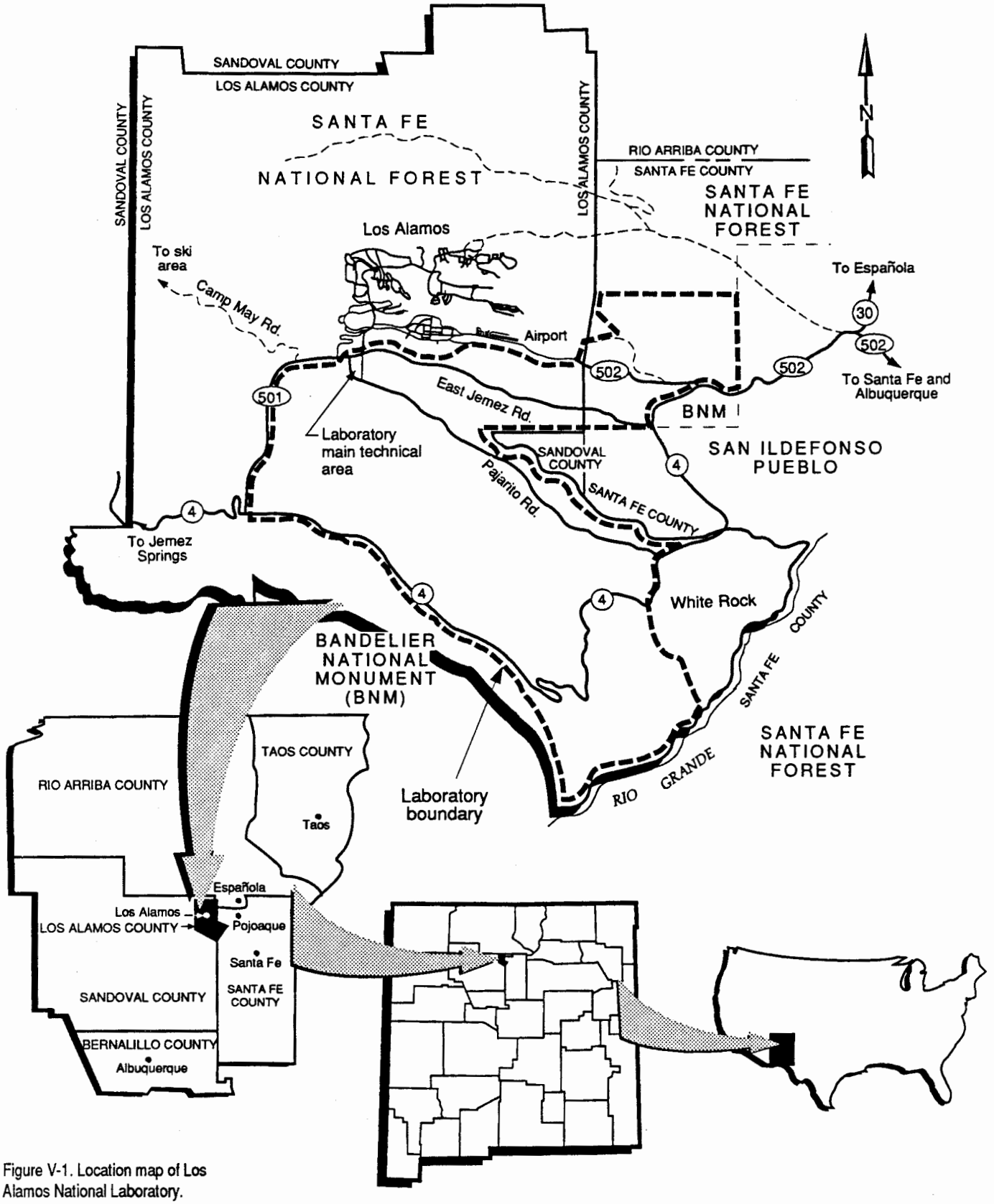

Figure V-1. Location map of Los Alamos National Laboratory.

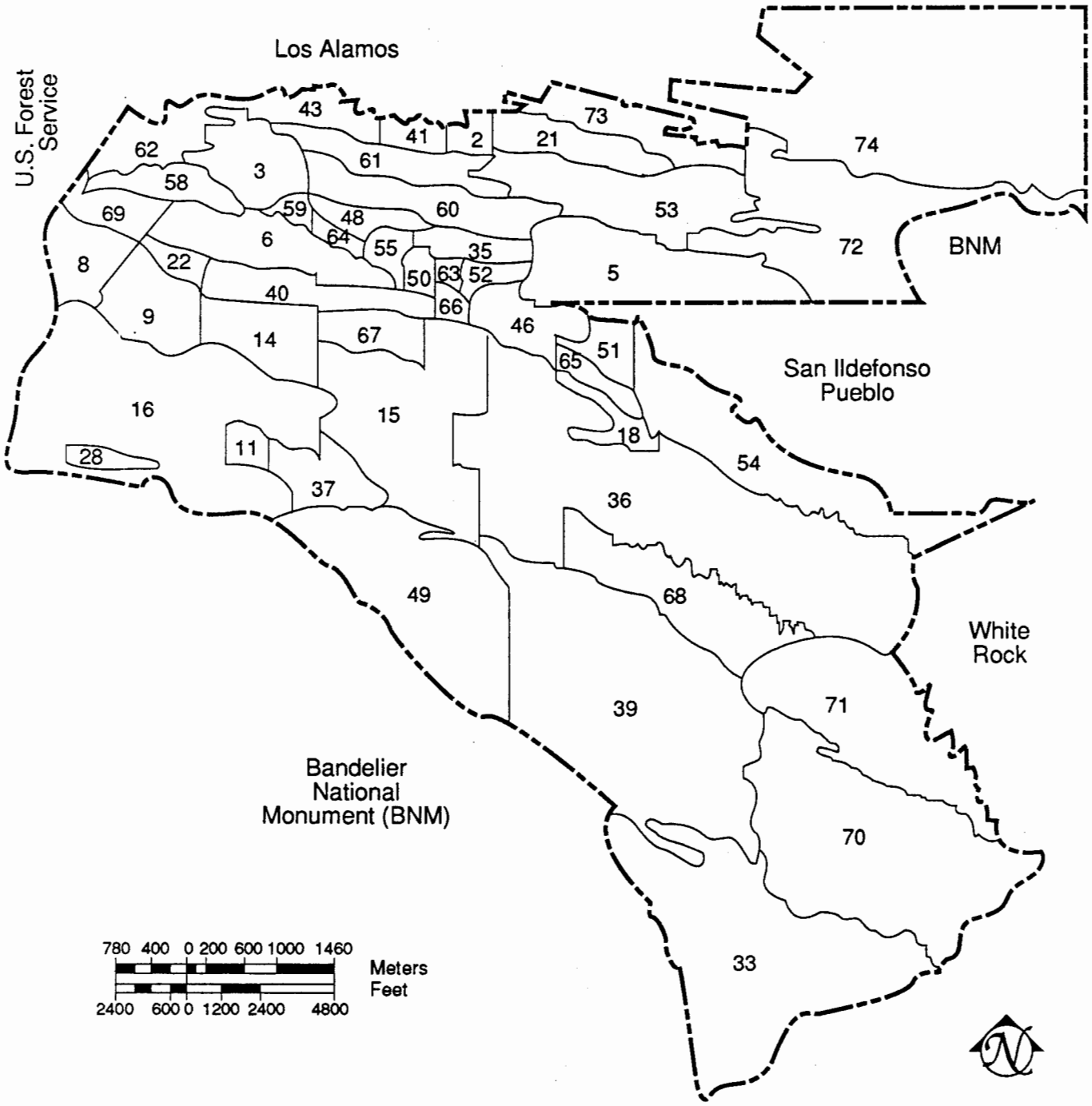

Figure V-2. Technical areas on Laboratory site.

undeveloped, except for those areas occupied by Laboratory facilities and associated residential communities. Large tracts of land in the Jemez Mountains to the north, west, and south of the Laboratory site are held by the US Forest Service and US National Park Service. Indian lands of the San Ildefonso and Santa Clara pueblos border the Laboratory on the east and northeast. Adjacent land ownership patterns are shown in Figure V-3.

2.2 INSTALLATION HISTORY

The U.S. Army Manhattan Engineer District, which began with theoretical studies performed at the UC (Berkeley) in 1942, quickly progressed to the point at which a remote site for experimental work was needed. The decision was made to locate weapons research, called "Project Y," at the Los Alamos Ranch School for Boys. The project acquired over 49,500 acres of land, including the Ranch School, nearby homesteads, and surrounding US Forest Service property.

In 1943, this land became known as the Los Alamos Site, later Los Alamos Scientific Laboratory. Its initial mission was to develop the world's first nuclear fission weapon. This project lasted for the duration of World War II. From its inception, the Laboratory was operated by UC under contract, although in its earlier years, Los Alamos was under the control of the US Army rather than the DOE.

Laboratory activities were first conducted in wooden buildings south of the original ranch school buildings in what is now downtown Los Alamos. Additional buildings were constructed for research, and army-style barracks, as well as temporary and prefabricated structures, provided housing.

With the end of World War II and the growth of international competition, a national policy of maintaining pre-eminence in the field of atomic energy was established. Congress chose to sustain the Los Alamos site; the Atomic Energy Commission (AEC) received control of the Laboratory from the Army and renewed the operating contract with UC. Thereafter, a major construction program was started south of Los Alamos Canyon, and most Laboratory operations were moved to the south mesa. During subsequent years, the Laboratory continued to expand at a steady rate—first under the AEC, later under the Energy Research and Development Administration (ERDA), and today under DOE.

2.3 THE ENVIRONMENTAL RESTORATION PROGRAM AT LOS ALAMOS

The primary objective of the ER Program at the Laboratory is to implement environmental assessment and remediation activities as required for solid waste managment units and areas of concern (ER sites). The ultimate goal

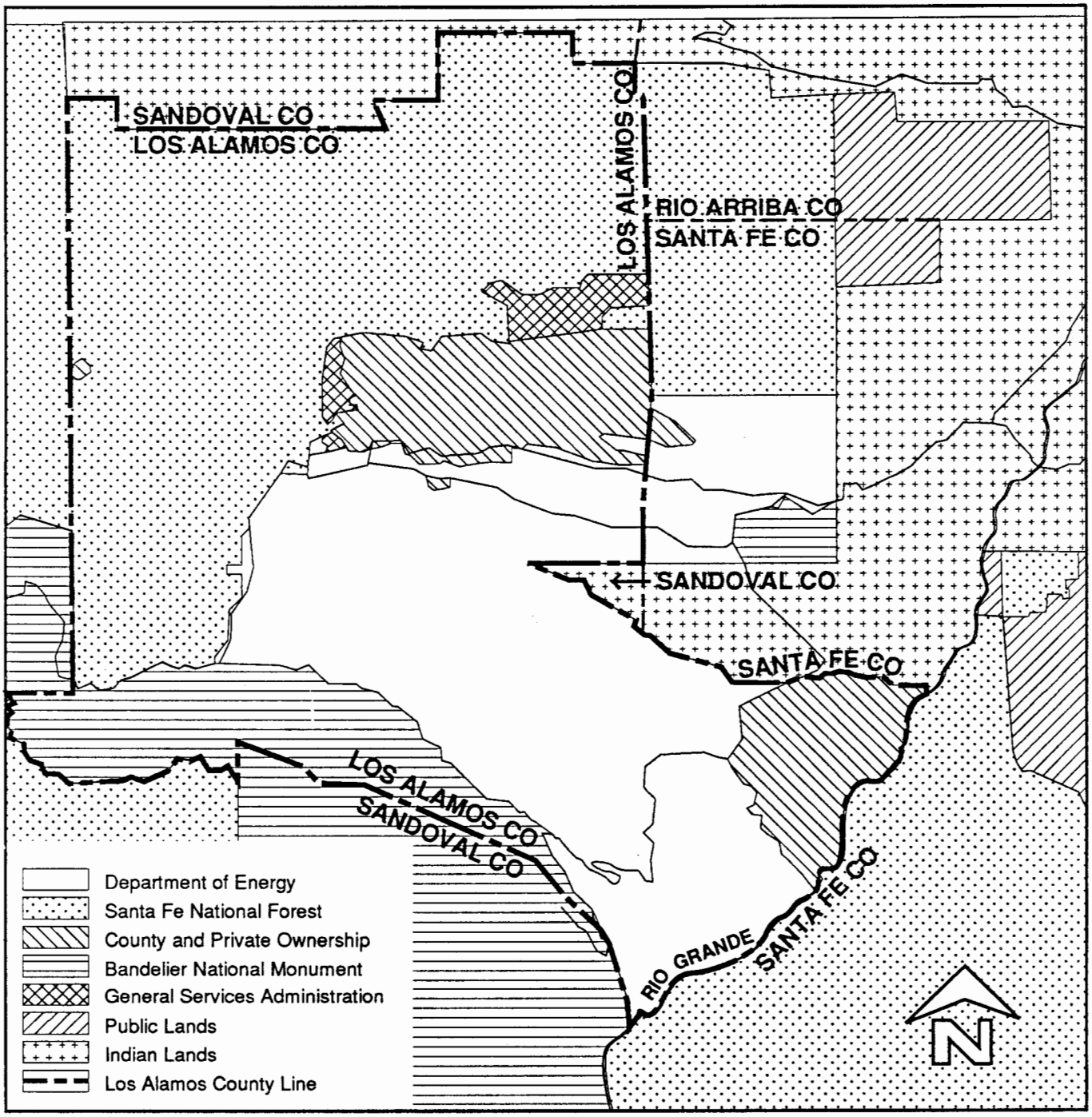

Figure V-3. Land ownereship in the Los Alamos area.

is to bring identified ER sites into compliance with environmental regulations and DOE orders that govern ER at the Laboratory while ensuring environmental protection and public health and safety.

3.0 COMMUNITY BACKGROUND

3.1 COMMUNITY PROFILE

The Laboratory is located in north-central New Mexico, 35 mi northwest of Santa Fe, the state capital. Los Alamos County was incorporated in 1968 and operates a joint city/county government.

Los Alamos County has two residential areas the townsite, which is located north of Los Alamos Canyon, and White Rock, which is located south of the Laboratory between State Route 4 and the Rio Grande. The population is estimated to be 20,000.

The area has a rich cultural history, as evidenced by the Indian ruins at Bandelier National Monument, which is located adjacent to the Laboratory's western border. Archaeological sites on Laboratory property have been identified and are actively protected. San Ildefonso Pueblo and Santa Clara Pueblo are located east of Los Alamos County. These pueblos are part of the Eight Northern Pueblos Agency, which also includes the San Juan, Taos, Picuris, Nambé, Pojoaque, and Tesuque pueblos. Cochiti Pueblo is south of the Laboratory in the Rio Grande drainage basin, and Jemez Pueblo is located west of Los Alamos near the Fenton Hill geothermal site. Residents of these pueblos will be actively included in community relations activities for the ER Program to ensure that tribal concerns are addressed during the remedial investigation (RI) and corrective measures studies (CMSs).

The Laboratory is an important factor in the economy of northern New Mexico. Sixty percent of the Laboratory's employees live in the residential areas of Los Alamos county. The balance of the employees commutes from Santa Fe and Rio Arriba counties. Population estimates for 1985 indicate that 84,700 people live in Santa Fe County and 32,900 people live in Rio Arriba County. Santa Fe County is the only area of northern New Mexico in which significant population growth is anticipated over the next 20 years. Economic development is an important regional concern. Although direct employment at the Laboratory is not expected to grow, the technology transfer effort by DOE is expected to increase employment opportunities by enhancing the possibility that spin-off companies will develop in the region.

3.2 HISTORY OF COMMUNITY INVOLVEMENT

UC maintains an ongoing environmental surveillance program, which includes routine monitoring for radioactive materials and chemical substances on the Laboratory site and in the surrounding region. These activities document compliance with appropriate standards, identify trends, provide information for the public, and contribute to general environmental knowledge. The monitoring program supports the UC's policy of protecting its employees, the public, and the environment from harm that could be caused by activities of the Laboratory and of reducing adverse environmental effects to the greatest degree practicable.

Several environmental groups are active in the region, primarily in Taos and Santa Fe counties. Citizens Against Radioactive Dumping (CARD) and Concerned Citizens for Nuclear Safety (CCNS) became visible during the DOE hearings on the Waste Isolation Pilot Plant (WIPP) held in Santa Fe in June 1989. Attention was focused on the Laboratory in August 1989 during public hearings on the Laboratory's RCRA permit application, primarily on the operation of the controlled air incinerator.

3.3 KEY COMMUNITY CONCERNS

In accordance with guidance in Chapter 3 of the community relations handbook (EPA 1988), interviews with community members were conducted before this Community Relations Program Plan (CRPP) was written. A technical review was conducted to identify key community issues. Community groups and leaders were also identified. The individuals interviewed were representative of their local communities or had a specific interest in the Laboratory's ER Program. Those interviewed lived in Los Alamos, Santa Fe, Española, Jemez Springs, and Taos and generally fit into one of the following categories:

- federal officials,
- state officials,
- local elected officials,
- UC staff,
- former UC staff,
- environmental interest groups,
- local business leaders,

- community and civic organizations,
- local news media, and
- local citizens.

The key concerns expressed by members of the community during interviews conducted in May and June of 1990 are listed below. Although not a scientifically conducted survey, this informal sampling of opinion does represent the diverse points of view and concerns that will be addressed through the CRPP. The items included in the summary are not ranked in order of importance, nor are they the only public concerns about the DOE/UC's ER Program.

- Environmental monitoring and surveillance at the Laboratory are inadequate, and there has been no independent verification that the information from annual reports on these activities is accurate or credible.

- The DOE/UC do not really know how much radioactive and hazardous waste exists in the area, and the information to date reveals only the "tip of the iceberg."

- Secrecy and security policies prevent any "real" information about radioactive and hazardous waste problems at the Laboratory from getting out to the public.

- If DOE/UC investigations reveal anything that points to a worse problem than is already known, the DOE/UC will cover it up and not reveal that information the public.

- The investigation of these sites will cause the DOE/UC to declare more of its properties and adjacent properties inaccessible for public use or expansion of Laboratory facilities.

- The DOE/UC will not be adequately funded for ER and will be forced to fence off contaminated areas or take other interim measures instead of effecting a final cleanup of the problems.

- The perceptions of the hazards associated with the environmental problems at the Laboratory are exaggerated far beyond reality. These perceptions could force the DOE/UC to shut down the Laboratory.

- Money now spent on valuable scientific research will be redirected to be spent on environmental cleanups and will dramatically change the mission of the Laboratory to one of environmental cleanup rather than research.

■ Because environmental problems have not been managed well in the past, the DOE/UC is using the ER Program to "play catch-up."

■ Any contamination found outside the Laboratory boundaries could have a severe economic impact on local businesses and on the price of homes near the contaminated site.

■ Publicity surrounding environmental problems at the Laboratory could negatively affect tourism in the area, especially at Bandelier National Monument.

■ Residents and workers in Los Alamos are dying of cancer at a higher rate than anywhere else in New Mexico.

4.0 HIGHLIGHTS OF THE COMMUNITY RELATIONS PROGRAM

The following subsections represent a broad sampling of the types of community relations activities that could be performed as part of the ER Program. Each activity will be assessed for its responsiveness to public needs and concerns and will be expanded, changed, or eliminated on the basis of assessments conducted after it has been implemented. Listed first are activities required under the HSWA Module; then, beginning with Section 4.9 are those activities that, time and resources permitting, will be conducted to encourage greater public understanding of and involvement in the ER process.

4.1 MAILING LIST

Part D, No. 1, of the HSWA Module provides for "establishing an active mailing list of interested parties (to be updated annually), including those on the official facility mailing list who wish to be on the program's list." The ER Program community relations project leader will manage the development and maintenance of this list, updating it in accordance with regulatory requirements.

4.2 INFORMAL MEETINGS

Part D, No. 2, of the HSWA Module provides for "informal meetings, including briefings and workshops as appropriate, with the public and local officials before and during the RFI (RCRA facility investigations) process, which includes activities associated with the RFI workplan and RFI report." The Laboratory's ER Program intends to meet this regulatory requirement by following the approaches described below.

4.2.1 Information Meetings

On a periodic basis, or whenever an ER Program activity generates significant public inquiry or concern, informal information meeting(s) will be called to provide up-to-date information and to address public concerns and questions. Technical staff in the ER Program will support these efforts, and DOE, EPA, and NMEID officials will be informed of plans for these meetings before they are announced to the public. Because the information meetings are informal, no formal response to comments or formal comment period will be observed. However, staff present at the meetings will respond to public comments and questions.

4.2.2 Special Briefings and Workshops

When a public group identifies a specific concern or a highly complex technical issue important to that group that could be too technically detailed or too narrowly focused for a general public audience, a special briefing or workshop, to be held in Los Alamos, or in the group's local community, may be required. Technical personnel from the ER program who have expertise in the field(s) of concern to the group will be available to meet with these groups to exchange information in an informal setting.

4.3 PUBLICATIONS

Part D, No. 3, of the HSWA Module provides for "news releases, fact sheets, approved RFI workplans, RFI (RCRA field investigation) final reports, special permit conditions reports, and publicly available quarterly progress reports that explain the progress and conclusions of the RFI." The Laboratory's ER Program considers the examples cited here as "information materials" and will develop them in response to regulatory requirements or to the public's need for information. The ER Program's community relations coordinator will assist ER Program technical staff in developing information materials such as news releases and fact sheets that are technically accurate, that conform with Laboratory public affairs policies for public information, and that are appropriate for the intended public audience(s).

4.4 PUBLIC READING ROOM

Part D, No. 4, of the HSWA Module provides for "creation of a public information repository and reading room." The Laboratory's ER Program will set up a public information repository and reading room in the town of Los Alamos so that the public can review the ER Program. The information will be managed by the community relations coordinator with support from the ER Program's Technical Data Management Team. All information used

in the decision-making process for ER activities at Los Alamos will either be available for review by the public, unless that information is generally available in public or other local libraries.

As the ER Program at Los Alamos gets under way, satellite locations for some public information materials may be established in communities outside Los Alamos. These satellite public information repositories (in most cases, local libraries) will contain only those reports and documents that require a formal public comment period.

4.5 INFORMATION UPDATES

Part D, No. 5, of the HSWA Module provides for "updates of materials in the information repository and public reading room." The community relations coordinator will work closely with the ER Program's Technical Data Management Team to develop a process that will keep information materials up-to-date and available to the public.

4.6 TOURS AND BRIEFINGS

Part D, No. 6, of the HSWA Module provides for "public tours and briefings to inform and to listen informally to public concerns and answer individual questions." The ER Program will meet this regulatory requirement using public forums, special briefings, information meetings, and responses to daily inquiries.

4.6.1 Public Tours Program

A regular program of ER site tours will be established for any public groups and individuals who wish to observe the activities and progress of the project. Depending on public need and available Laboratory resources, these tours will be scheduled either at a specified time for large groups or as requested by individuals.

4.6.2 Special Briefings and Workshops

Special briefings and workshops are described in Section 4.2.2.

4.6.3 Response to Inquiries

The program will provide the highest possible priority to responding to inquiries from outside the Laboratory. The community relations coordinator will work closely with Laboratory management, the Laboratory's Public Affairs Division, and ER Program staff to ensure that timely and accurate information is provided. When needed to respond to detailed and complex

inquiries, technical personnel with expertise in the area of inquiry will be available.

4.6.4 After-Hours Inquiries

The community relations program will provide an answering machine for after-hours inquiries from the public and will respond to these inquiries during the next Laboratory business day.

4.6.5 Information Meetings

Information meetings are discussed in Section 4.2.1.

4.7 PROGRESS REPORTS

Part D, No. 7, of the HSWA Module provides for "quarterly technical progress reports for the Administrative Authority." The community relations program will contribute information about its activities to the ER Program's manager.

4.8 TIMELY NOTIFICATION

Part D, No. 8, of the HSWA Module provides for "procedures for immediate notification of the San Ildefonso Pueblo or other affected parties in case of a newly discovered off-site release which could impact them." The community relations will follow the requirements set forth in the EPA's regulatory directive on notification of new SWMUs and will inform the above parties in accordance with these requirements.

4.9 ADDITIONAL COMMUNITY RELATIONS ACTIVITIES

New methods of providing information will be incorporated in the CRP, subject to the availability of resources, to meet community and ER Program information needs. These methods may include video records, communications training, public forums, a speakers' bureau, and environmental education.

4.9.1 Video Tape Record

The community relations program project leader will explore the possibility of obtaining a video tape of identified hazardous work sites and of the activities performed at these sites. This raw information will be stored at the community reading room (Section 4.4.2), and video tape footage from this record will be included in site-specific video tapes and ER Program progress reports.

4.9.2 Communications Training

Because information pertaining to the ER Program is complex, the community relations coordinator will conduct training programs for key personnel so that they will be able to communicate complex technical issues clearly.

4.9.3 Participation in Public Forums

If a topic related to ER arises in a meeting or forum, the community relations program project leader will, whenever ER Program staff are available, solicit or respond to an invitation to speak or participate in that forum.

4.9.4 Speakers' Bureau

The ER community relations project leader will identify ER Program staff members who are effective speakers, will prepare presentations on major technical issues and disciplines of the ER Program, and will make them available to the public upon request.

4.9.5 Environmental Education Programs

To increase public understanding of ER Program activities and public participation in the ER process, the project leader will seek opportunities to develop educational programs in local communities on environmental issues and concerns related to the ER Program. Examples of such educational programs include, but are not limited to, workshops, lecture series, seminars, continuing adult education programs, environmental curricula in local school systems, student internships, science fair projects, information displays and demonstrations, and ER Program open houses.

5.0 TIMING AND SCHEDULING OF COMMUNITY RELATIONS ACTIVITIES

As described in Section 4, the community relations activities required by the HSWA Module will be implemented on a schedule that complies with EPA regulations. Additional community relations activities not required under the HSWA Module (Section 4.9) will be implemented as the time and resources of the ER Program allow and in a manner that is responsive to

■ REFERENCES

EPA (Environmental Protection Agency) June 1988. "Community Relations in Superfund—A Handbook," Interim Version: EPA/540/G-88/002, OSWER Directive 9230.0-3B, Washington, DC.

APPENDIX A

Description of Technical Areas at Los Alamos National Laboratory

DESCRIPTIONS OF TECHNICAL AREAS AT LOS ALAMOS NATIONAL LABORATORY

Locations of the 51 technical areas (TAs) operated by the Los Alamos National Laboratory (the Laboratory) in Los Alamos County are shown in Section 2, Figure 2-2. The main programs conducted at each of the 34 active, developed areas are listed in this appendix.

TA-2, Omega Site: Omega West Reactor, an 8-MW nuclear research reactor, is located here. It serves as a research tool by providing a source of neutrons for fundamental studies in nuclear physics and associated fields.

TA-3, South Mesa Site: This is the main technical area of the Laboratory where the Administration Building that contains the Director's office and administrative offices and laboratories for several divisions is located. Other buildings house the central computing facility, administration offices, materials division, science museum, chemistry and materials science laboratories, physics laboratories, technical shops, cryogenics laboratories, a Van de Graaff accelerator, and the main cafeteria.

TA-6, Two-Mile Mesa Site: This is one of three sites (TA-22 and TA-40 are the other two) used in the development of special detonators to initiate high-explosive systems. Fundamental and applied research in support of this activity includes investigating phenomena associated with initiating high explosives and research in rapid shock-induced reactions.

TA-8, GT Site (or Anchor Site West): This is a nondestructive testing site operated as a service facility for the entire Laboratory. It maintains capability in all modern nondestructive testing techniques for ensuring quality of material ranging from test weapons components to high-pressure dies and molds. Principal tools include radiographic techniques (x-ray machines to 1,000,000 V and a 24-MeV betatron), radioactive isotope techniques, ultrasonic and penetrant testing, and electromagnetic test methods.

TA-9, Anchor Site East: At this site, fabrication feasibility and physical properties of explosives are explored. New organic compounds are investigated for possible use as explosives. Storage and stability problems are also studied.

TA-11, K-Site: Facilities are located here for testing explosive components and systems under a variety of extreme physical environments. The facilities are arranged so that testing may be controlled and observed remotely and so that devices containing explosives or radioactive materials, as well as those containing nonhazardous materials, may be tested.

TA-14, Q-Site: This firing site is used for running various tests on relatively small explosive charges and for fragment impact tests.

TA-15, R-Site: This is the home of PHERMEX, a multiple-cavity electron accelerator capable of producing a very large flux of x rays for certain weapons development problems and tests. This site is also used for the investigation of weapons functioning and systems behavior in nonnuclear tests, principally by electronic recording means.

TA-16, S-Site: Investigations at this site include development, engineering design, pilot manufacture, environmental testing, and stockpile production liaison for nuclear weapons warhead systems. Development and testing of high explosives, plastics, and adhesives and research on process development for manufacture of items using these and other materials are accomplished in extensive facilities.

TA-18, Pajarito Laboratory Site: The fundamental behavior of nuclear chain reactions with simple, low-power reactors called critical assemblies is studied here. Experiments are operated by remote control and are observed by closed-circuit television. The machines are housed in buildings known as kivas and are used primarily to provide a controlled means of assembling a critical amount of fissionable materials. This is done to study the effects of various shapes, sizes, and configurations. These machines are also used as a source of fission neutrons in large quantities for experimental purposes.

TA-21, DP-Site: This site has two primary research areas—DP-West and DP-East. DP-West is concerned with chemistry research; DP-East is the high-temperature chemistry and tritium site.

TA-22, TD Site: See TA-6.

TA-28, Magazine Area A: This area is one of two storage areas for explosives.

TA-33, HP-Site: A major high-pressure tritium-handling facility is located here. Laboratory and office space for the Geosciences Division that is related to the Hot Dry Rock Geothermal Project are also located at this site.

TA-35, Ten Site: Nuclear safeguards research and development conducted here are concerned with techniques for nondestructive detection, identification, and analysis of fissionable isotopes. Research in reactor safety and laser fusion is also done here.

TA-36, Kappa Site: Various explosive phenomena, such as detonation velocity, are investigated here.

TA-37, Magazine Area C: See TA-28.

TA-39, Ancho Canyon Site: Nonnuclear weapons behavior is studied here, primarily by photographic techniques. Investigations are also made into various

phenomenological aspects of explosives, interactions of explosives, and explosions involving other materials.

TA-40, DF-Site: See TA-6.

TA-41, W-Site: Personnel at this site are engaged primarily in engineering design and development of nuclear components, including fabrications and evaluation of test materials for weapons.

TA-43, Health Research Laboratory: The Biomedical Research Group does research here in cellular radiobiology, biophysics, mammalian radiobiology, and mammalian metabolism. A large medical library; special counters used to measure radioactivity in humans and animals; and animal quarters for dogs, mice, and monkeys are also located in this building.

TA-46, WA-Site: Applied photochemistry, which includes development of technology for laser isotope separation and laser enhancement of chemical processes, is investigated here. Solar energy research, particularly in the area of passive solar heating for residences, is also done at this site.

TA-48, Radiochemistry Site: Laboratory scientists and technicians at this site study nuclear properties of radioactive materials by using analytical and physical chemistry. Measurements of radioactive substances are made, and hot cells are used for remote handling of radioactive materials.

TA-50, Waste Management Site: Personnel at this site have responsibility for treating and disposing of most industrial liquid waste received from Laboratory technical areas, for development of improved methods of solid waste treatment, and for containment of radioactivity removed by treatment. Radioactive liquid waste from most technical areas is piped to this site for treatment.

TA-51, Environmental Sciences Facility: Here, experiments are carried out on waste cover and stabilization alternatives, land reclamation, contaminant movement, and ecology.

TA-52, Reactor Development Site: A wide variety of activities related to nuclear reactor performance and safety is done at this site.

TA-53, Meson Physics Facility: The Los Alamos Meson Physics Facility (LAMPF), a linear particle accelerator, is used to conduct research in areas of basic physics, cancer treatment, materials studies, and isotope production. The Los Alamos Neutron Scattering Center (LANSCE) and the Proton Storage Ring (PSR) are also located on this site.

TA-54, Waste Disposal Site: This is a disposal area for solid radioactive and toxic wastes that meet regulatory acceptance criteria.

TA-55, Plutonium-Processing Facilities: Processing of plutonium and research in plutonium metallurgy are done here.

TA-57, Fenton Hill Site: This is the location of the Laboratory's Hot Dry Rock Geothermal Project. Scientists at this site are studying the possibility of producing energy by circulating water through hot, dry rock located hundreds of meters below the earth's surface. The water is heated and then brought to the surface to drive electric generators.

TA-59, Occupational Health Site: Occupational health and environmental science activities are conducted at this site.

TA-60, East Jemez Road: This area contains physical support facilities, including the existing landfill.

TA-63: This area contains physical support facilities operated by World Services, Inc.

TA-74, Los Alamos Airport: This area contains the DOE-owned airport that serves the Laboratory.

APPENDIX B

Waste Management Plan

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1989 WASTE MANAGEMENT SITE PLAN
Los Alamos National Laboratory

2.0 GENERAL SITE INFORMATION

2.1 Organization and Administration

2.1.1 Responsible Office

Los Alamos National Laboratory is operated for the U.S. Department of Energy (DOE) by the University of California under Contract W-7405-ENG-36. The Laboratory is under the cognizance of the DOE's Los Alamos Area Office (DOE/LAAO), which reports to the DOE's Albuquerque Operations Office (DOE/AL).

2.1.2 Contractors

The University of California is the prime contractor for those operations involving waste generation and management. Pan Am World Services, Inc. (Pan Am), provides the major support work for the Laboratory and also generates waste from its own activities.

The current organizational structure of the Laboratory appears in Fig. 1. Overall responsibility for waste management is under the direction of the Associate Director for Operations and the Health, Safety and Environment Division (HSE) (Fig. 2).

2.1.3 Waste Management Organization and Responsibilities

The Waste Management Group, HSE-7, operates all waste management facilities at the Laboratory, except those related to high-explosives wastes and those operated by waste generators in preparing their wastes for disposal. HSE-7 also prepares the annual Waste Management Site Plan and authorizes exemptions from site-specific disposal requirements. (The Environmental Surveillance Group, HSE-8, and DOE/AL are primary consultants in granting exemptions from site-specific disposal requirements.) Activities within HSE-7 include treating radioactive liquid and solid waste; packaging, transporting, treating, and disposing of mixed and hazardous chemical waste; and operating the disposal and storage sites for radioactive and mixed waste.

Organizations that generate radioactive wastes must properly identify, segregate, and document their wastes for disposal. Pan Am janitorial personnel package most radioactive waste, but personnel in Laboratory operating groups package certain wastes, such as transuranic (TRU) wastes. Pan Am personnel transport waste on-site under the guidelines established by the Laboratory's waste management and radiation protection groups. Radiation protection personnel provide general Laboratory support in monitoring and general waste controls, and provide direct support at the sites for storing, treating, and disposing of radioactive waste.

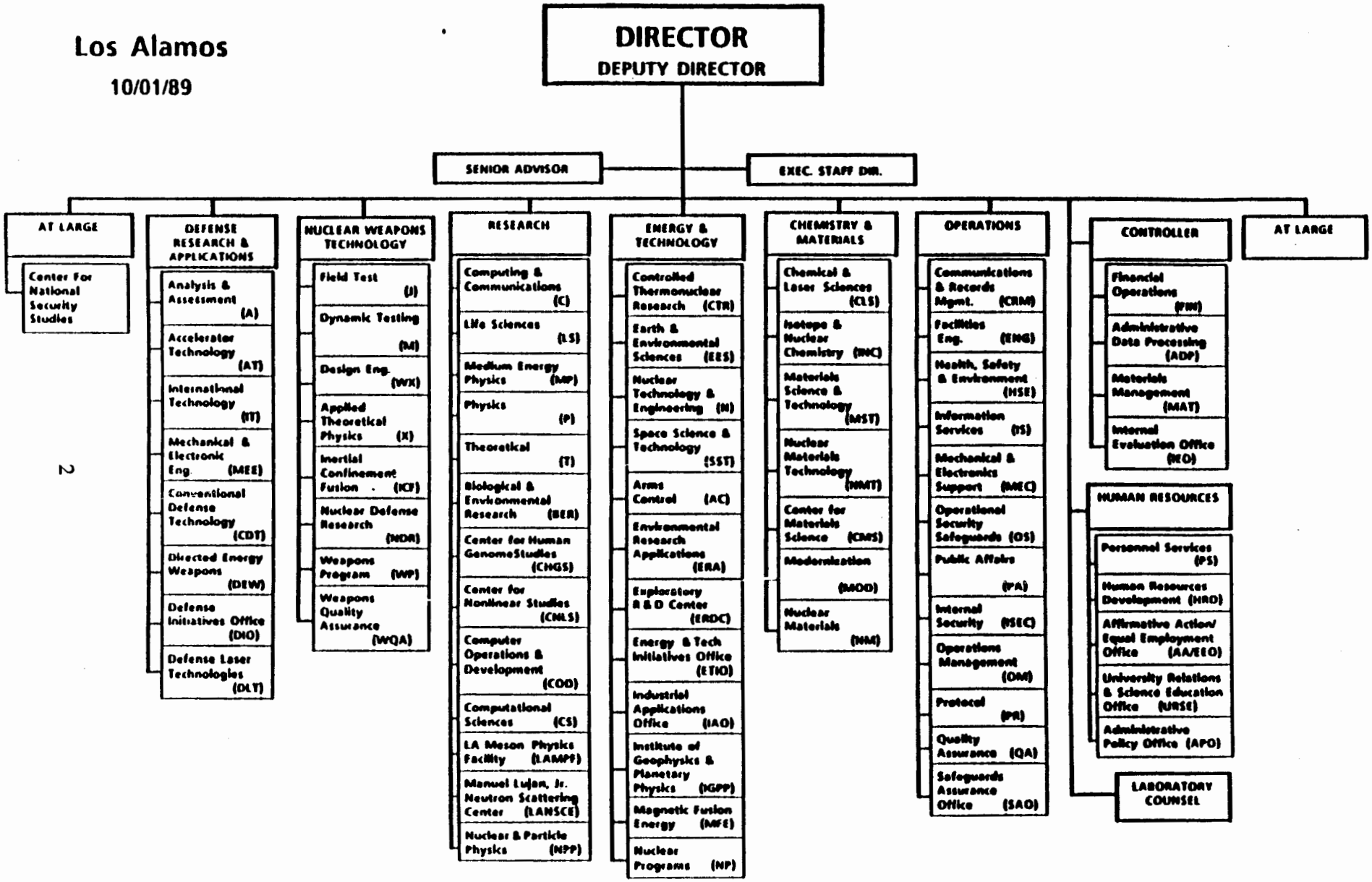


Fig. 1. Los Alamos National Laboratory Organizational Structure

HEALTH, SAFETY, AND ENVIRONMENT DIVISION

LOS ALAMOS NATIONAL LABORATORY - SEPTEMBER 1, 1989

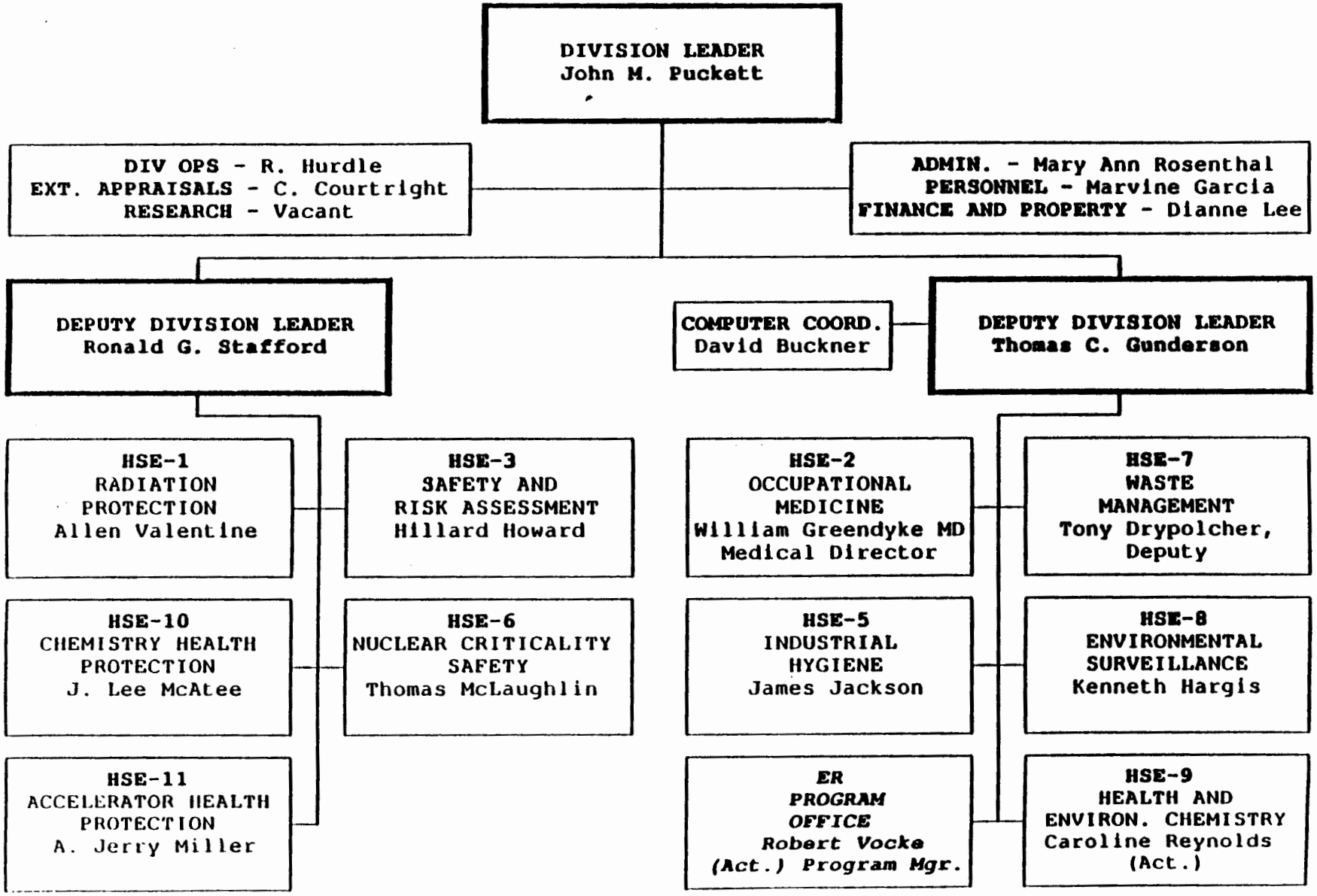


Fig. 2. HSE Division Structure

HSE-8 does environmental monitoring at the present and old burial sites. HSE-8 also ensures overall Laboratory compliance with environmental regulations related to hazardous materials disposal, impact analyses, performance assessments for disposal sites, and National Environmental Policy Act (NEPA) reviews required by the DOE/AL Order 5440.1B.

2.2 Site Description

2.2.1 Site Description General Plant Mission

The Laboratory's principal mission is to design and develop weapons for the nation's nuclear arsenal; however, considerable research and development (R&D) is directed toward developing the peaceful uses of nuclear energy, including research on controlled thermonuclear reactions, fission reactors, nuclear safeguards, laser fusion, and medium energy physics. Extensive basic research programs in physics, chemistry, metallurgy, mathematics and computers, earth sciences, and electronics support these efforts. Biomedical and environmental research includes programs in molecular biology, radiobiology, radio-ecology, and industrial hygiene. Expansion into nonnuclear areas is represented by applied technology development of solar and geothermal energy and superconducting power transmission lines.

2.2.2 General Area

The Laboratory and the resident communities of Los Alamos and White Rock are located in north-central New Mexico on the Pajarito Plateau, situated west of the Rio Grande on the eastern slopes of the Jemez Mountains (Fig. 3). The Laboratory was established here during World War II in part because of the mild climate and relative isolation of the location. The Laboratory site covers about 11 129 hectares (27 500 acres) in and adjacent to Los Alamos County. The surrounding area, including most of Los Alamos County and portions of Sandoval, Rio Arriba, and Santa Fe Counties, is largely undeveloped except for those areas occupied by Laboratory facilities and the associated communities. Large tracts of land in the Jemez Mountains to the north, west, and south of the Laboratory site are held by the US Forest Service and US National Park Service. This land is largely covered by pine, fir, and aspen forests and supports the usual variety of western mountain wildlife. Agriculture is limited to home gardens and some cattle grazing. In the river valleys to the east, agriculture is limited to the cultivation of relatively small, irrigated plots. Primary crops are corn, chile, tree fruits, and alfalfa. Milk is produced in commercial quantities in the neighboring community of Pojoaque. A more detailed description of the geology, climatology, and economy of the area appears in the Los Alamos Final Environmental Impact Statement.[1]

Laboratory activities are located in 33 technical areas (TA) widely spread over the site (Figs. 4 and 5).

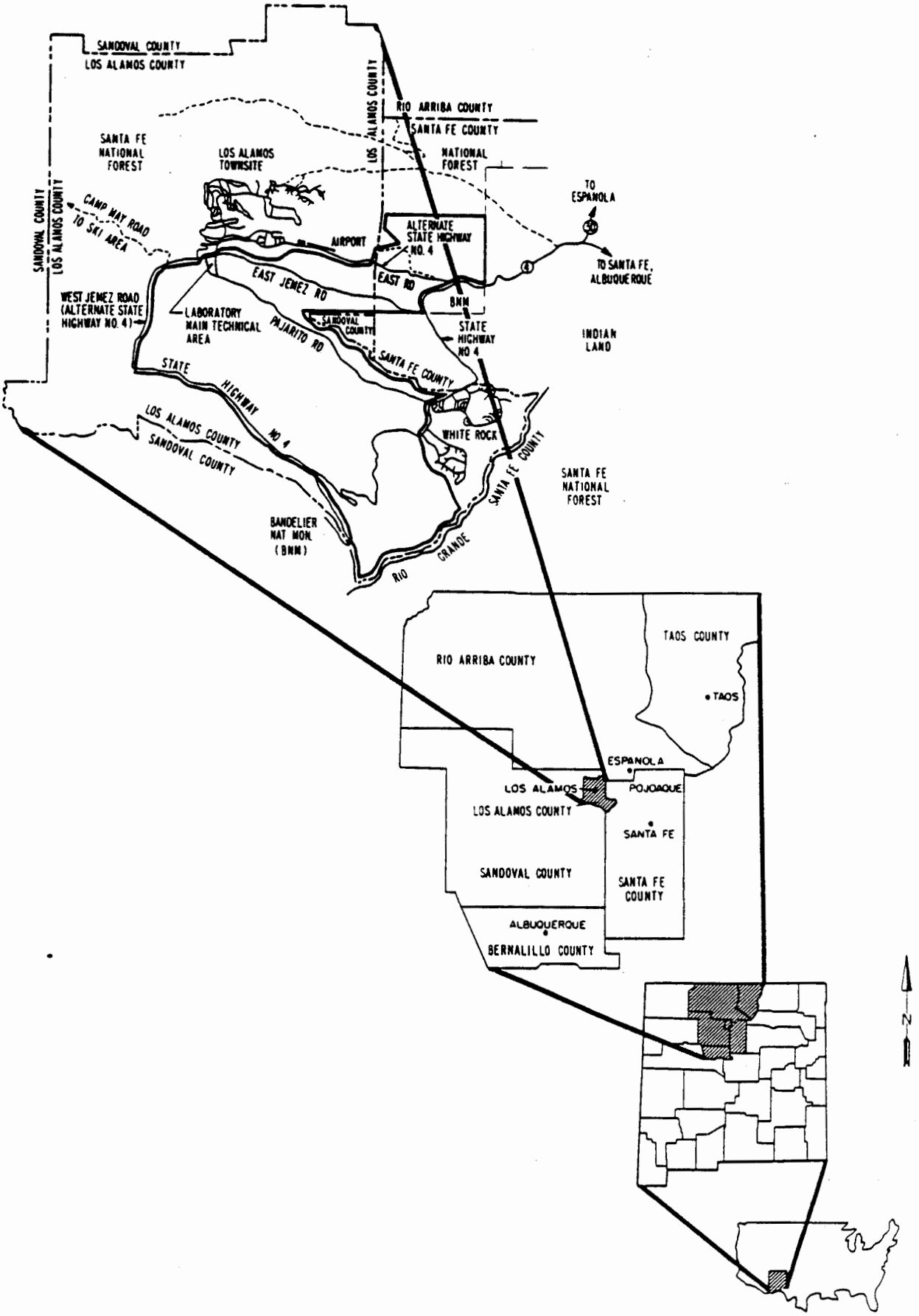


Fig. 3. Location of Los Alamos

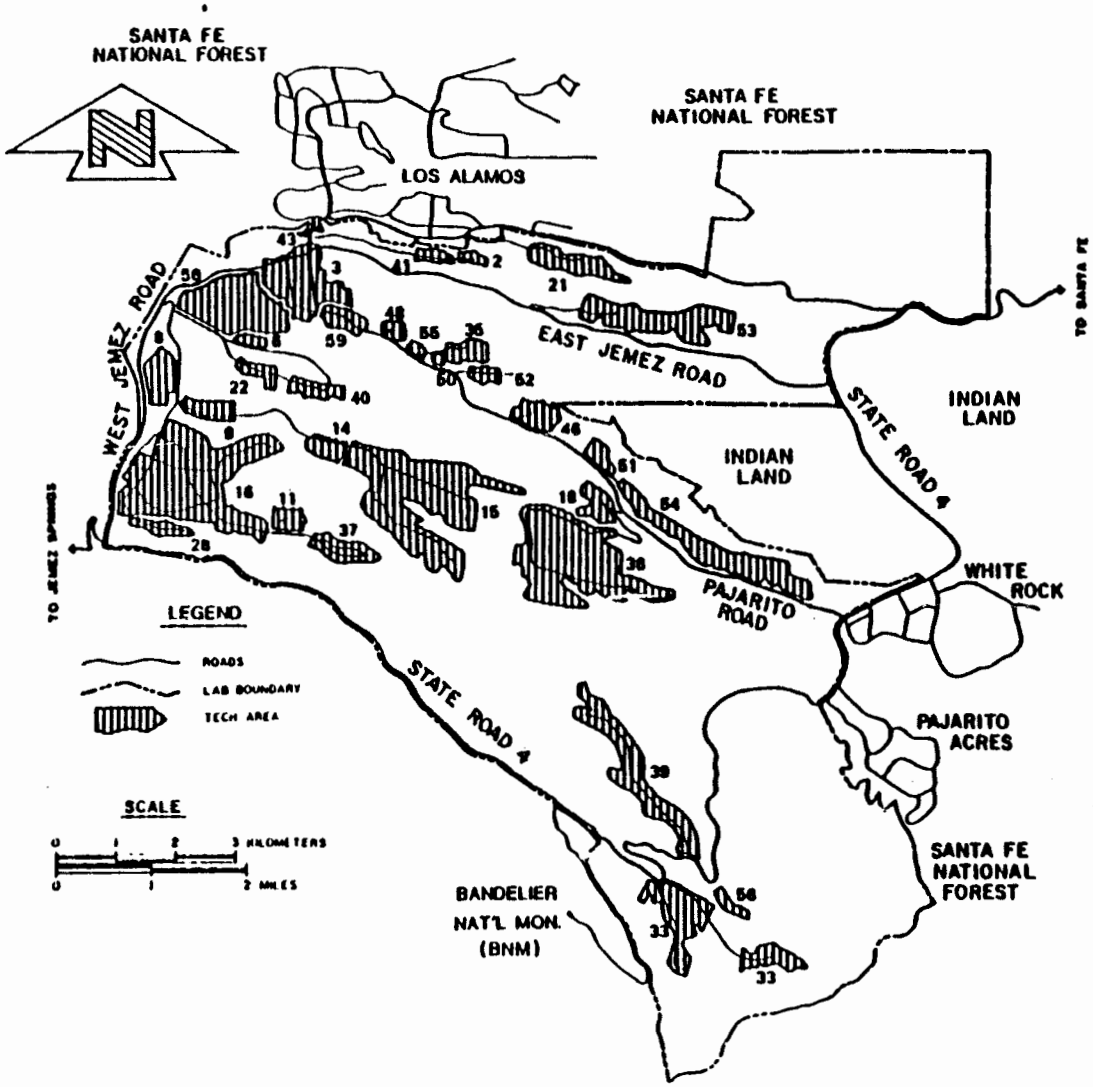


Fig. 4. Los Alamos National Laboratory—Technical Areas and Adjacent Communities

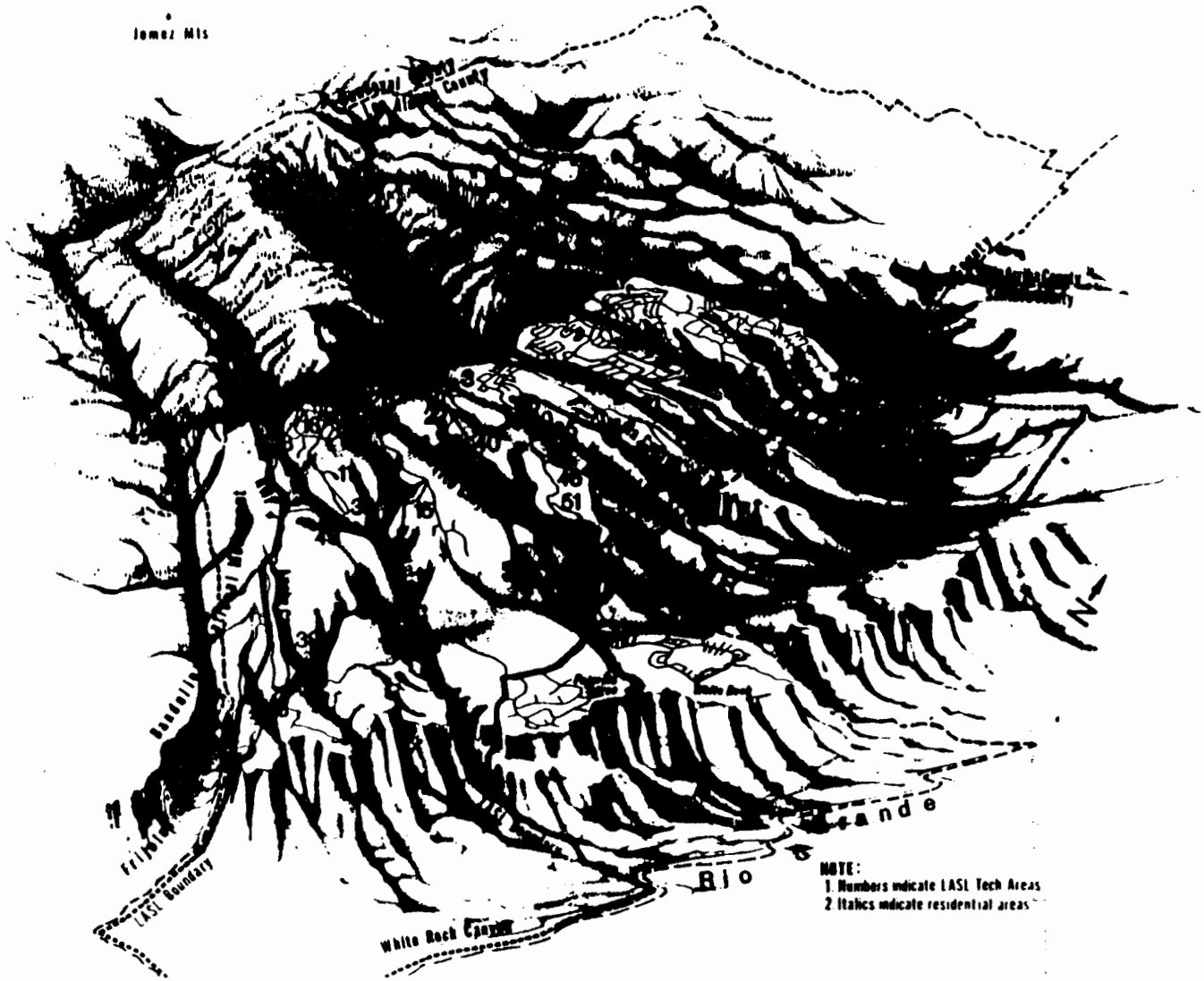


Fig. 5. Topography of the Los Alamos Area

2.2.3 Geographic Features

The Pajarito Plateau consists of a series of finger-like mesas separated by deep east-west oriented canyons cut by intermittent streams (Fig. 5). Mesa tops range in elevation from approximately 2400 m (7800 ft) on the flank of the Jemez Mountains to about 1800 m (6200 ft) at their eastern termination above the Rio Grande valley.

2.2.4 Geology and Hydrology

Most of the finger-like mesas in the Laboratory area are found in Bandelier Tuff (Fig. 6). Ashfall, ashfall pumice, and rhyolite tuff form on the surface of Pajarito Plateau. The tuff ranges from nonwelded to welded and is in excess of 300 m (1000 ft) thick in the western part of Pajarito Plateau and thins to about 80 m (260 ft) toward the east above the Rio Grande. It is deposited as a result of a major volcanic eruption in the western Jemez Mountains about 1.1 to 1.4 million years ago.

The tuffs overlap onto older volcanics, which form the Jemez Mountains along the western edge of the plateau. They are underlain by the conglomerate in the central and eastern edge along the Rio Grande. Basalts interfinger with the conglomerate along the river. These formations overlie the sediments, which extend across the Rio Grande valley and are in excess of 1000 m (3300 ft) thick.

Los Alamos area surface water is primarily in intermittent streams. Springs on flanks of the Jemez Mountains supply base flow into upper reaches of some canyons, but the amount is insufficient to maintain surface flows across the Laboratory site before it is depleted by evaporation, transpiration, and infiltration. Runoff from heavy thunderstorms or heavy snowmelt reaches the Rio Grande several times a year. Effluents from sanitary sewage treatment plant, industrial waste treatment plants, and cooling tower blowdown are released to some canyons at rates sufficient to maintain surface flows for about 1.5 km (1 mi).

Groundwater occurs in three modes in the Los Alamos area: (1) water in shallow alluvium in canyons, (2) perched water (a groundwater body above an impermeable layer that is separated from the underlying main body of groundwater by an unsaturated zone), and (3) the main aquifer of the Los Alamos area (Fig. 6).

The main aquifer of the Los Alamos area is the only aquifer capable of serving as a municipal water supply. The surface of the aquifer rises westward from the Rio Grande beneath the central and western part of the plateau. Depth of the aquifer decreases from 360 m (1200 ft) along the western margin of the plateau to about 180 m (660 ft) at the eastern margin. The main aquifer is isolated from alluvial and perched waters by about 110 to 190 m (350 to 620 ft) of dry tuff and volcanic sediments. Thus, there is little hydrologic connection or potential for recharge to the main aquifer from alluvial or perched water. The major recharge to the main aquifer is from the intermountain basin of the Valles Caldera in the Jemez Mountains west of Los Alamos. Floods, earthquakes, or volcanic eruptions sufficient to compromise the integrity of confinement are not likely.

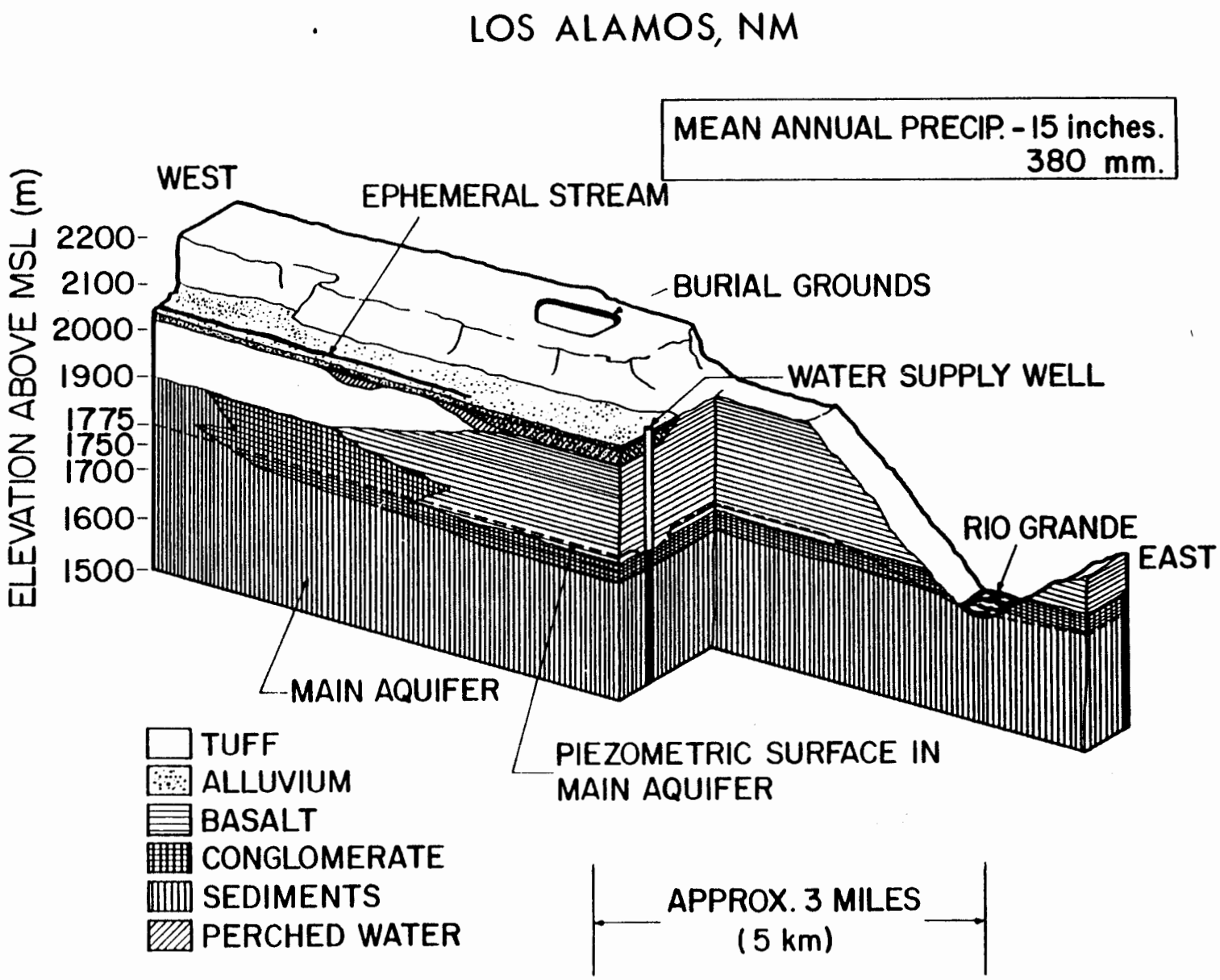


Fig. 6. Conceptual Illustration of Geologic-Hydrologic Relationships in the Los Alamos Area

2.2.5 Climate and Frequency and Types of Severe Weather

Los Alamos has a semiarid, temperate mountain climate characterized by clear skies, light winds, dry atmosphere, warm days, and cool nights. Generally, the predominant winds are southwesterly over all sites though more southerly over TA-54. A daily wind cycle exists with upslope southeast daytime winds and nighttime drainage winds from the west. Superimposed on the cycle are significant spatial and daily variation of surface winds caused by the complex terrain.

Summer maximum temperatures are usually below 32°C with overnight temperatures dropping to 12 to 15°C. Winter temperatures typically range from -10 to 5°C, although occasionally temperatures drop to near -18°C or below. The average annual precipitation is 45 cm (18 in.). Forty percent or 18 cm (7 in.) is produced by warm-season migratory storms. Warm-season precipitation falls primarily during brief afternoon thundershowers, especially during July and August. The rest, about 23 cm (9 in.), is typically cold-season migratory snowstorms.

Although winds at Los Alamos are characteristically light, strong wind gusts exceeding 27 m/sec (60 mph) are common during spring months. Historically, no tornadoes have been reported in Los Alamos County proper, although the potential for them does exist. Tangential wind velocities often exceed 31 m/sec (70 mph). A funnel cloud was sighted and photographed east of the Laboratory boundary in 1982. Dust devils are common during the warm months and probably do the most annual storm damage of any other weather phenomenon.

Lightning is sufficiently common over the Pajarito Plateau that lightning protection is an important consideration applied to each facility at the Laboratory. Los Alamos has an average of 58 thunderstorm days per year. Hailstones with diameters up to 0.6 cm (0.25 in.) are common, but 1.3-cm-diameter (0.5 in.) hailstones are rare. Thundershowers occasionally generate flash floods in local canyons.

2.2.6 Waste Management Mission

The major objective of the waste management program is to protect public health and the environment. To accomplish this objective, the Laboratory is committed to attaining and maintaining compliance with all Federal and State environmental regulations. The major environmental concerns and issues stated in this plan are the goals for accomplishing the major objective.

The goals of the waste management operations at the Laboratory are to provide the highest possible level of protection to employees, the public, government property, and the environment that could arise from the operations, and to comply with federal and state regulations.

The Laboratory requires that the amount of waste generated by Laboratory operations be reduced to a minimum; that the storage, treatment, and disposal of wastes be performed in ways that protect employees, the public, government property, and the environment; and that radioactivity of waste discharges be kept to a level as low as reasonably achievable.

Before being discharged to the environment, low-level and transuranic (TRU) liquid wastes are treated to the release limits outlined in DOE 5840.1.A. If the solid residues from treatment are low-level, they are stored as mixed low-level waste (LLW); if they are TRU, they are stored retrievably. Program emphasis is on the following:

- improving the removal of radionuclides;
- reducing liquid discharges to a longer term goal than zero; and
- maintaining the dewatered sludge product from treating low-activity wastes as low-level by controlling and minimizing the inputs of TRU and RCRA-regulated constituents.

The goal of waste storage at the Laboratory is to control hazardous materials and eliminate the potential for their endangering life or the environment, and to ensure that all storage fully complies with applicable regulations.

3.0 WASTE MANAGEMENT

3.1 Radioactive Waste Management

Locations of major radioactive waste management facilities appear in Fig. 7. Facilities include liquid waste treatment plants with associated effluent control systems, and treatment, storage, and burial facilities for solid waste. Flow diagrams of the generation and disposition of radioactive solid waste at the Laboratory are presented in Figure 8.

3.1.1 High-Level Waste

The laboratory does not generate, store, treat, or dispose of high-level radioactive wastes.

3.1.2 Transuranic (TRU) Wastes

3.1.2.1 Liquid TRU Waste

3.1.2.1.1 System and Facility Descriptions

3.1.2.1.1.1 Overview. The process liquid caustic and acid wastes from the Plutonium Facility (TA-55) are the primary source of the liquid TRU waste. Treatment yields a TRU solid and a liquid low-level waste that is further treated in the TA-50 plant.

3.1.2.1.1.2 Facility Description. The pretreatment facility consists of storage and neutralization tanks, a clarifloculator and filter tanks, two precipitate storage tanks, and an in-drum cement mixing area. Lime and/or iron sulfate are added to the liquid TRU stream, resulting in a precipitate

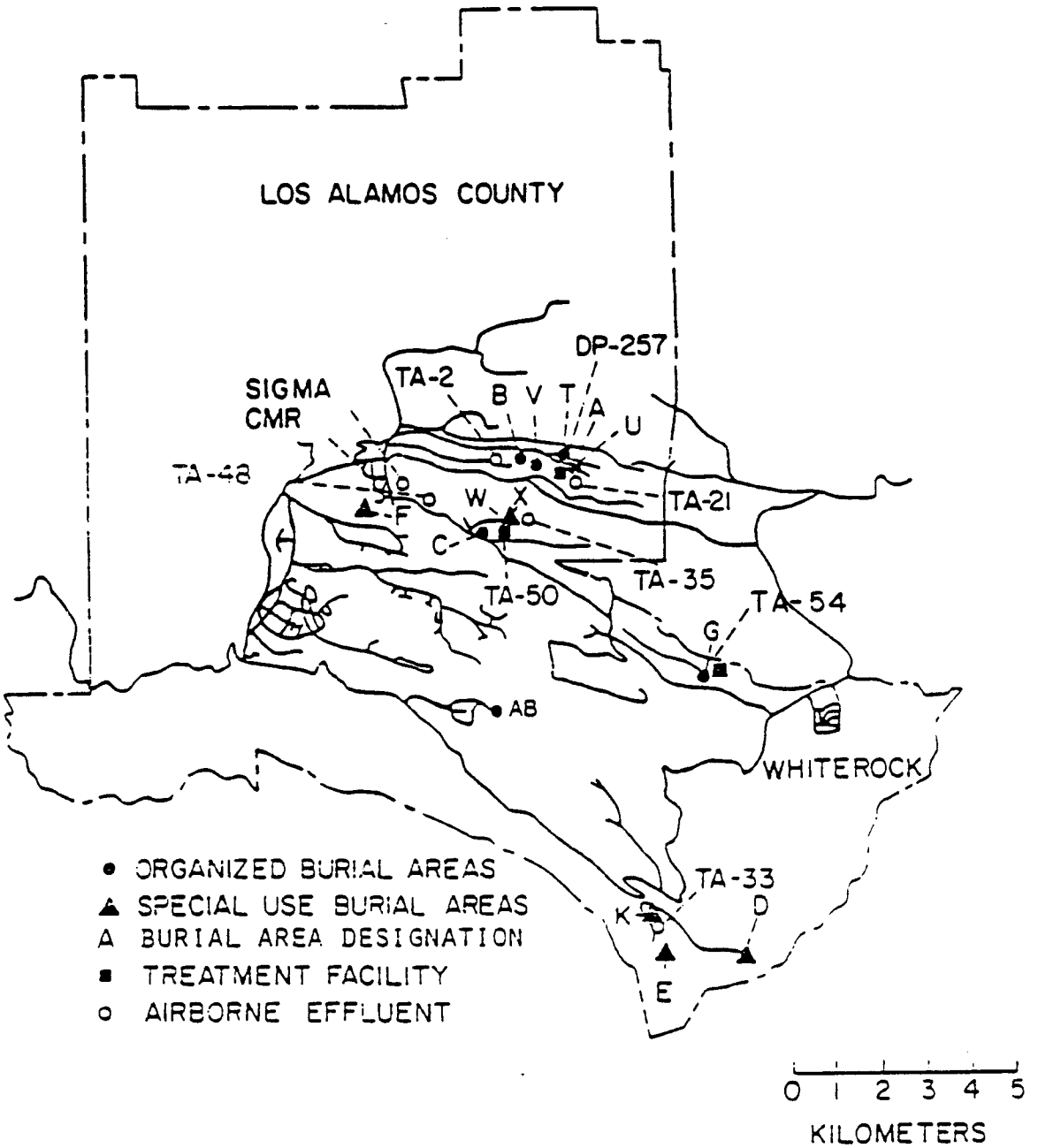


Fig. 7. Radioactive Waste Management Facilities

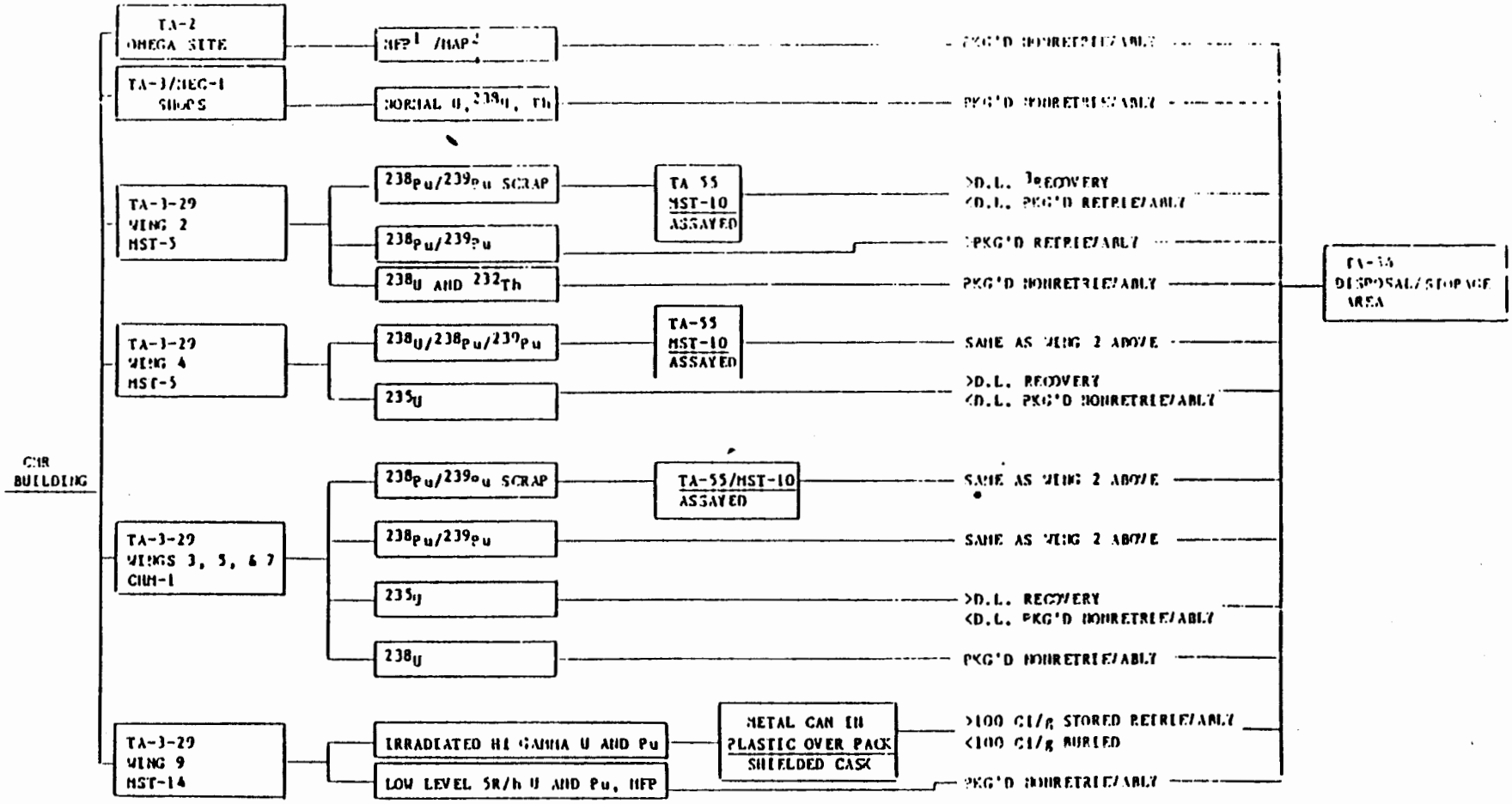


Fig. 8. Flow Sheet for Los Alamos Radioactively Contaminated Solid Waste (Page 1 of 4)

[1]MAP=Mixed Activation Products
[2]MFP=Mixed Fission Products
[3]D.L. = Discard Limit

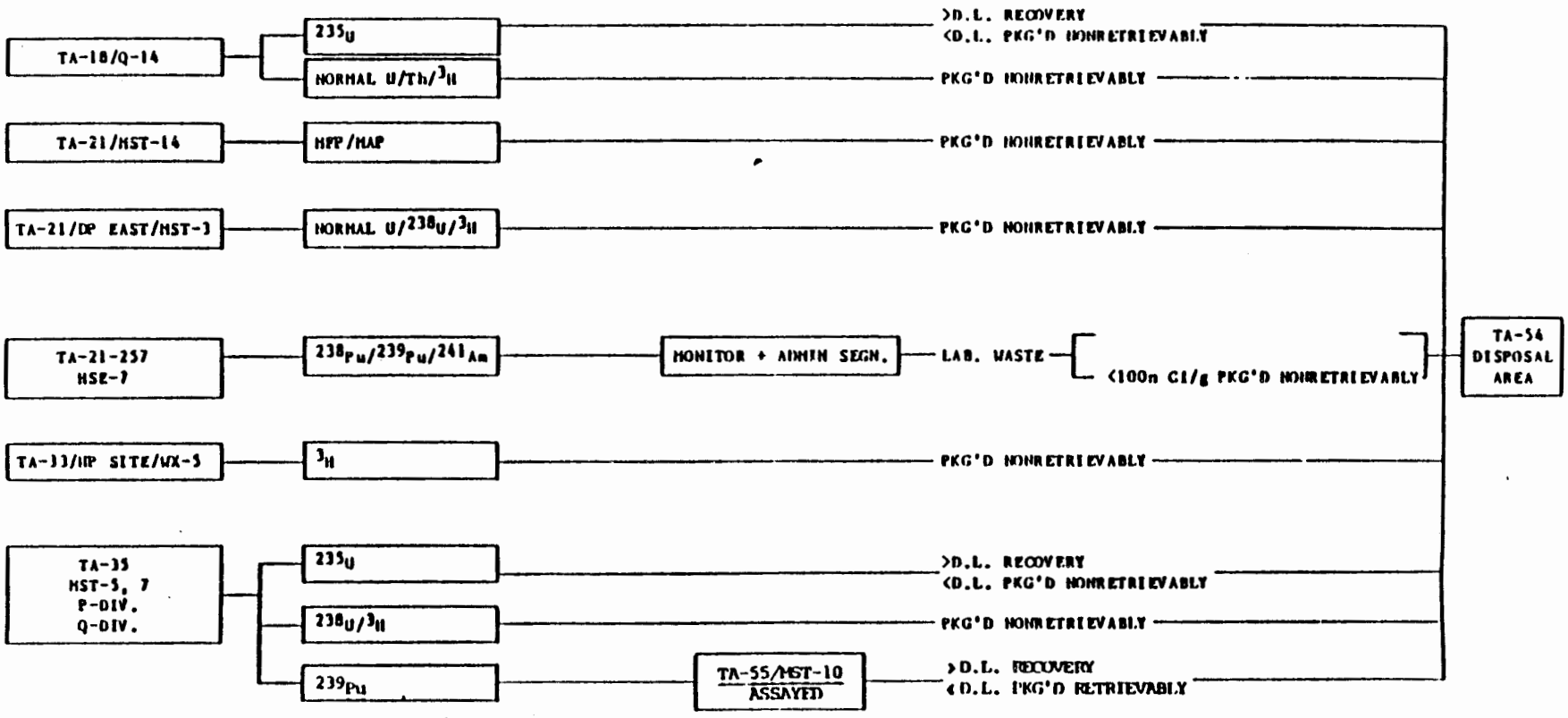


Fig. 8. (Page 2 of 4)

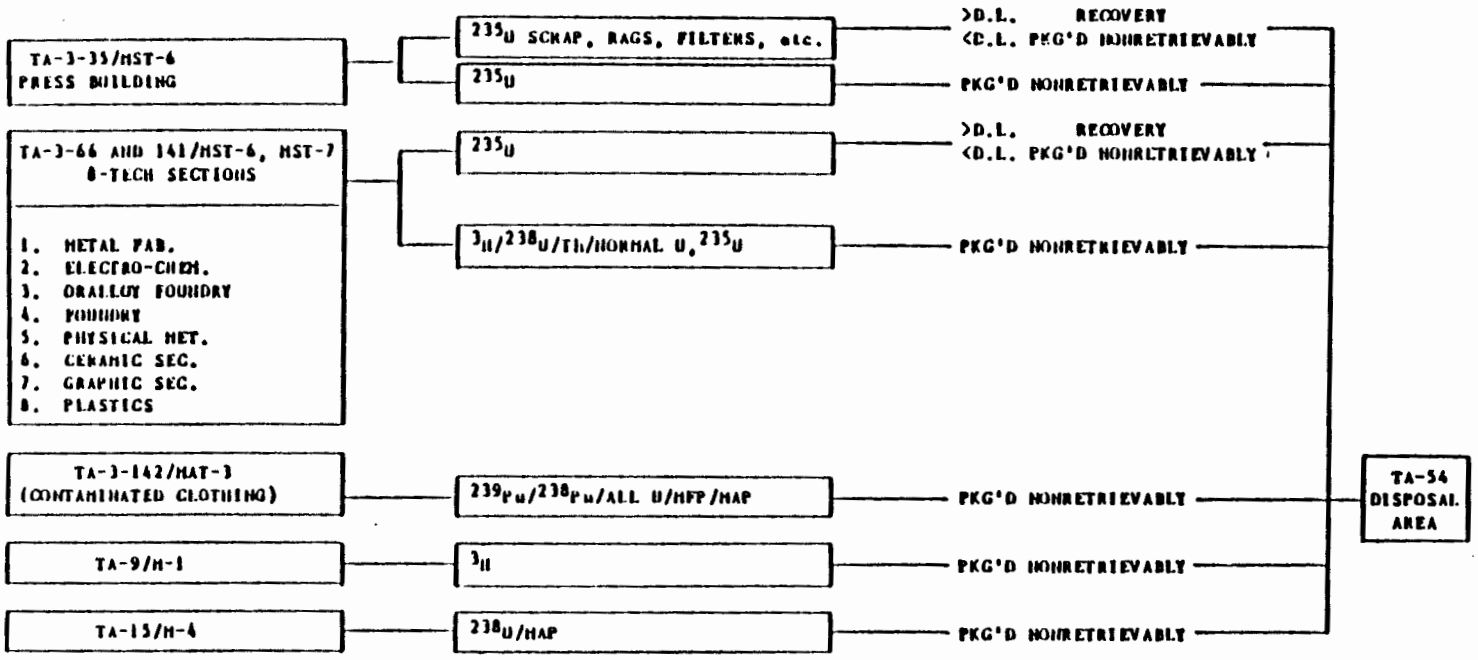


Fig. 8. (Page 3 of 4)

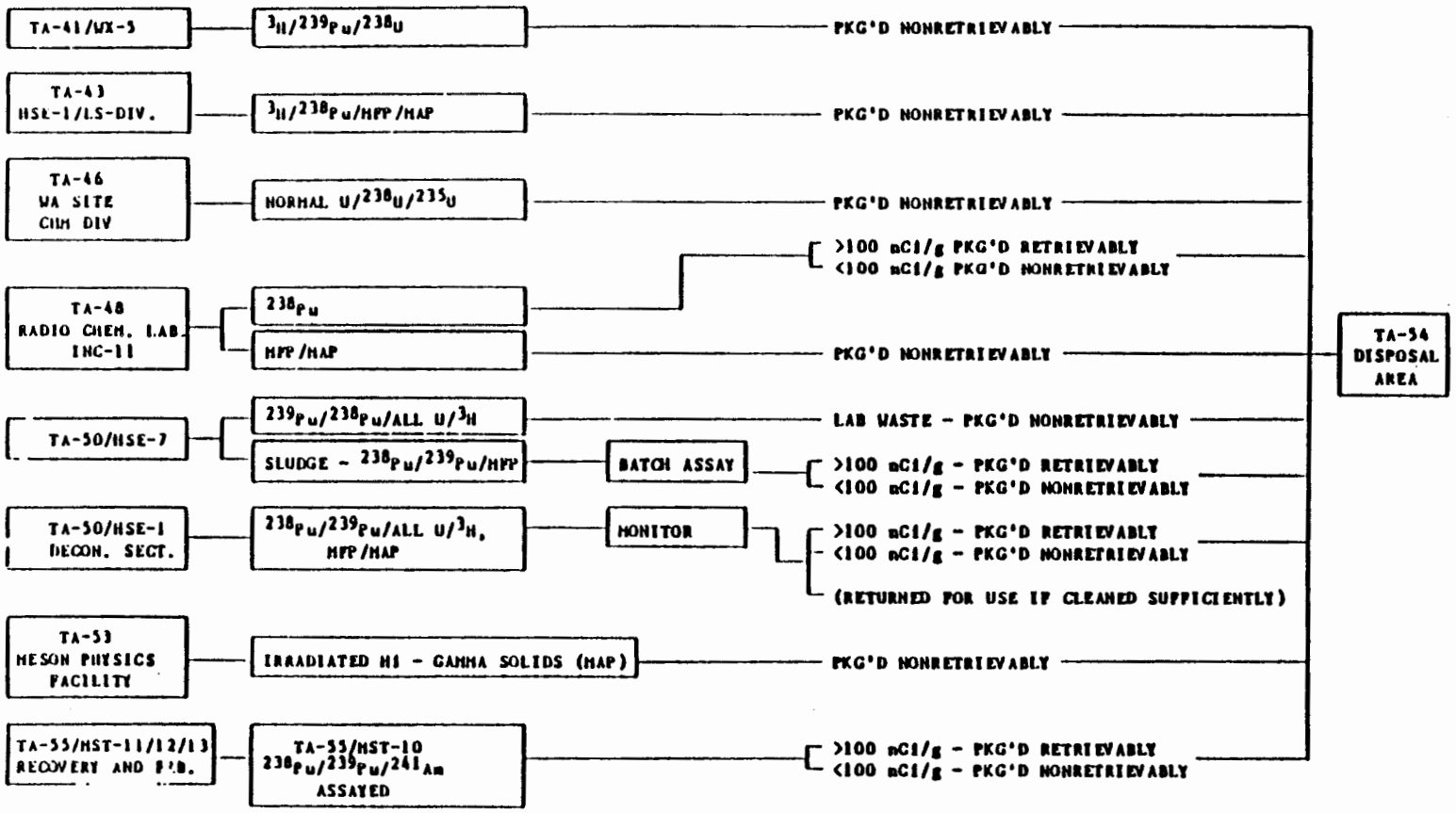


Fig. 8. (Page 4 of 4)

containing over 99.9% of the Pu and Am. The precipitate is mixed with cement in drums to form the TRU solid waste.

During FY89, liquid process wastes totaling 1.7×10^5 l (4.5×10^4 gal.) were pretreated, a process which yielded 37 drums, each containing 140 l (36 gal.) of cement paste. For this period, the total amount of ^{238}Pu, ^{239}Pu, and ^{240}Pu contained in these drums was 57.3 Ci; the total amount of ^{241}Am was 64.2 Ci.

Also in FY89, another 75 55-gal. drums of TRU solid waste were generated from operations at the TA-50 low-level treatment facility. This TRU solid waste was formed when equipment failure at the Plutonium Facility sent TRU liquid waste to the TA-50 low-level treatment facility.

3.1.2.1.2 Current and Future Plans. During FY90, no changes in the treatment of TRU liquids are planned. FY90 General Plant Project (GPP) funds totaling $1M are available for replacement of the transfer lines for TRU liquid and low-level liquid waste from the Plutonium Facility (TA-55-4) to the Waste Management Facility (TA-50-66). The pretreatment plant will be replaced as a part of the SNM Laboratory project. A Preliminary Safety Analysis Report (SAR) and Environmental Impact Statement (EIS) are being prepared beginning in FY90. Title I design was completed in FY89, and a review of Title I and Title II design work will proceed in FY90.

3.1.2.1.3 Implementation Requirements. No implementation requirements were identified for FY89.

3.1.2.2 Solid TRU Waste

3.1.2.2.1 System and Facility Descriptions

3.1.2.2.1.1 Overview. In the plutonium operations at TA-55 and TA-3-29, in which the concentration of TRU nuclides may be economically recoverable, higher concentrations of TRU residues are assayed to segregate recoverable scrap materials from TRU wastes. Routine area waste is assayed before packaging to segregate TRU from LLW. Solid wastes resulting from liquid waste treatment are analyzed radiochemically before packaging for the same purpose. When remote-handled TRU waste is generated, the TRU concentration is determined by inventory control and mechanical measurement. This waste is never recoverable scrap because it is residue from the examination of experimental irradiated fuel pins. Radium-226 sources and uranium-233 and -235, when at concentrations >100 nCi/g, are managed as TRU; management is consistent with DOE-AL Order 5820.2, Chapter IV, and with earlier definitions of TRU waste.

Requirements for reducing TRU waste generation are defined in Administrative Requirements (AR) 10-5, "Transuranic (TRU) Solid Waste," in the Laboratory Health and Safety Manual.[2] These requirements address waste segregation, materials handling, and decontamination.

TRU waste inventory and projection data on TRU waste are submitted annually to the DOE Integrated Data Base System. A summary of the radioactive solid waste buried and stored during FY89 appears in Table I, and

Table I
Waste Buried/Stored
FY89

Waste Category	Buried (B) Stored (S)	Volume (m^3)	Radioactivity (Ci)[a]	Radionuclide Content (g) Pu	Am	U/Th
1. Contact-Handled–TRU	S	153.0[b]	5021.9[c]	25692.6	345.7	0
2. Uranium/Thorium	B	800.0	1.5			4190885.2
3. Mixed Fission Products	B	742.6	566.9			
4. Mixed Activation Products	B	450.9	935.7			
5. Tritium	B	84.9	67890.2			
6. Remote-Handled–TRU	S	0	0	0	0	0
7. Alpha	B	2301.6	2.8	5.8	0	6542.1
Totals		4533.0	74419.0	25698.4	345.7	4197427.3

[a] Total activity of all contaminants
[b] WIPP Certified Volume 123.8 m^3; Uncertified Volume 29.2 m^3
[c] Only newly generated TRU wastes

projections for burial and storage volumes for FY90-95 appear in Table II. Variations in waste volumes and radioactive content result primarily from program changes, facility D&D activities, and general cleanup programs for Laboratory areas.

3.1.2.2.1.2 Facility Description

3.1.2.2.1.2.1 Certification Development for Newly Generated Waste. The Los Alamos TRU Waste Certification Plan for newly generated waste has received final DOE approval. Supplemented by attachments from each TRU waste generating organization, this document defines the Los Alamos plan for ensuring the Waste Isolation Pilot Plant (WIPP) operators that waste shipped to them from Los Alamos complies with the WIPP Waste Acceptance Criteria (WAC) and associated requirements. Attachments covering all identified TRU waste streams are now planned. By the end of FY89, the Waste Acceptance Criteria Certification Committee (WACCC) approved six. Waste can be fully certified only after the WACCC approves the plan and the attachment appropriate to that waste, comments from the State of New Mexico Environmental Evaluation Group (EEG) have been resolved, and the WACCC audits and approves operation under the attachment.

Six attachments have received formal WACCC approval, and the WACC has successfully audited five of these. None of the current Los Alamos TRU waste streams appear to be impractical to certify. Classified TRU waste is not accepted at the TA-54 storage site, and the generator must render all such waste nonclassified before storage. At the end of FY89, approximately 99% of regular newly generated Los Alamos TRU wastes is covered by approved attachments. However, difficulties with implementing some aspects of certification for fractions of newly generated waste streams resulted in only about 70% of the regular, newly generated streams being certified/certifiable. One other waste stream that normally is LLW, the sludge from the TA-50-1 treatment plant, became TRU for a short period because of a system leak at the generator's facility. A total of 14.6 m^3 (575 ft^3) of this waste thus became TRU and was uncertified.

The TRU Waste Certification Plan specifies the containers permitted for TRU waste packaging; all are currently DOT Type A containers. Waste requiring future processing before certification may be stored on-site in nonspecification containers that are suitable for health and safety purposes. To date, Los Alamos TRU waste has never been shipped off-site. All information on certifiable/certified TRU waste that is required for transportation, for completion of the WIPP data package, and for certification is supplied by the waste generator on a standard form (Fig. 9). The data are reviewed for completeness and compliance with the WIPP WAC before the waste is accepted by HSE-7. Completed forms are stored on microfilm or hard copy. Portions of the data package are also maintained in a readily retrievable form in the HSE-7 group computer. These records will be destroyed after the retention/removal decision has been made at WIPP.

Table II
Projections of Waste Buried/Stored at Los Alamos

Waste Category	Buried (B) Stored(S)	FY90 Volume (m^3)	FY91-95 Volume (m^3)
1. Contact-Hazardous–TRU	S	175	200
2. Uramium/Thorium	B	1200	1500
3. Mixed Fission Products	B	900	100
4. Mixed Activation Products	B	1000	975
5. Tritium	B	150	250
6. Rrmote-Handled–TRU	S	1	1*
7. Alpha	B	2200	220

*FY91–FY92 only; no generation projected thereafter

Los Alamos

Los Alamos National Laboratory
Los Alamos, New Mexico 87545

CERTIFIED WASTE STORAGE RECORD

WASTE PACKAGE SERIAL NUMBER
LA 8 5

I. GENERATOR'S PACKAGE INFORMATION

ORIGIN OF WASTE	PN Items C&D No.	Additional Information
Group		
TA		
Building		
Room		

CONTAINER	CODE	SS MATERIALS WRITE-OFF		RADIONUCLIDE CONTENT		C = Curie M = Gram
		Account	Project Code	Nuclide	Amount	
☐ Steel Drum (55 gal.)	01					
☐ Steel Overpack (Drums)	02					
☐ Steel Box (53 in. X 54 in. X 38.5 in.)	03					
☐ Steel Overpack (FRP Box)	04					
☐ Other *(Describe)*						
Drum Lot Code / Year of Mfr.						
Manufacturer's Box Serial Number						

	TOXIC OR CORROSIVE MATERIALS		
Process Batch Code			
Gross Wt. (kg)	Name	Code	Quantity (g)
Organic Mat'l Wt. (kg)			
Organic Mat'l Vol (%)			
Content Code			
Date Closed (MMDDYY)			

The data in this section were collected, and the waste described herein was packaged and labeled according to the procedures defined in the Los Alamos TRU Waste Certification Plan and its appropriate attachment(s). The data are correct and complete to the best of my knowledge.

Printed Name	Signature	Date

II. GENERATOR SITE HEALTH PHYSICS INFORMATION

Surface Dose Rate (mrem/h)	The data in this section were collected as prescribed in approved procedures. The package is properly closed and is safe to handle and transport.
Survey Meter Model	
Survey Meter Serial No.	
Alpha Contamination (dpm/100cm2)	Printed Name / Date
Beta-Gamma Cont. (dpm/100cm2)	Signature

III. HSE-7 SOLID WASTE RECORDS OFFICE INFORMATION

The data package for this waste has been reviewed by HSE-7. The generator is authorized to arrange transportation to TA-54 per AR 10-2.	Printed Name / Date
	Signature

IV. STORAGE SITE HEALTH PHYSICS INFORMATION

Surface Dose Rate (mrem/h)	The data in this section were collected at the TA-54 waste storage/disposal site as defined in approved procedures. The package is acceptable for handling and storage.
Survey Meter Model	
Survey Meter Serial No.	
Alpha Contamination (dpm/100cm2)	Printed Name / Date
Beta-Gamma Cont. (dpm/100cm2)	Signature

V. STORAGE SITE INFORMATION

This package was visually inspected when received and was found to be properly labeled and in good condition. It was accepted according to approved procedures.	Pad No.	Layer	☐ E ☐ C ☐ W
	Post No.	Date Stacked	
	This waste package was stored at this location according to approved procedures.		
Printed Name / Date	Printed Name / Date		
Signature	Signature		

HS Form Number 10-28 (6/84)

Fig. 9. Certified Waste Storage Record

3.1.2.2.1.3 Storage. Most of the Laboratory's TRU waste is currently stored on four asphalt pads measuring 12.2 m by 123.4 m (40 ft by 405 ft), one of which is currently designated for WIPP-certified wastes. Other TRU wastes are stored in facilities designed by modifying LLW burial pits and shafts described below.

Uncertified waste packages, primarily stored in drums and crates, are stacked 3.6-4.8 m (12-16 ft) high on the pavement. As the stack progresses down the pad, the top and sides are covered with 19-mm-thick (0.75 in.) plywood, and the entire stack is enclosed with 0.5 mm (0.02 in.) nylon-reinforced vinyl sheeting. The stack is then covered with 1-2 m (3-6 ft) of tuff to create an artificial mound (Fig. 10). One modified pit has also been used for TRU waste storage in much the same manner.

Special modes have been created for storing highly beta-gamma active hot-cell wastes [remote-handled (RH) TRU wastes], for wastes containing more than one gram of ^{238}Pu, and for the TRU cement paste previously generated at the TA-21-257 liquid waste treatment plant. The hot-cell waste is handled remotely and stored in modified shafts (Fig. 11). Because the waste is actually below ground during storage, little additional shielding is needed. The storage array currently employed is compatible with the remote-handled canister now approved for WIPP disposal.

Through FY85 the high activity ^{238}Pu wastes have been routinely packaged in 114-l (30-gal.) drums and placed in concrete casks for storage. Drums of combustible and noncombustible waste were placed in separate casks. The casks were sealed with asphalt and then covered with tuff (Fig. 12). In FY86, based upon the revised WIPP WAC, these wastes now are being packaged in 210-l (55-gal.) drums for storage on the aboveground pads.

A cement paste product previously generated by the TA-21-257 liquid waste treatment plant contained TRU levels of ^{239}Pu and ^{241}Am. The paste was solidified in corrugated metal pipes (CMPs), 0.75 m (2.5 ft) in diameter and 6 m (20 ft) long, with a 0.3-m-thick (1 ft.) uncontaminated concrete plug at the bottom. The pipe was filled to within 0.3 m (1 ft) of the top, then sealed with uncontaminated concrete. Through FY85, the pipes were stored vertically in a 6-m-deep (20 ft) pit that was backfilled with 1 m (3 ft) of tuff at Area T, TA-21. This waste stream is no longer generated. During FY86 the 158 TRU waste-containing CMPs were retrieved, decontaminated, and moved to TA-54, Area G, for storage until a treatment facility for WIPP-processing becomes available.

Packages of certified/certifiable TRU waste are stacked on the asphalt storage pad under the protective covering of a tension support structure. This expandable structure is fabricated by stretching reinforced vinyl material between aluminum I beams formed into arches. The present shell, with its two semicircular ends, measures 180 feet long by 50 feet wide. Plans have been initiated to add additional panels to increase the overall length by 110 feet.

As of the end of FY 1989, approximately 7351 m^3 (259 490 ft^3) of uncertified TRU waste remained accumulated in storage at TA-54 in Los Alamos. Of this, approximately 29 m^3 (1025 ft^3) is remote-handled wastes stored in concrete casks; approximately 339 m^3 (11 967 ft^3) is high-activity ^{233}U and ^{238}Pu wastes packaged in 114-l (30-gal.) drums stored in concrete casks;

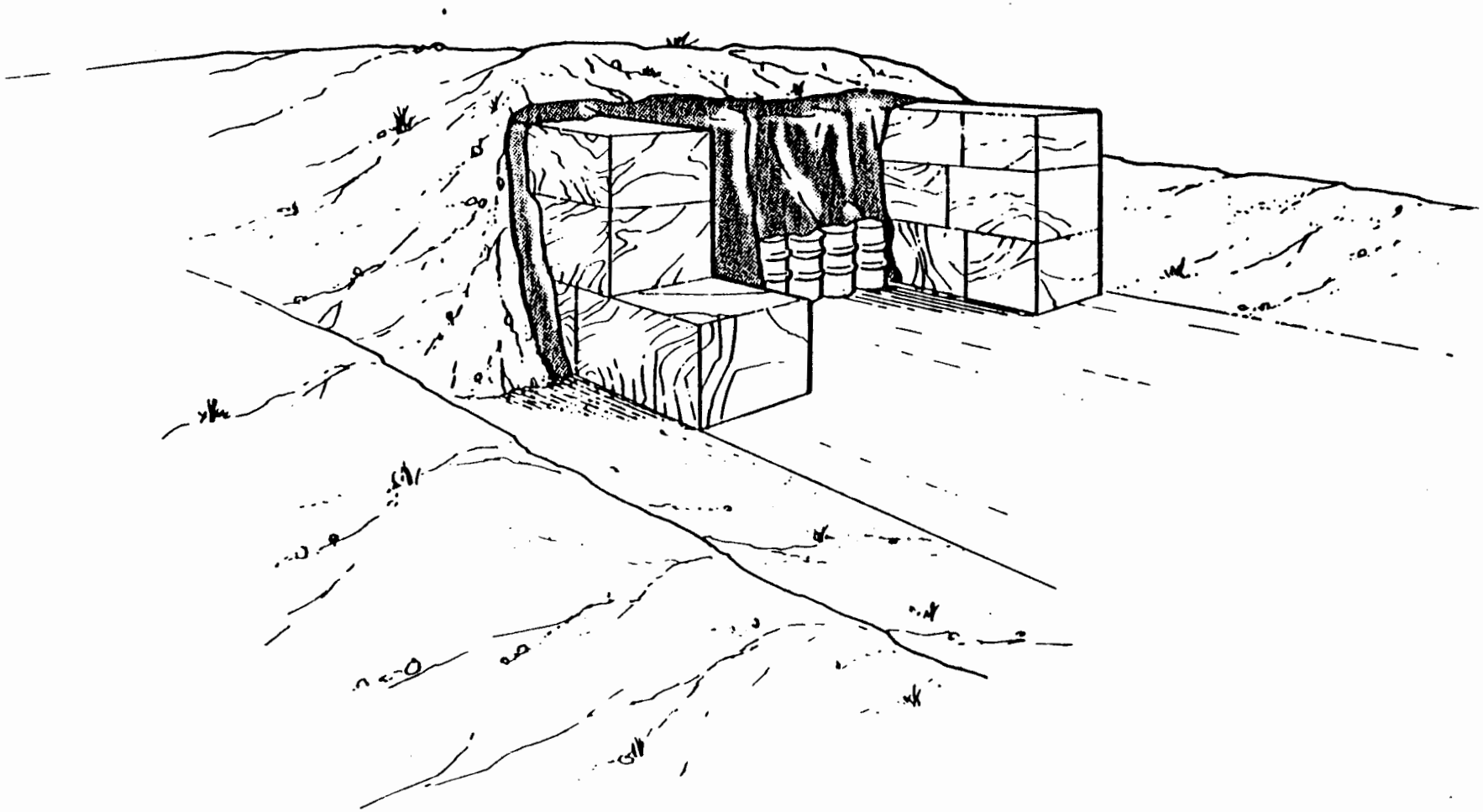
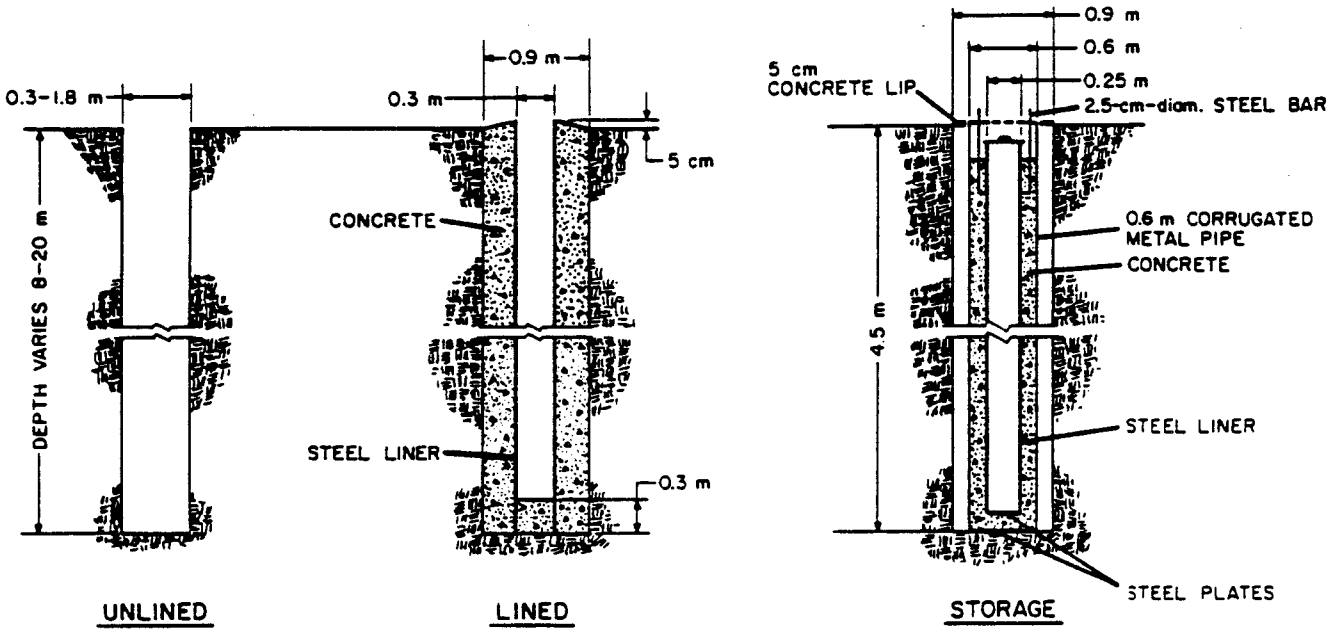
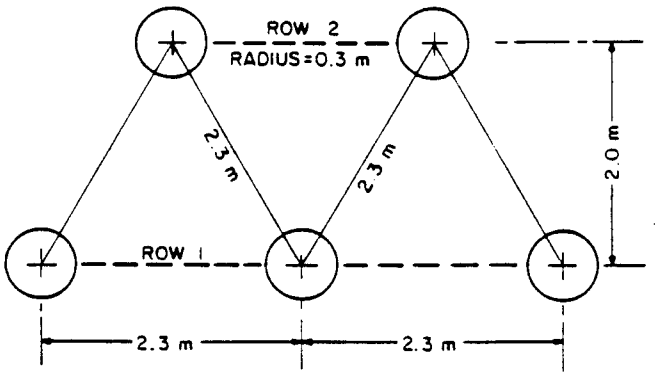


Fig. 10. TRU Waste Storage Area

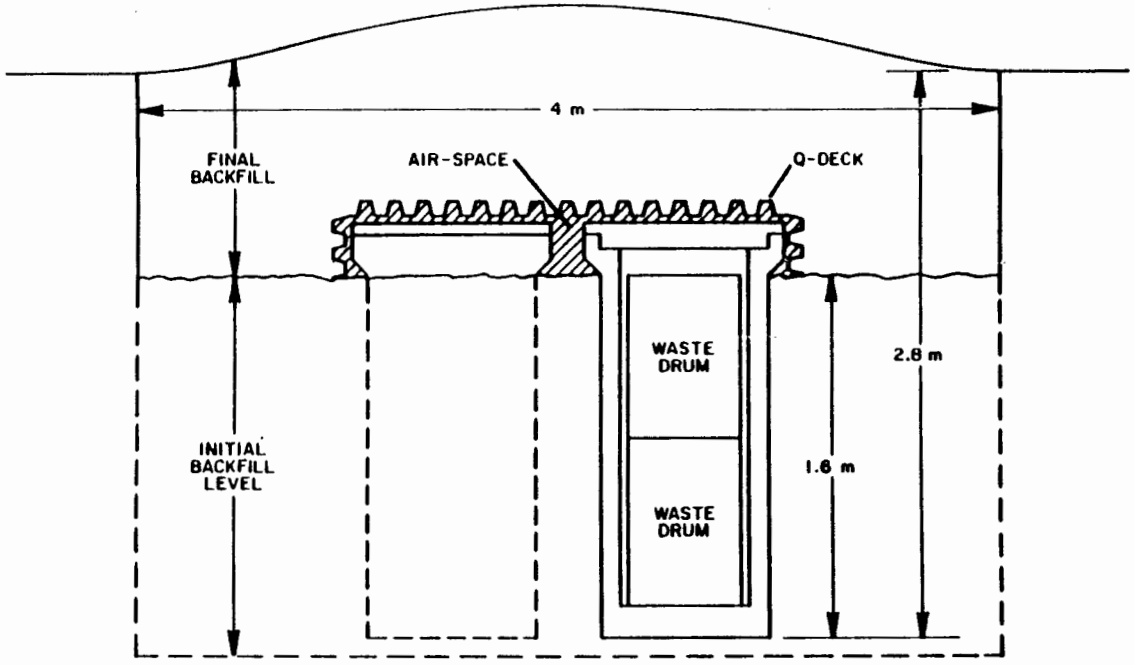


TYPICAL SHAFT DIAGRAM

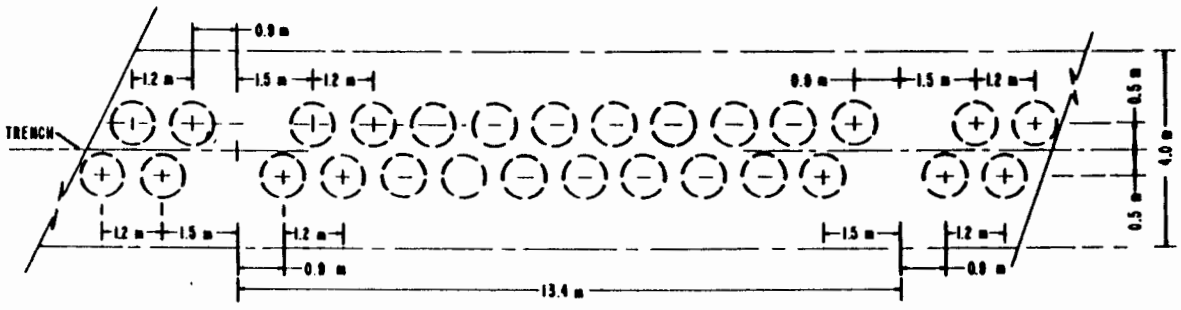


TYPICAL ORIENTATION FOR 0.3-0.9-m-DIAMETER SHAFTS

Fig. 11. Los Alamos Burial/Storage Shafts



TYPICAL CASK BURIAL



CASK LAYOUT DETAIL

Fig. 12. TRU Concrete Storage Cask Usage

and 442 m^3 (15 600 ft^3) is cemented sludge in CMPs. The rest is stored primarily in 210-l (55-gal.) drums and fiberglass-coated plywood crates. Also, approximately 207 m^3 (7201 ft^3) of certified/certifiable TRU waste was in storage awaiting shipment to WIPP.

3.1.2.2.1.2.3 Treatment

Size Reduction Facility, TA-50-69. The Los Alamos TRU Waste Size Reduction Facility (SRF) is designed to repackage and reduce the volume of various types of metallic waste items such as gloveboxes, process equipment, and ductwork. The original concept of the SRF was developed in mid 1979 as part of the overall process of decontamination and rehabilitation of an old plutonium processing facility. SRF treatment packages waste in appropriate containers for eventual disposal at WIPP; it also reduces waste volume, handling, and WIPP disposal costs. Through FY86, approximately 2239 m^3 (79 037 ft^3) of various metallic wastes requiring SRF processing had accumulated in storage at Area G. The SRF enclosure is divided into four modules according to function: airlock module, a disassembly module, a cutting module, and a packaging/bagout module (Fig. 13).

To process a waste item, the package is placed into the SRF building and the building locked. External packaging is removed and the item is brought into the airlock. The item passes from the airlock to the disassembly area where attached combustible items are removed. It is then moved into the cutting area where a plasma torch cuts it into smaller pieces for packaging. The pieces are placed into accepted WIPP containers in the bagout area. The crate or drum is then sealed for storage at Area G.

Operations with TRU waste in the SRF began in August 1983. In trial operations through FY86, a total volume of 94.3 m^3 (3329 ft^3) of TRU waste was processed, resulting in an output volume of 26.1 m^3 (421 ft^3). Waste processing in the SRF during FY86 was restricted because of the requirements of several special studies and facility modification.

Improvements to the SRF completed in early FY87 include providing additional work space, adding airlocks at all facility access points, and modifying the heating and ventilation systems. DOE approved the final safety analysis report (FSAR) for the SRF in March 1987, and the facility went into full production operation then. The FSAR establishes an inventory limit for the SRF of 150 g TRU isotopes from weapons-grade plutonium, a level allowing subsequent processing of a large portion of the stored and newly generated TRU wastes. During its operational period from March 1987 through the end of FY89, the SRF processed 328.7 m^3 of newly generated and stored TRU waste, resulting in an output volume of 81.2 m^3; the overall reduction factor was about 4.0:1. All output packages from the SRF have been WIPP certified.

Controlled-Air Incinerator for TRU Wastes (TRU-CAI), TA-50-37. The controlled-air incinerator (CAI) was constructed in the TDF in 1975 as a development and demonstration process for volume reduction and chemical stabilization of defense TRU wastes. These initial demonstration objectives were achieved in 1979 and, subsequently, the TRU-CAI process has been

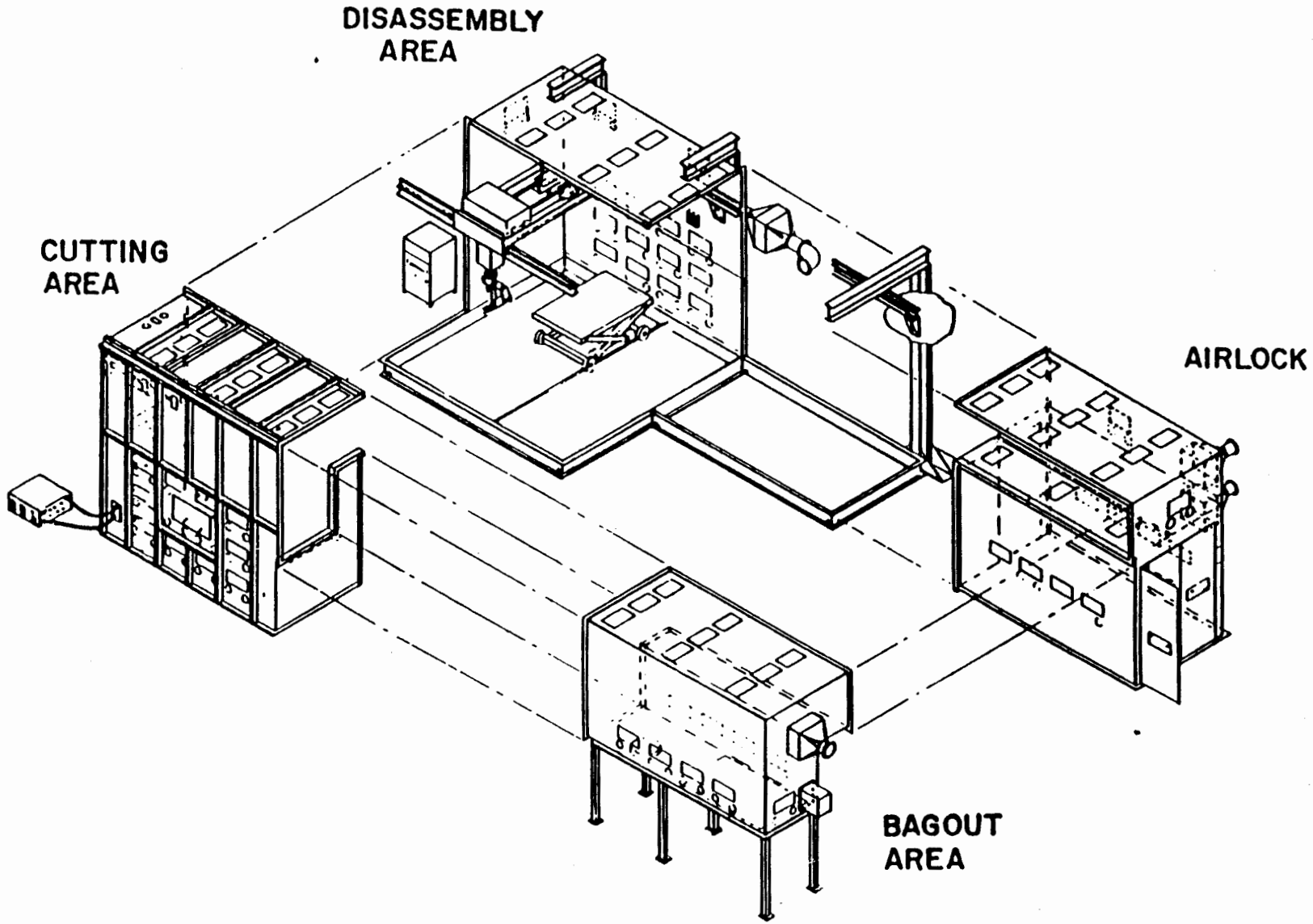


Fig. 13. Size-Reduction Facility Enclosure

modified to treat other wastes. These additional wastes include beta-gamma waste, ion exchange resins, carcinogens, and other hazardous chemical wastes in both solid and liquid form.

Other uses of the TRU-CAI were R&D programs conducted for the Army and Navy in which multiple test burns established operating conditions and design parameters necessary to thermally destroy colored smoke and flare compounds. A prototype transportable incinerator, developed from the test program, is now being fabricated and tested at Los Alamos for the Navy.

Jointly sponsored DOE/EPA incineration studies, involving polychlorinated biphenyls (PCBs), led to a 1984 EPA Region VI permit under the provisions of the Toxic Substances Control Act (TSCA) for disposal treatment of liquid PCB wastes.

More recently, the New Mexico Environmental Improvement Division (NMEID) granted interim authority for CAI treatment of selected Resource Conservation and Recovery Act (RCRA) wastes. In September 1986, a trial burn was conducted to obtain final RCRA authorization, and the final trial burn report was submitted in March 1987. The NMEID granted an RCRA permit in November 1989. Portions of the permit that required monitoring of radioactivity have been appealed; until the appeal is resolved, Los Alamos will operate under interim status. To respond to public concern regarding emissions of radioactivity from the incinerator, Los Alamos will negotiate a monitoring agreement for radioactivity with NMEID outside the RCRA permit.

An amendment prohibiting the operation of CAI for one year, or until NMEID promulgates regulations for radioactive waste incinerators (whichever comes first), was added to the Defense Appropriations Bill by New Mexico's Congressman Bill Richardson. Under this amendment, the CAI can not be operated before November 29, 1990 unless the State promulgates regulations before that date.

The Los Alamos TRU-CAI process is built around a dual-chamber, commercially available incinerator. For low-density, combustible TRU waste, the system has demonstrated weight and volume reduction ratios of 40:1 and 120:1, respectively, and produced a chemically stable dry product.[3] As modified, the CAI can also accept liquid wastes with a wide range of viscosities. CAI process functions, from feed preparation through ash removal, are described below.

The feed preparation capabilities include provisions to assay and to x-ray inspect the solid feed material. Liquid feed can be filtered and blended with diesel oil and other additives to adjust heat content and physical properties before injection into the incinerator. Off-gas cleanup equipment downstream of the incinerator removes particulates and acid gases from the effluent and conditions the gas stream for passage through high-efficiency particulate air (HEPA) filters before discharge to the environment. The scrub-solution recycle system supplies liquids at required pressures to the off-gas system and provides cleanup and conditioning for recycle and/or discharge to the liquid treatment plant. Ash is removed by gravity transfer from the lower chamber of the CAI to drums for final assay and immobilization.

As initially installed, the TRU-CAI process was designed to accommodate a variety of development and demonstration objectives. As such, the original process train contained components, instrumentation, and sampling capabilities to facilitate studying the combustion process and ancillary functions. Beginning in FY87 and continuing through FY89, the TRU-CAI process is undergoing a substantial production-oriented upgrade to simplify the operation and to improve the long-term reliability of the equipment. The process schematic showing the process on completion appears in Fig. 14. The most substantial changes are substituting a hydrocyclone for scrub solution filters and eliminating the condenser between the absorber and superheater. Major physical changes include constructing an ash receiver pit and replacing fiberglass piping and vessels with Hastelloy or similar corrosion-resistant alloys.

In FY87, and before extensive dismantling required for the final upgrade, the CAI disposed of 4.1 m^3 (144 ft^3) of scintillation vials, a RCRA mixed waste. The plastic vials contained pseudocumene and a wide range of radionuclides, including some transuranics. Other wastes treated in the TRU-CAI include newly generated TRU waste and biological wastes, some containing trace quantities of radionuclides. After the system upgrade, the TRU-CAI will stabilize and reduce the volume of newly generated and stored TRU waste. Operating plans also include thermal destruction of mixed waste and other problem wastes until the new incineration system for low-level waste (LLW) and hazardous mixed waste becomes operational in 1993.

Stored Waste Work-Off. TRU waste withdrawn from retrievable storage for transfer to WIPP will be certified before shipment. A draft plan for retrieval, processing, and certification was prepared in FY83; the "Final TRU Waste Inventory Work-Off Plan" was prepared during FY86.[4] Planned methods of meeting WIPP criteria include visual inspection, ultrasonic examination, real-time x-ray radiography, active and passive radionuclide analysis, sorting and repackaging, cementing, and size and/or volume reduction by sectioning or incineration.

Certification of stored waste (except that processed in the TDF and SRF) depends on construction of several new facilities. Four facilities are in varying stages of design, construction, and preparation for operations. Retrieved waste packages first will be taken to the Waste Preparation Facility at Area G for initial sorting, cleaning, verifying package integrity (both visually and ultrasonically), and providing any required overpacking. An added operation now planned to be done at the Waste Preparation Facility is the installation of special filters in the drums of previously stored TRU waste to allow their safe shipment to WIPP in accordance with shipping requirements, accompanied by a sampling and analysis of headspace gases to verify compliance with transport criteria. The Waste Preparation Facility was completed in FY87. Design of the installation system for the drum filters was begun in FY89.

From the Waste Preparation Facility, packages will be staged for shipment to other facilities for additional processing and certification. A Nondestructive Examination and Analysis (NDE/NDA) Facility, located at TA-54 (west) (Fig. 15) for certifying wastes that need no processing is scheduled to begin operation in FY90. Facility construction was completed in

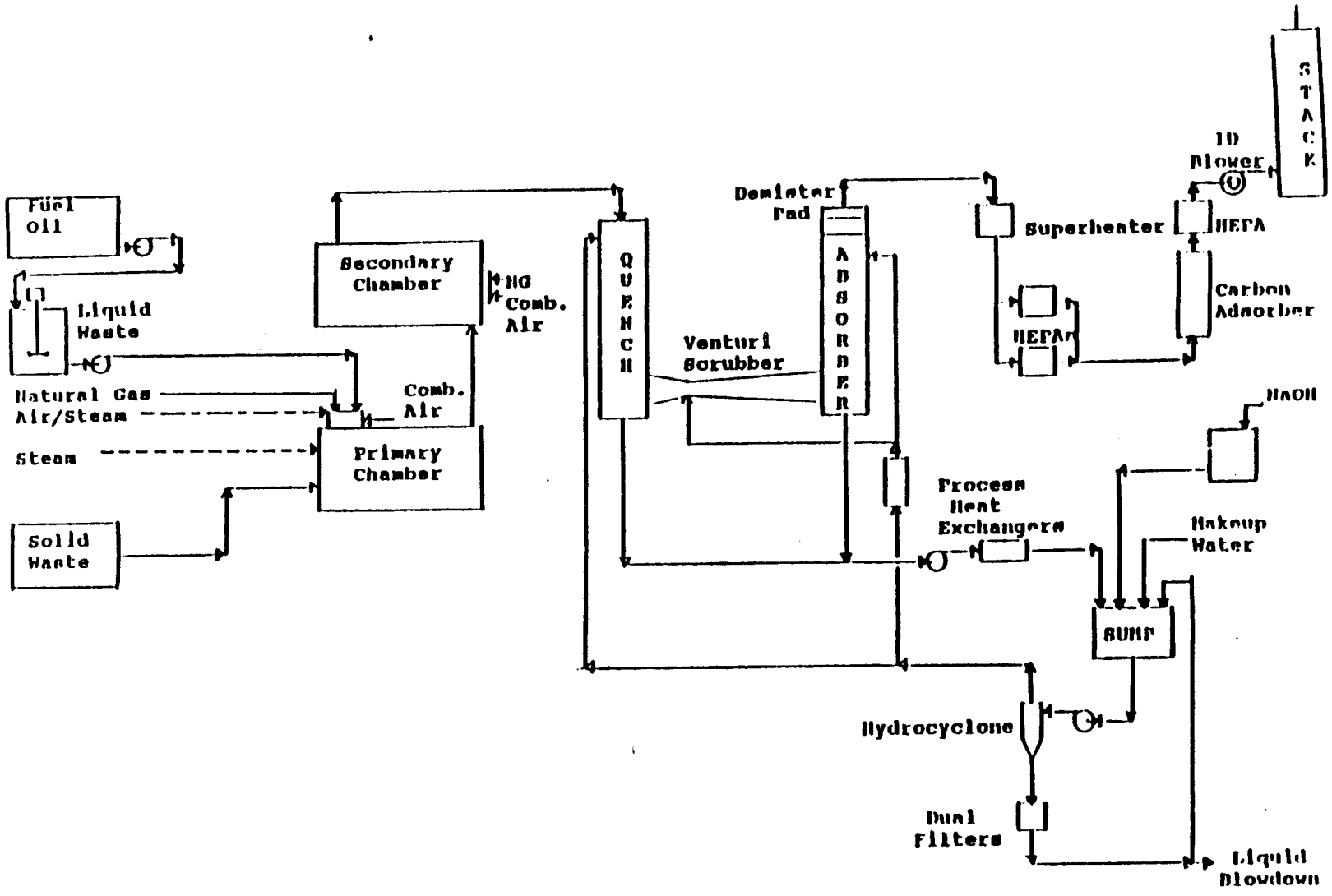
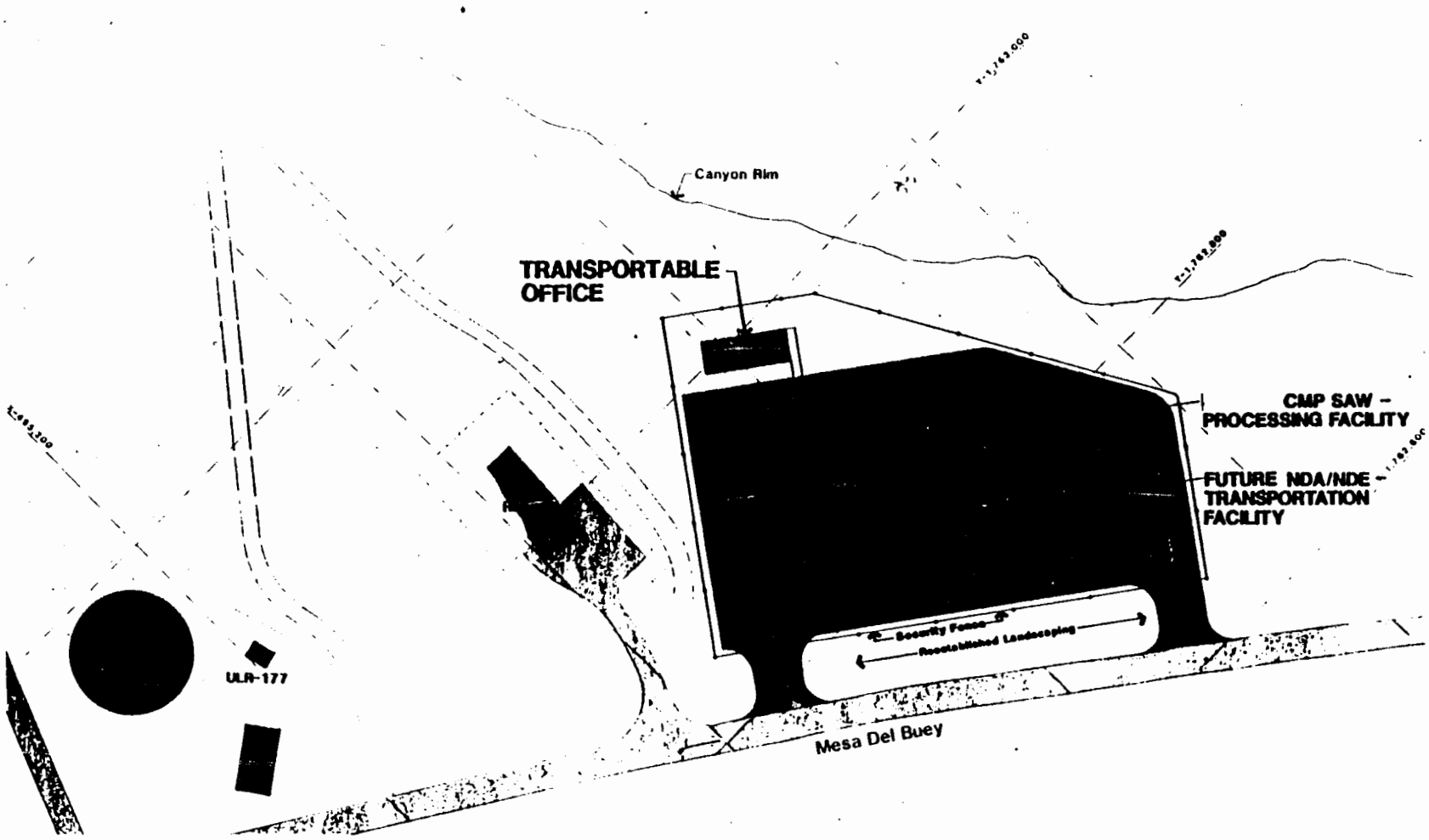


Fig. 14. CAI Process Schema[illegible]hout Feed Preparation Line



SITE PLAN

LEGEND

REF-15	Animal Holding Facility
ULR-176	Pajarito Pump Station No. 2
ULR-177	Clorinator Building

This drawing is intended solely to illustrate basic design concepts and criteria.

0 40 80 120 160
Feet

Fig. 15. TA-54 (West)

December 1988. Major capital equipment items for NDE/NDA include the TRU drum assay system and the real-time x-ray radiography system. During FY89 these were installed, tested, and calibrated, and since then have been used for operator training. Subsequently, we initiated an effort to verify classification of approximately 1000 drums of newly generated, precertified waste. This effort will continue into FY90.

Associated with the NDE/NDA Facility is the Transportation Facility in which the TRUPACT will be loaded and prepared for shipment to WIPP. Construction of this facility also was completed during FY89. However, no further activities associated with the facility or its operations were accomplished due to the now anticipated long delay before Los Alamos shipments can begin. This facility consists of a high-bay building with large access doors located on opposite sides. The TRUPACT truck will enter through one door, which will then be closed. A 5-ton capacity bridge crane will be used to remove the TRUPACT lids, load the TRUPACT, then reseal the lids. Vehicle axel weights will be checked with a scale before the vehicle exits the building through an opposite door.

A CMP-Saw Facility, also to be located at TA-54 (west) and which will be used for processing the cement paste filled CMPs, is scheduled for operation in FY92. This facility currently is in Title II design. Once in operation, each CMP will be cut remotely into 4 or 5 pieces, which will then be packaged into WIPP approved, standard waste boxes. The limiting factor on the number of pieces will be total package weight. Liquid wastes and cutting residues will be solidified in drums in another facility operation. We estimate this operation will take at most 1.5 years to complete. The large bandsaw to be used in this facility, with some associated CMP handling equipment, was received in FY89.

After the CMPs have been treated, the interior of the facility will be redesigned to sort and immobilize the remaining volume of uncertifiable waste. Once the CMP Saw system is removed and properly disposed of, several major equipment items will be installed, including glovebox lines and an appropriate immobilization system. Immobilization will be required primarily for free liquids, high salt-containing process residues, soils, and other particulates. Overall, once initiated we anticipate this treatment operation to require at least five years to complete. At that time, other waste management operations may be identified for this facility.

Funding for the Waste Preparation Facility, $330K, was received in FY85; construction of this facility was completed in FY87. Funding for the first-phase site preparation of construction on the NDE/NDA Transportation Facility, $570K, was received in FY86, and this has been completed. Funding for construction of the NDE/NDA-Transportation Facilities, approximately $970K, was received in FY87. Construction of a building to house these facilities was completed in December 1988. Most funding for the Waste Processing (CMP-Saw) Facility ($865K) was received in FY88, with the balance of $335K received in FY89.

3.1.2.2.1.2.4 Remote-Handled (RH)-TRU Close-out. The overall goal of this effort is to close-out all RH-TRU waste work at Los Alamos. Included will be the certification and preparation for WIPP of all RH-TRU wastes to be generated in the decontamination and close-out of the Los Alamos TRU hot cell facilities. The prototype RH-canister welding system (developed by another DOE contractor) has been obtained and modified for use with the full size RH-cannisters, as well as for use within the Los Alamos hot cell system. RH-canisters are being obtained; these will be filled with certifiable wastes generated in the cell decontamination operations, such that the resultant filled, sealed canister is fully WIPP certified. In addition, RH-TRU wastes generated in recent years and currently stored in a manner compatible with final packaging in the RH canister will be retrieved, certified, and packaged for WIPP disposal. Certified RH waste canisters will be stored until they can be shipped to WIPP. In effect, all readily certifiable RH-TRU wastes at Los Alamos will be prepared for WIPP disposal through this project. In addition to closing out all RH-TRU waste operations at Los Alamos through the preparation of all readily certifiable RH waste for WIPP, this effort will provide demonstration waste canisters for WIPP, and also will serve as a unique demonstration for RH-TRU waste handling and certification technology. Finally, an evaluation of options for disposal of not readily certifiable RH-TRU also will be completed.

Efforts began on this project in late FY86, when the canister welder assembly developed at Hanford was obtained. The unit was found to be unsuitable for operation in the Los Alamos hot cell originally designed. As a result, the design of a new fixture for operating in a horizontal positions was developed. A seam tracking device was incorporated in this design. Other work in FY86 included design and fabrication of a fixture for remotely installing the lid and bolt ring on a 55-gal. DOT-17c steel drum.

Through FY89, the hot cell operating group has been preparing store fuel for shipment off-site. The TRU waste produced in this operation will be certified and packaged in small containers and stored while awaiting canisterization. Two cells previously have been decontaminated and stripped to provide storage space for the waste. An on-site transportation shield container for filled RH cannisters was designed and has been constructed. The shield container is required to protect Laboratory personnel and the public when the completed RH canisters are transported to the TA-54 storage site.

3.1.2.2.1.2.5 Disposal. Shipping certified TRU Waste to WIPP is not currently scheduled to begin before FY95. Until then, certified waste is stored aboveground on an asphalt-paved pad protected from the elements by a tension support structure.

A small amount of the currently stored waste may eventually prove to be impractical to certify, generally because it is too massive or unsuitable for processing in current or planned facilities. The final design of the facilities to be built for processing and certifying stored waste will largely determine the quantity of waste in this category. Disposal of this waste in greater confinement is a possible alternate means of handling uncertifiable waste.

3.1.2.2.2 Current and Future Plans. All aspects of the program as described above will be continued. The volume of newly generated TRU waste is estimated at 200 m^3/yr, with the volume actually shipped to WIPP being somewhat less than that generated, due to operations of the SRF involving both newly generated and stored TRU wastes and the planned future incineration of a large fraction of newly generated combustible TRU wastes.

Storage facilities for TRU wastes will be provided and operated as required to assure compliance with both RCRA and retrievability criteria. Monitoring and surveillance to affirm retrievability of this waste will be implemented as required. Wastes retrieved from storage that are not able to be certified directly or processed for certification at this time will need to be replaced into storage until appropriate processing capabilities become operational.

Packages of precertified TRU wastes awaiting WIPP disposal are stored on a asphalt pad covered by a tension support structure. At least a five-year delay is now anticipated for the start of Laboratory shipments. Consequently, additional storage capacity is required in FY90 because less that one year of capacity currently remains. The planned addition will provide storage capacity for one or two additional years, with the actual time depending on generation rates and the requirements of the State of New Mexico for mixed TRU wastes. About 40% of Laboratory TRU wastes are known to be or are suspected of being mixed.

The modifications to the controlled-air incinerator (CAI) solid feed and off-gas treatment processes will be completed in FY90. Low-ash liquid feed operations can technically begin in December 1990. Completion and installation of the ash removal system will be completed in FY91, with solid waste incineration operations technically beginning soon after.
An incremental increase in staffing, system testing, shakedown, and operator training are scheduled for FY91. However, current and pending regulatory actions are expected to overshadow the technical aspects and to further delay the start of operations. Also, the actual start up date for the incinerator is subject to discussions on NEPA requirements. If an EIS or supplemental is required, start up could be delayed two years.

As an adjustment to establishing routine incineration operations at the TDF, an addition to the Chemical and Radwaste Staging Facility will be constructed to accumulate waste before an incineration campaign. The facility, which will have approximately 140 m^2 (1500 ft^2) of floor space, is being constructed. Funding for this facility comes from a $535K FY88 allocation of research and development (RDT) GPP funds. In the conceptual design, half of the floor space is allocated for TRU waste accumulation; the rest will be used for chemical and mixed waste accumulation. Safe handling practices for both radioactive and chemical wastes are being incorporated into the facility design.

Work-off of stored TRU waste will continue this fiscal year through the operation of the SRF. The NDE/NDA Facility, which will certify stored wastes, is set for start up in late FY90. Stored TRU wastes certified in NDE/NDA operations now will be returned to certified waste storage.

Non-certifiable wastes which require processing (sorting and immobilization) will be placed back into uncertified storage pending operation of the Processing Facility in FY94.

A major FY90 effort will be to complete design and related preliminary safety analysis documentation for the CMP-Saw Facility. Facility construction should begin in FY90 and be complete in FY91. At that time we will complete installation of all equipment in preparation for FY92 start up. Cold test operations are scheduled to begin during the fourth quarter of FY91. The large bandsaw and a portion of the CMP handling equipment was received in FY89. FY90 efforts will include the design and initiation of procurement of the glovebox-like enclosure for the saw, as well as associated process and waste handling equipment items.

Concurrent with efforts leading to start up of CMP-Saw Facility operations in FY92 will be the completion of design work and initiation of a acquisition of equipment for the subsequent Process Facility. The majority of capital equipment funding this fiscal year will be for the gloveboxes, sorting, and associated waste handling systems required for this operation. Long lead times, especially for the glovebox lines, are anticipated.

Another major FY90 TRU waste work-off project will be fabrication of a system to install approved filter vents in drums of TRU waste. Design of this system was nearly complete in FY89. While remotely installing the filter vent into the lid of each 55-gal. waste drum, the system will allow sampling and on-site analysis of the drum head space gas for hydrogen and combustible volatile organic concentrations.

The Los Alamos TRU waste hot cell facility is proceeding toward complete shutdown and decontamination, with the effort now scheduled to be completed by the end of FY92. An estimated 30 canisters of remote handled (RH) TRU waste will be prepared for WIPP disposal. In the RH TRU waste project, efforts early in FY90 will be directed toward complete cold testing of all RH waste handling systems, including filling the first canister(s) with simulated waste. The canister(s) will then be provided to Westinghouse at Hanford for Type A package testing. Assuming this testing is successful, and regulatory issues regarding canister design can be resolved, we will proceed to acquire the remaining canisters from the fabricator. Several canisters will then be filled with RH and TRU waste, sealed, and certified. In FY91 and FY92 the remaining canisters, to an estimated total of 28, will be filled and sealed.

With at least a five-year delay in planned Los Alamos shipments, a far more substantial storage facility for these canisters is mandated. The Laboratory currently does not have the option of delaying the filling of these RH TRU canisters because the hot cell facility must now be closed down. The storage area for the canisters will be constructed at TA-54, Area G.

Finally, an EA covering the entire proposed TRU work-off project at Los Alamos originally was drafted in 1986 and has subsequently been drafted by DOE. Now, at the request of DOE-HQ, the draft will be revised to both update the document and incorporate current guidelines for preparing an EA. This effort is anticipated to be completed in FY90.

3.1.2.2.3 Implementation Requirements. The current status of compliance with DOE Order 5820.2A requirements for TRU (and TRU mixed) waste is summarized in Table III. Only the status of items originally identified to be in noncompliance are listed; all other requirements are assumed to be in compliance.

3.1.3 Low-Level Waste (LLW)

3.1.3.1 Liquid LLW

3.1.3.1.1 System and Facility Descriptions

3.1.3.1.1.1 Overview. Figure 16 shows a schematic of the double walled, computer monitored pipeline system which serves the liquid LLW Treatment Plant at TA-50-1. While liquid LLW is collected from many areas throughout LANL, during FY89 more than 50% of the waste was generated in the Chemistry-Metallurgy Building (TA-3-29). Other major generators were Plutonium Processing (TA-55-4), TA-21 Site, and Radiochemistry (TA-48-1).

Discharges of wastewaters containing up to a few microcuries per liter of radionuclides are allowed in the collection system for liquid LLW. These limits are specified in written procedure (Generator Standard Operating Procedure and Administrative Requirements in the Los Alamos Health and Safety Manual). The concentrations are based on the goal to maintain the solid waste (sludge) resulting from the treatment at less than 100 nCi/g.

3.1.3.1.1.2 Facility Descriptions. Low-level liquid waste treatment facilities at the Laboratory include the following:

- A 950-l/min (250 gal./min) chemical-treatment and ion-exchange plant at TA-50-1;
- A 475-l/min (125 gal./min) chemical treatment plant at TA-21-257; and
- Many storage buildings and neutralization and/or pumping stations.

Liquid Waste Treatment, TA-50. The TA-50 facility (Fig. 17) provides a neutralization chamber, flash mixers, chemical feeders, flocculator-clarifiers, distributor for CO_2, ion-exchange columns, spent regenerant storage-treatment tank, vacuum filter, and wiped-film evaporator.[5-9] Chemicals used for separating and concentrating alpha-emitting radionuclides include ferric sulfate, lime, and coagulant aids.

The sludge produced by chemical treatment is dewatered by vacuum filtration to 20-40% solids, placed in lined 210-l (55-gal.) steel drums (if the TRU radionuclide activity is >100 nCi/g, the lined drums from Rocky Flats are used), and forwarded to Area G.

In FY89, the TA-50 plant treated 2.0×10^7 l (5.5×10^6 gal.) of liquid waste containing 1.0 Ci of plutonium and 1.3 Ci of americium. Effluents discharged contained 6.5×10^{-3} Ci of plutonium and americium. The uranium content in this waste was negligible. The vacuum filter at TA-50 was used to dewater 249 drums of low-level waste. This sludge contained 0.8 Ci Am and 1.2 Ci Pu.

Table III
TRU (and TRU mixed) Waste Implementation Summary
Page 1 of 2

DOE 5820.2A Requirement	Actual Practice	Current Plans	Status/Progress
II.3.b(1)	No documented program for volume reduction.	TRU waste minimization program developed in parallel with minimization for LLW/mixed waste.	Minimization Plan approved and program being staffed.
II.3.c(1)	Partially implemented; certification generators must supply operational procedures before plan can be implemented.	Generators must commit to implementation schedule and costs of implementation before LANL can comply.	Have received certification authority for all regular newly generated wastes, with exception of two small streams. Anticipate all regular streams included by end of FY90.
II.3.c(8)	Cannot be implemented until generators supply the attachments.	HSE-7 has plans that include all wastes; cannot comply with and implement requirement until generator supply attachments and commit to implementation schedules and costs.	As above.
II.3.e	RCRA regulations do not apply.	Negotiate with regulatory agencies to determine which regulations have been defined and apply.	Certified storage being reconfigured to allow regular inspection of all packages in accordance with RCRA; effort complete FY90. No changes currently planned for previously stored, uncertified waste.
II.3.e(4)	RCRA regulations do not apply.	Negotiate with regulatory agencies and State of New Mexico to determine which regulations have been defined and apply. Also determine what LANL can reasonably do to follow said regulations.	As above.

Table III, continued
TRU (and TRU mixed) Waste Implementation Summary
Page 2 of 2

DOE 5820.2A	Actual Practice	Current Plans	Status/Progress
II.3.3(6)	Contingency plan does not now exist.	LANL will write SAR and develop the contingency plan after consequences of releases have been analyzed.	Anticipate initiating preparation of SAR in FY90, which will cover all disposal/storage site operations (see Table IV). Scheduled 1/91 submission to DOE
II.3.g(2)	No appropriate RCRA requirements now exist.	LANL has sufficient capacity for several years with existing facilities; inspection requirements tied to negotiation with regulatory agencies; requirements for mixed waste storage must be negotiated and defined.	See II.3.e on the preceding page. State of New Mexico does not yet have mixed waste regulatory authority.
II.3.g(2) (h)	Closure plans do not now exist.	Plans will be developed in accordance with negotiations; earliest that sites can be close is FY94; most will be closed by FY98 or later.	Unchanged; costs are included in permitting costs.
II.3.g(3)	RCRA permit needed after 7/89.	FY89-91 Defense Waste Operations funding for preparing Part A and B permits for TRU mixed waste facilities, including storage.	Unchanged; $100K-150K through 10/91.
II.3.i(2-4)	Characterization, verification, and developing closure plan and strategy are in progress.	Evaluation of old burial sites and development of closure plan are under DOE ER program; six sites containing buried waste will be evaluated under ER program.	Unchanged; $166.5M after 2000.

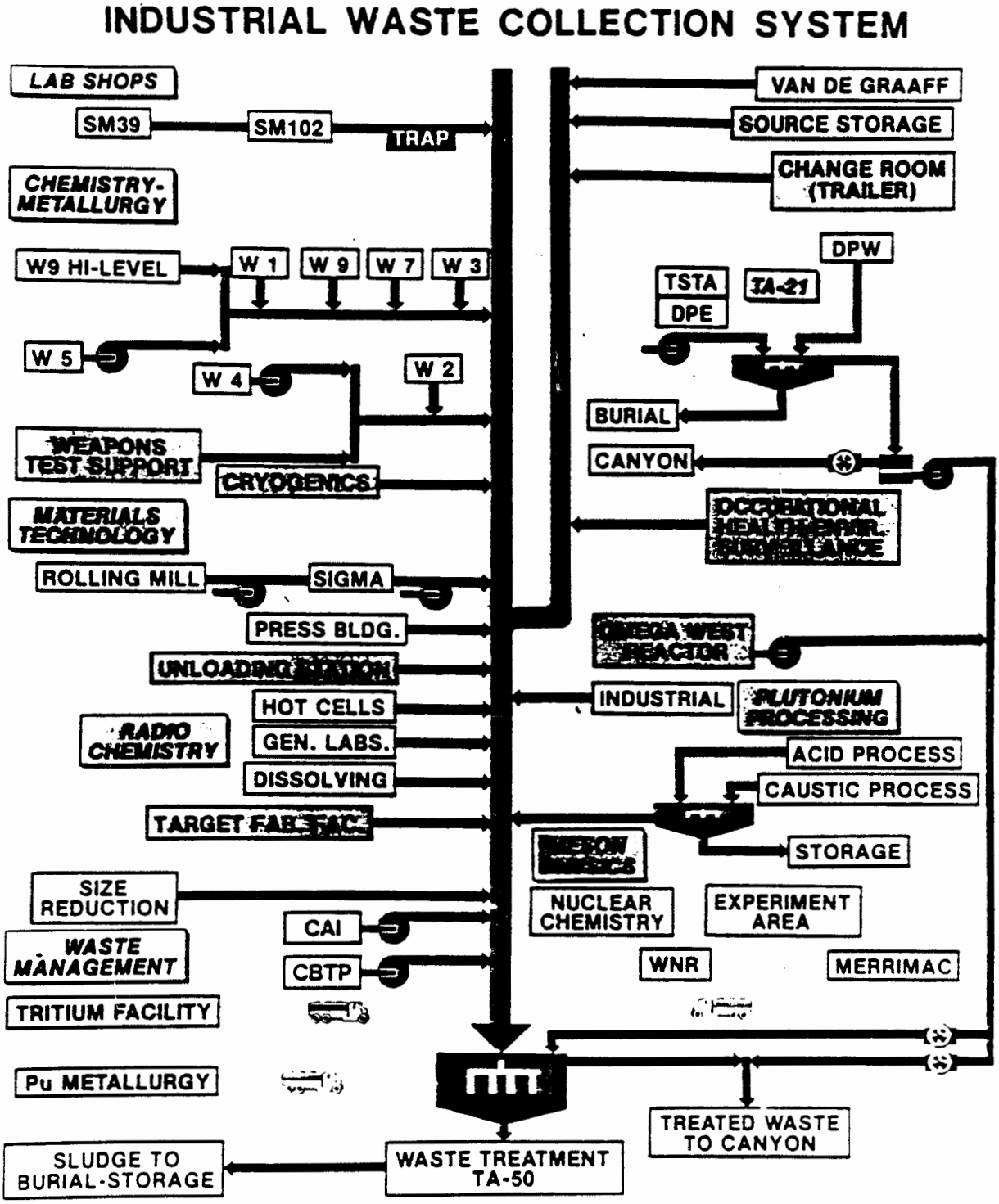


Fig. 16. Industrial Waste Collection System

LIQUID WASTE TREATMENT FACILITY TA-50

Los Alamos National Laboratory

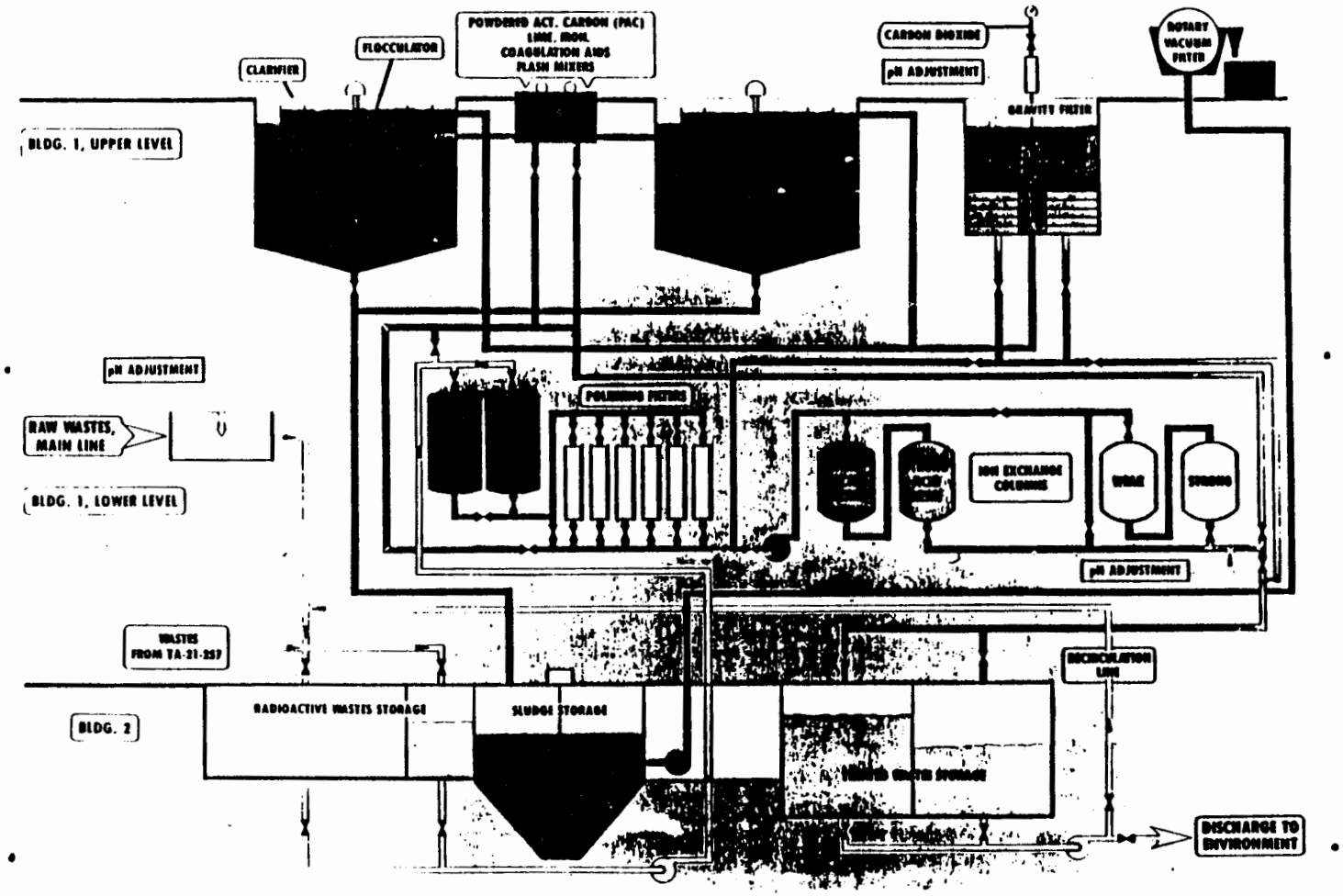


Fig. 17. Liquid Waste [illegible]ent Facility, TA-50

This material was buried as low-level waste before May 1988. Since May of 1988, this waste has been stored as potentially mixed waste.

Low-Level Liquid Waste Treatment, TA-21-257. This plant (Fig. 18) provides a bar screen, grit chamber, raw waste storage, flash mixer, chemical feeders, flocculator, sedimentation tank, filter sump, pressure filter, and treated waste storage tanks for treatment of low-level radioactive wastes.[6-10] In FY89, 2.4×10^6 l (6.2×10^5 gal.) of waste containing about 5.4×10^{-3} Ci of Pu and Am were treated. The effluent was transferred by pipeline to TA-50 for discharge into Mortandad Canyon. No solid waste was generated at the TA-21-257 plant during FY89.

3.1.3.1.2 Current and Future Plans. No substantial changes in operation of the TA-50 or TA-21-257 low-level treatment plants are planned for FY90.

Planning for replacement of the TA-50 low-level liquid treatment plant will begin in FY90, with a FY93 line item request for funding.

3.1.3.1.3 Implementation Requirements. No implementation requirements were identified.

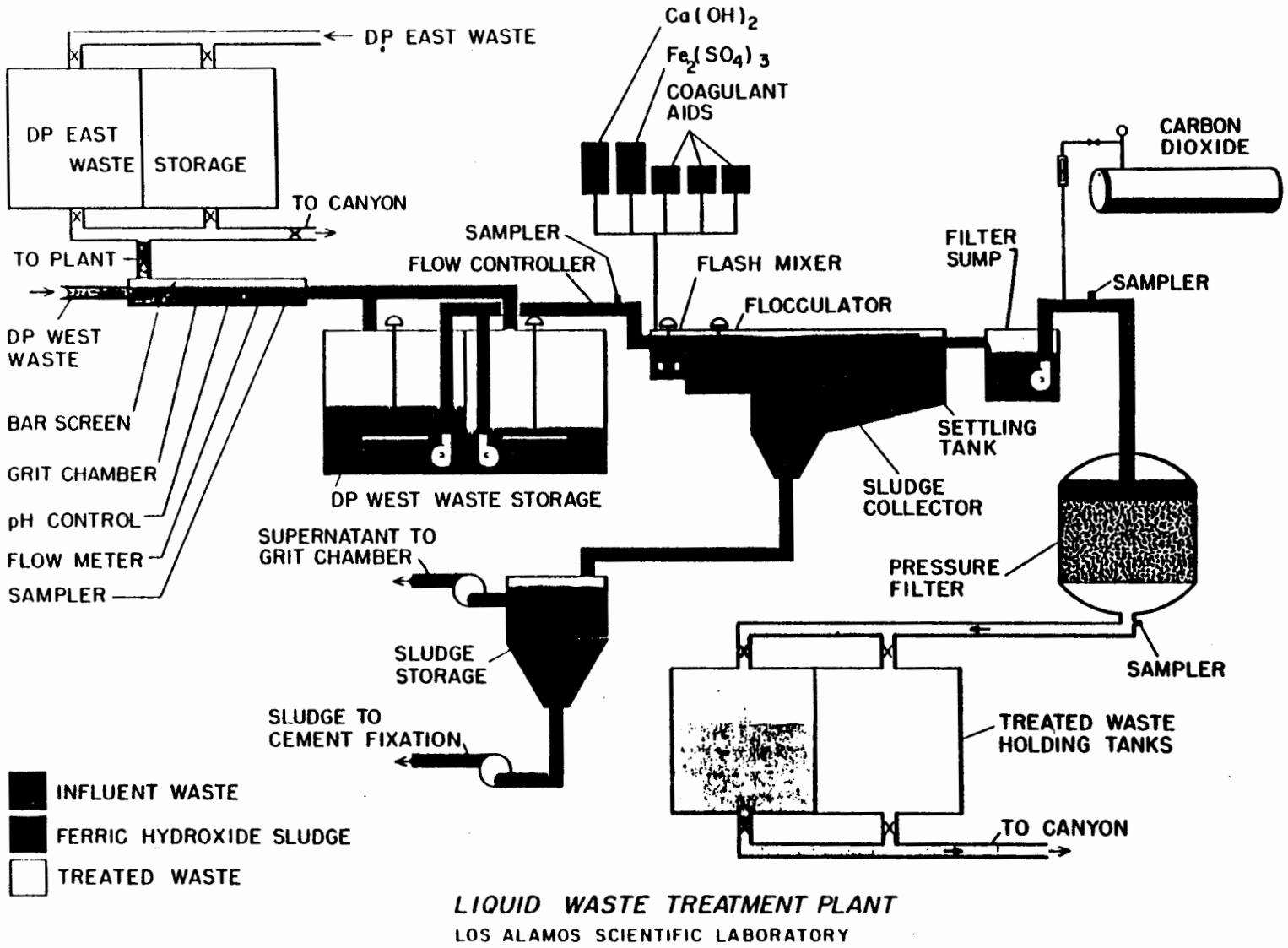
3.1.3.2 Solid LLW

3.1.3.2.1 System and Facility Description

3.1.3.2.1.1 Overview. Significant waste-generating processes at the Laboratory are concentrated in nine technical areas: TA-2, Omega Site; TA-3, South Mesa, (mainly the Chemistry and Metallurgy Research (CMR) Building and the Sigma Complex); TA-21, DP-Site; TA-35, Ten-Site; TA-46, WA-Site; TA-48, Radiochemistry Laboratory; TA-50, Waste Management Site; TA-53, Meson Physics Facility; and TA-55, Plutonium Facility.

Packaging for low-level waste in most instances serves to meet requirements of safe on-site handling and transport. Routine low-level solid wastes, i.e., paper, plastic, glassware, rags, etc., are separated into compactible and noncompactible materials. Then they are packaged in 0.06 m^3 (2 ft^3) plastic-lined cardboard boxes and placed in Dempster Dumpsters for transport to TA-54 for compaction/burial. Large equipment items and much of the decontamination/decommissioning wastes generally are not packaged but are delivered to the burial site in covered or enclosed vehicles. Other waste packaging used as required include metal or fiber drums, wooden crates with and without a protective coating of fiberglass, and plastic bags and wrap.

Standard low-level waste packaging is described in the AR 10-2, "Low-Level Radioactive Solid Waste," in the Health and Safety Manual.[2] AR 10-2 also details which wastes, such as untreated reactive material and free liquids, are unacceptable for disposal. The criteria for the transportation of radioactive material appear in AR 3-5, "Shipment of Radioactive Materials,"[2] and in the "On Site Transportation Manual."[11] These documents were developed with contributions from personnel in HSE-1, Radiation Protection, and HSE-7, Waste Management.



LIQUID WASTE TREATMENT PLANT

LOS ALAMOS SCIENTIFIC LABORATORY

Fig. 18. Contaminated Liquid Was' nent Plant, TA-21, DP-257

Actual volumes and activities of low-level solid waste generated and disposed of at Los Alamos are submitted as part of the DOE Solid Waste Information Management System (SWIMS). A summary of the radioactive solid waste buried and stored during FY89 appears in Table I, and projections for burial/storage volumes for FY 90-95 appear in Table II. The variations in waste volumes and radioactive content result primarily from program changes, facility D&D activities, and general cleanup programs for Laboratory areas.

3.1.3.2.1.2 Facility Description

3.1.3.2.1.2.1 Storage. Currently there exists no long-term storage of low-level solid wastes. Short term storage may occur at treatment or disposal facilities to accumulate a required quantity of waste for an operation to be conducted effectively.

3.1.3.2.1.2.2 Treatment

Compactor, Area G. Waste generators must separate low-level waste into compatible and noncompactible categories. Compactible waste is

> Solid waste that consists of trash-type materials such as paper, plastic, rubber, and small items of glassware up to a 1-gal. size; and small items such as short lengths of pipe conduit and small pieces of wood or sheet metal. Excluded are larger noncompactible items, waste chemicals, free or absorbed liquids, biological waste, pressurized containers, powders and other particularly hazardous materials.[2]

Most of this type of waste is received in 0.06 m^3 (2 ft^3) boxes inside Dumpsters. Boxes have a maximum weight of 13.6 kg (30 lb). After inspection, Dumpsters are directed to the compactor area where they are unloaded into a large bin. The operator removes the boxes from the bin and hand-feeds them into the compactor. This process is continued between compacting cycles until a bale 0.4 m^3 (14 ft^3) in size and weighting approximately 200 kg (440 lb) is formed. This bale is banded, wrapped and sealed in plastic, and placed in the disposal pit. Besides reduced volume, specific attributes include minimizing the combustibility of the waste and the potential for future pit subsidence. Acquired in 1977 at a cost of approximately $30 000, the Los Alamos compactor-baler through FY89 has compacted 9695.4 m^3 (342 248 ft^3) of waste to a burial volume of 1943.6 m^3 (68 600 ft^3), for an overall volume reduction of 5.0:1. Annually this reduction results in a net cost savings of approximately $70 000.

Low-Level Waste/Mixed Low-Level Waste (LLW/Mixed LLW) Incinerator, TA-50-37. DOE Order 5480.2 and the revised DOE Order 5820.2A, Chapter III, provided the impetus to examine the role of the incineration to comply with the more stringent requirements for LLW and mixed wastes management under the provisions of the RCRA regulations. The rationale for using incineration technology is based on the unique capability of high-temperature

oxidation to completely destroy organics and reduce the volume of radioactive wastes; thus, dependence on landfill disposal for environmental protection is eliminated or dramatically reduced.

Analysis of existing Laboratory data bases for waste management indicated that 1100-1300 m^3/year of LLW, biological, chemical, and mixed wastes potentially could be incinerated. The calculated heat load associated with this waste volume determined that the required capacity for the new system would be 3-4 million btu/hr, 3 to 4 times the production capacity of the existing CAI. Physical characteristics of the waste also dictated using a primary combustor that could accept a wide range of waste forms, including significant fractions of non-combustible materials.

After careful review of state-of-the-art equipment available for solid waste incineration, the conceptual process design was developed (Fig. 19). A controlled-air primary chamber that incorporates positive ash displacement is followed by a vertical fixed-chamber afterburner; the off-gas cleanup system is identical in concept to that used in the TRU-CAI process. Compared with the TRU-CAI, the capability for positive ash displacement facilitates complete combustion and transport of noncombustibles through the chamber. Liquid wastes will be introduced into a high-energy burner at the top of the secondary chamber. Dimensioning and layout of these components indicated that the larger process can fit in the existing Bay II of the TDF and can use much of the ancillary equipment already in place.

Preliminary cost estimates for the LLW/mixed LLW incineration process indicate that $4 million will be required: $3 million Capital Equipment and $1 million GPP. The funding strategy adopted for constructing and operating the new system is based on direct allocation of costs to waste generation sources. The conceptual design was completed at the end of FY88; final design concepts were in place for the process headend; funding was defined; and the permitting process had been initiated. Uncertainties in NEPA requirements halted progress in FY90. Assuming timely resolution of these uncertainties, completion and start up could occur in FY93.

3.1.3.2.1.4 Disposal. Area G is situated on Mesita del Buey in TA-54 and is the active burial and storage site for radioactive solid waste at the Laboratory. The area has been used since 1957 and is expected to remain active through the foreseeable future. In FY77, the active portion of the site was expanded to a total area of 25.5 hectares (63 acres); further expansion of this area is planned during the next three years. Burial facilities within the area include pits and shafts of varying dimensions. Figure 20 shows the present layout of Area G, including the past and future planned use of disposal facilities within the fenced portion of the site and the support facilities at the site. A more detailed description of the use of these facilities and of waste management operations appears in the Los Alamos Final Environmental Impact Statement.[1]

Certain nonreactive hazardous chemical wastes have been buried in pits and shafts with the radioactive and mixed wastes at Area G. Such wastes include asbestos, beryllium residues, empty pesticide containers, PCB and PCB-contaminated solids (transformers, capacitors, solids [before 1978]), and solid trash type wastes contaminated with known or suspected carcinogens.

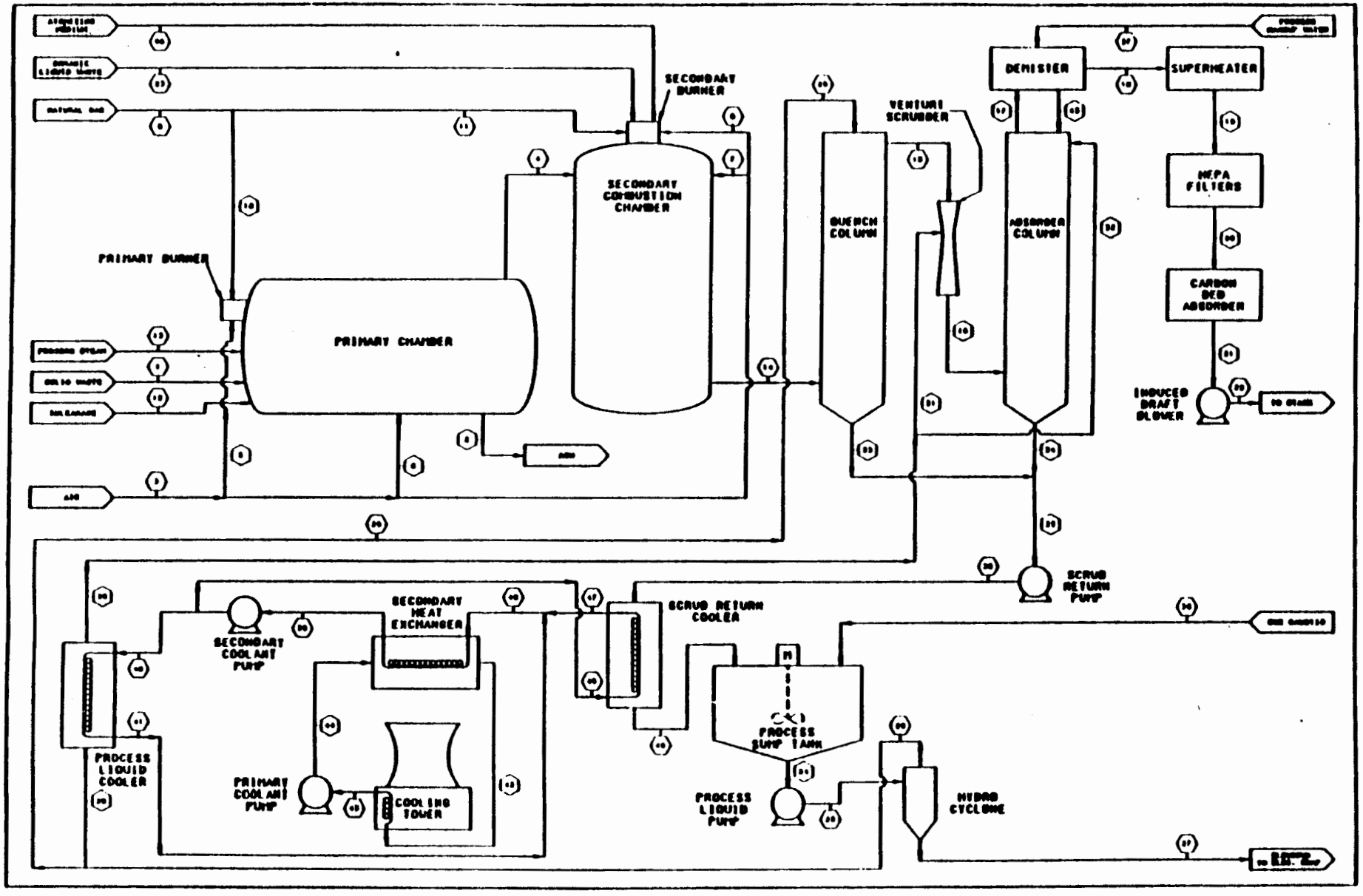
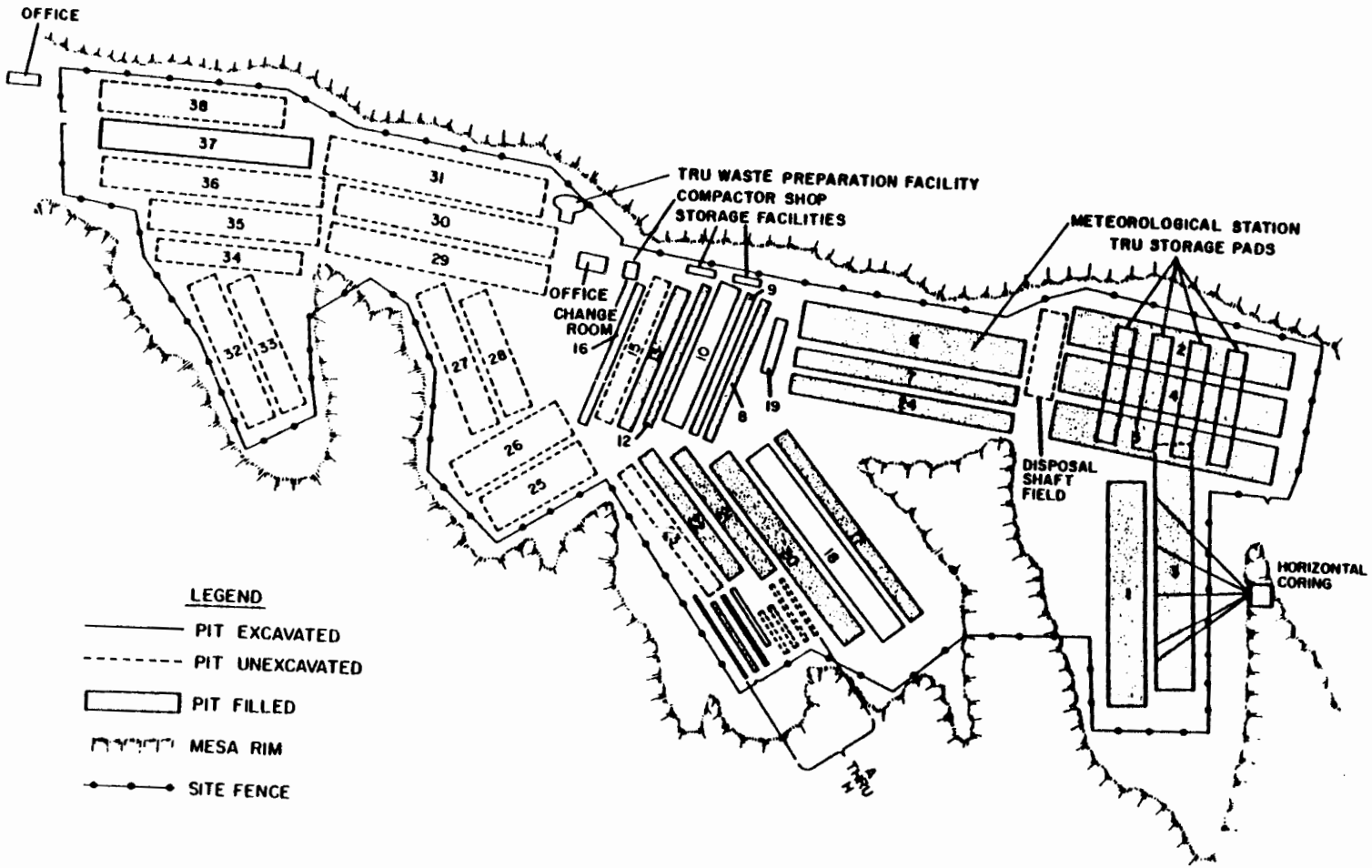


Fig. 19. Low-Level Waste/Hazardous Mixed Waste Incineration Process: Conceptual Design Flow Sheet


OFFICE
38
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32
33
27
28
26
25
OFFICE
CHANGE
ROOM
16
TRU WASTE PREPARATION FACILITY
COMPACTOR SHOP
STORAGE FACILITIES
9
10
8
19
12
METEOROLOGICAL STATION
TRU STORAGE PADS
DISPOSAL
SHAFT
FIELD
HORIZONTAL
CORING
LEGEND
PIT EXCAVATED
PIT UNEXCAVATED
PIT FILLED
MESA RIM
SITE FENCE

Fig. 2[illegible] Area G

Between 1976 and 1980, much of this waste was buried at the site. In 1980, EPA approved disposal of PCB contaminated PCB-solid waste in special facilities at Area G. Landfill of nonradioactive material regulated under RCRA was discontinued May 1, 1985.

Mixed wastes have been buried as LLW at Area G through April 1985. In accordance with the anticipated DOE/EPA regulations and because of the small volume of this waste, the Laboratory discontinued this practice on May 1, 1985. This definition was modified in May, 1987 and resulted in additional wastes, uranium chips and turnings, managed as mixed wastes. Mixed wastes have been placed in storage at Area L and Area G until they can be treated and disposed of.

Procedures and facilities have been developed at Los Alamos to ensure proper management and disposal of radioactive solid waste. Key areas of management are packaging and on-site transportation, waste acceptance, site design, and disposal activities. Once approved by DOE/AL, any shipments received from off-site facilities must meet the same guidelines established for on-site waste generators. No off-site shipment was received for burial in FY89.

Goals for operating an area for waste receiving and acceptance include controlling radiation and contamination, complying with appropriate transportation requirements, and providing proper documentation. An important related aspect of waste receiving and acceptance is monitoring procedures developed by Laboratory waste generators for preparing waste for disposal and ensuring that guidelines for these procedures have been met when waste is accepted at the disposal site.

Standard operating procedures (SOPs) are developed to cover specific operations to ensure that all necessary health and safety precautions have been considered. At the Laboratory, HSE-7 must approve an SOP for any operation that creates radioactive solid waste. Waste management segments of the SOP must clearly address not only the operation, but also the packaging and transportation of the waste. HSE-7 personnel review these SOPs annually, a process which includes an on-site inspection of a generator's facilities to determine whether procedures are being properly implemented. The SOP and documented on-site inspection are quality assurance and control measures for the form the waste is in when it arrives at the disposal site.

At the disposal site, vehicles containing waste are first stopped at a barrier gate for documentation review. A Radioactive Solid Waste Disposal Form must accompany each shipment (Fig. 21). The signature of the waste generator certifies compliance with all applicable disposal requirements, and the signature from health physics certifies that packaging and transportation requirements have been met. The vehicle is then moved just beyond the barrier for physical inspection. Radiation levels are checked and contamination swipes are taken. HSE-7 personnel verify that all aspects of the waste packaging and transportation comply with proper procedures. If only waste transportation discrepancies are noted, they are documented before proceeding with disposal. Discrepancies involving improper waste form, packaging, or documentation require that the shipment be moved to a holding area until corrective action can be determined. Personnel at the

Los Alamos
Los Alamos National Laboratory
Los Alamos, New Mexico 87545

RADIOACTIVE SOLID WASTE DISPOSAL RECORD

NOTE Read instructions on back carefully before completing this form

HSE-7 Waste Management
Ext. 6095, MS J592

1. Form Number S 9 0 2288

2. Date M M D D Y Y

3. Retrievable Serial Number

4. Origin of Waste: Group | TA | Building | Wing | Program Code

5. Waste Code

6. Waste Description

7. Numbers of Waste Packages: Plastic Bags | Card-Board Boxes | Drums No. | Drums Gal. | Wooden Crates No. | Wooden Crates Volume-ft³

8. Gross Volume: Amount | (M = meter³, F = foot³, G = gallon)

9. Package Radiation at: Surface (mr/hr) | 1 Meter (mr/hr)

10. Gross Weight: Amount | (K = kilogram, P = pound, T = ton)

11. Additional Description of Packaging and Packaging Materials

12. Radionuclide Content

Nuclide	Amount	±	(C = curie, M = gram)	Error on Amount	±	Amount Determined By: (A = analysis, M = measurement, E = estimate)	SS Materials Write-Off: Account	Project Code
	E			E				
	E			E				
	E			E				
	E			E				
	E			E				
	E			E				

APPROVALS

Waste Generator *(Print Name Here)*	**HSE-1/-10/-11 Area Representative** *(Print Name Here)*	**Additional Signatures** *(Optional)*
Signature certifies that the waste is as represented here and that **ALL** applicable acceptance and disposal/storage criteria have been met *(Signature)*	*Signature certifies that waste package or shipment is safe to handle and transport (Signature)*	

13. Date Disposed M M D D Y Y

14. Disposal/Storage Location: Area | Shaft | Pit | Post(s) | Layer | Pos.

15. Shaft Surface Dose mr/hr

HSE-7 Waste Management Representative *(Print Name Here)*	Received	Logbook	Computer	Verified
Signature certifies that all waste receiving, handling, and disposal/storage requirements were met. *(Signature)*	Date	Date	Date	Date

Form Number HS 10-2A (12/89)

Fig. 21. Radioactive Solid Waste Disposal Form

waste generator's site are always contacted to assist in determining corrective action and to initiate action to prevent recurrence. When all disposal criteria have been satisfied, the shipment is directed to the appropriate location for storage, treatment, or disposal.

Disposal site operations must involve adequate procedures and/or facilities for proper waste segregation, disposal, and control of contamination and pollution. The type of disposal facility used, the waste form and packaging, the application of cover material, and site restoration are items that are considered in achieving these goals. The method and location of disposal of waste depend on the physical, chemical, and radiological properties of the waste.

Most waste generated at the Laboratory is buried in large pits ranging in size from 120-180 m (400-600 ft) long, 8-30 m (26-100 ft) wide, and 8-20 m (26-65 ft) deep. Pits are oriented with the long dimension as parallel as possible to the area surface contours to minimize surface erosion. The ends of pits are excavated with slopes that allow access by vehicles and equipment. As a final step, tuff is ground and compacted in the pit bottom to a depth of 0.15-0.30 m (0.5-1 ft) to provide a seal for any fractures in the pit bottom and an absorption medium for precipitation that enters the pit before waste burial. A set of guidelines have been developed to document the design criteria of a waste disposal unit. Greater confinement disposal in a pit is practiced for those wastes with TRU contamination between 10 nCi/g and 100 nCi/g.

To provide better isolation following burial and to increase worker safety, certain Los Alamos wastes are buried in augered shafts measuring 0.3-1.8 m (1-6 ft.) in diameter and up to 20 m deep (65 ft). Several oversize shafts, 1.8 x 3.6 x 13.7 m (5.9 x 11.8 x 45 ft), have been drilled for disposing of large, highly activated metal wastes from the LAMPF accelerator. Although most shafts are unlined, a few are lined with concrete or metal for additional containment (see Fig. 11).

To prevent possible contact between buried waste and perched water that exists in alluvial material in the floors of adjacent canyons, no burial facilities may be deeper than the adjacent canyon floor which is 23 m (75 ft) deep. Both pits and shafts are located no closer than 15 m (50 ft) to a canyon wall, and all topsoil is removed and stockpiled for future site revegetation.

Before use, HSE-8 surveys,records, and approves for use all burial facilities. Pits and shafts are filled to a level 1 m (3 ft) below the spill point, the lowest point on the facility rim, to ensure complete containment of waste by undisturbed tuff. Pits are then covered with tuff and a layer of topsoil and are revegetated. Shafts are capped with concrete the entire final meter. During FY89, Pit 37 was excavated and approved for use. This pit measured approximately 24.4 m (80 ft) wide, 222.5 m (730 ft) long, and 18.3 m (60 ft) deep (deepest point).

Most of Los Alamos waste is placed in pits. Waste includes large equipment, most decommissioning wastes, all compacted waste bales, and most routine noncompactible waste. Items such as biological waste and highly activated materials are routinely placed in unlined shafts .

Waste packaging is usually provided primarily for contamination and radiation control during transportation because the disposal site environment is the primary containment after burial. Occasionally,

however, disposal facility liners or special packages supplement containment, especially with waste contaminated with tritium. Tritium waste with activity >20 mCi/m^3 must be placed in asphalt lined or encapsulated drums and then placed in lined shafts. This type of containment is being evaluated to determine its effectiveness against tritium migration.[12]

The immediate cover on all waste disposed of at Los Alamos is excavated tuff. In the shafts, tuff covers packages to better isolate individual packages and to fill voids. In pits, all combustible and/or disposable waste is covered daily using a layered-landfill approach. During the covering, the weight of the bulldozer provides additional compaction. Special packages supplement containment. This operation has proved effective in preventing pit subsidence.

Efficient site use is achieved through a combination of disposal facility design, operations, and closure. Maximum land use is accomplished by leaving minimal space between shafts and by having storage areas for TRU waste located on top of old pits. Operationally, reducing waste volume by compaction is encouraged wherever possible to minimize land use. Partial closure of a disposal facility includes revegetation with native grasses, appropriate surface drainage control by restoration of natural gradients, and monument installation for permanent identification.

3.1.3.2.2 Current and Future Plans. Based on current guidance, FY90 funding is not sufficient to meet all identified programmatic goals. While operations in most task areas can continue at FY89 levels, funding is not provided to continue implementation of several new requirements of DOE 5820.2A.

The volume of low-level waste to be buried is estimated to be 5450 m^3. This projection includes the estimated effects of continuing volume reduction program efforts and of planned and ongoing decontamination or decommissioning projects. Additional projects could result in a significant increase in waste disposal volumes. Waste burial pits and shafts will continue to be provided as required.

Maintenance of Area G and the inactive disposal sites will be continued to assure long-term containment. Routine burial site monitoring and other studies initiated in prior years will be continued. This includes a detailed surface reconnaissance to all radioactive waste disposal areas and an intensive sampling survey at one or more of the areas.

Funding to continue the essential, radiological performance assessment effort is included at this level; however, efforts to initiate the required systems performance assessment are not funded for FY90. The radiological performance appraisal will assess the long-term risk to the general public of the active disposal site, TA-54, Area G. A complete assessment of this site is required for operations to be in compliance with DOE 5820.2A. When the performance assessment is complete, the waste acceptance criteria and the environmental surveillance program for the site will be finalized. Operations criteria and plans for site closure will also be developed. Efforts in future years will be devoted primarily to continued validation of the established criteria and results of the performance assessment.

All reporting requirements will continue to be met. In addition, we will improve the records management system as soon as possible.

Compaction of trash-type, low-level waste prior to burial will continue. At current generation rates, an estimated 800 m^3 of waste will be compacted to a burial volume of approximately 180 m^3.

Interactions with Laboratory waste generators to reduce volumes and better manage waste generation processes will be continued. Laboratory employee training/education in areas of waste segregation, material control, waste handling procedures, and overall waste management-volume reduction philosophy will continue (see also 6.5). At this funding level, however, the significant efforts mandated for LLW certification cannot be initiated.

Efforts will continue to expand the present Area G burial site to assure continued operation to meet Laboratory LLW disposal needs. This expansion will add sufficient area to the site for approximately 15 more years of service (at current generation rates). Further expansion of the site within the area previously designated (in 1957) for waste disposal still is possible. Major site expansion tasks will include clearing and fencing, utilities, modification and relocation of the current office facility, removal/remediation of archaeological sites, and providing a new equipment storage building.

3.1.2.2.3 Implementation Requirements. The current status of compliance with DOE Order 5820.2A requirements for LLW (and mixed LLW) waste is summarized in Table IV. Only the status of items originally identified to be in noncompliance are listed; all other requirements are assumed to be in compliance.

3.2 Mixed Waste Management

Generally, mixed waste is radioactive waste that is also regulated as a chemical waste under RCRA. Until May 1987, this definition was applied only to certain low-level waste streams. The waste streams that met this criterion at Los Alamos were scintillation vials, uranium-contaminated lithium hydride, and miscellaneous reagent chemicals. Through April 1985, this waste was buried at Area G as radioactive waste. Currently, these wastes are stored at Areas G and L. Since May 1987, additional waste streams have become regulated and we have added uranium chips and turnings and the LLW sludge from the TA-50 treatment plant to the waste stored. A fraction of the TRU waste also meets this definition. The Laboratory is evaluating the options for storage available under the regulations; under current plans, uncertified TRU waste will continue to be stored at Area G in the same configuration as before. When guidance is available to the Laboratory, this practice may have to be changed. The future management of these mixed waste streams is anticipated to be storage and incineration when possible.

3.2.1 Mixed High-Level Waste

The Laboratory does not generate, store, treat, or dispose of mixed high-level radioactive waste.

Table IV
Low-level (and Mixed Low-Level) Waste Implementation Summary
Page 1 of 6

DOE 5820.2A Requirement	Actual Practice	Current Plans	Status/Progress
III.3.b(1)	No performance assessment	Prepare radiological performance assessment in thress phases:	Task initiated FY89 and continues on schedule.
		1. Develop scenarios, data bases, and simulation models.	
		2. Complete screening and second- and third-level simulations.	
		3. Complete performance assessment.	Estimated completion 11/91; $557K.
		Ongoing maintenance of performance assessment.	$450K/yr, beginning FY92.
III.3.b(2)	No system performance assessment	Prepare systems performance assessment.	Implementation delayed due to funding shortfall in FY90. Estimated completion date 9/92. Cost to complete $551K.
		Ongoing maintenance of assessment	$205K/yr, beginning FY93.
III.3.b(3)	Current monitoring evaluates actual and prospective performance of active LLW facilities.	Compare monitoring results with model output.	Costs in III.3.b(1) above.
III.3.c(1)	Adminstrative requirements to reuce waste (AR 10-2).	Develop and implement proactive waste reduction program.	Task on schedule; full implementation by 9/91. Cost to implement $2507K.
		Complete and implement maintenance.	$1109K to $1326K per year, beginning FY92.

Table IV, continued
Low-level (and Mixed Low-Level) Waste Implementation Summary
Page 2 of 6

DOE 5820.2A Requirement	Actual Practice	Current Plans	Status/Progress
III.3.c.(3)	Adminstrative requirments to segregate waste (AR 10-2); no established BRC level for distinguishing uncontaminated waste from LLW.	Alternatives study of methods for BRC waste segregation and disposal.	Changed approach to incorporate identified study. Estimated completion 9/92. Estimated cost $450K.
III.3.d	Characterization procedures (Ar 10-2) for radionuclides.	Develop new characterization procedures.	Effort unfunded for FY90. Identified requirment of waste generators to be based upon completed performance assessment and development of revised waste acceptance criteria.
	No established chemical analysis to differentiate between LLW and mixed waste.	Major effort planned to allow RCRA characterization of contaminated waste.	Proposed mixed waste analysis effort initiated FY90. The effort will be at a full funding level of $569K/yr, which will begin in FY91.
III.3.e	Waste acceptance criteria defined by AR 10-2.	Preparation and implementation of LLW certification program.	Effort currently unfunded in FY90, resulting in project delay.
		Prepare plan and implement.	9/92; $1236K
		Maintain program.	$905K/yr, beginning FY93.

Table IV, continued
Low-level (and Mixed Low-Level) Waste Implementation Summary
Page 3 of 6

DOE 5820.2A Requirement	Actual Practice	Current Plans	Status/Progress
III.3.ft	Current treatment adequate to meet near-term objectives. No treatment for some mixed waste.	Develop and construct LLW/mixed LLW incinerator.	$4.0M; 9/93 Further delay possible because of NEPA issues.
		Obtain RCRA permit for an LLW/mixed LLW incinerator.	$500K; 9/93 Delay possible as above.
		Ongoing operating expenses for LLW incinerator.	$600K/yr
		Interim incineration of selected mixed waste at CAI, operating expense.	$100K/yr Delay due to NEPA and regulatory issues (Richardson ammendment)
		Add solidification process for LLW liquid treatment sludge.	$1.2M; 10/93
		Ongoing operating expense.	$180K/yr
		RCRA hazardous waste treatment facility.	$8.0M 10/94
		Ongoing operating expense.	$210K/yr
		Develop interim treatment processes for mixed LLW; study alternative processes.	$75K Delayed due to FY90 funding shortfall
		Provide interim treatment.	$425K Delayed due to FY90 funding shortfall

Table IV, continued
Low-level (and Mixed Low-Level) Waste Implementation Summary
Page 4 of 6

DOE 5820.2A Requirement	Actual Practice	Current Plans	Status/Progress
II.3.g(4)	Program for labeling packages in accordance with DOW 1540.1 is in the Laboratory's On-Site Transportation Manual	Full implementation of program.	Program implemented.
III.3.h	Mixed wastes are stored; no storage for liquid and reactive waste.	Build receiving and storage facility.	$2.6M; 10/95
		Build storage addition to support CAI.	$630K; 4/91 Delayed by Safety Assessment
		Ongoing operating cost.	$105K/yr $150K
		Interim mixed waste storage of reactives and liquids.	$150K 10/90
		Possible interim expansion of solid mixed waste storage.	Expansion FY89-90 to add 6600 ft^2 at cost of approx. $150K. Future expansions now anticipated.
III.3.i(1-2)	Disposal methods meet the performance objectives.	Cannot be identified until the performance assessment is complete.	Included III.3.b(1).
III3.i(5) (a)	Wastes are currently disposed of in cardboard boxes.	Study to determine alternative technologies for compacting, reducing size, and stabilizing wastes.	Unfunded in FY90; delay to 9/92 estimated completion.
		The study may determine alternative action.	$1367K CE and GPP requested FY90 through FY92.

Table IV, continued
Low-level (and Mixed Low-Level) Waste Implementation Summary
Page 5 of 6

DOE 5820.2A Requirement	Actual Practice	Current Plans	Status/Progress
III.3.i(7) (b)	Disposal area operated and expanded under 1979 EIS.	Complete SAR for disposal area.	Increased cost resulting from revised DOE guidance. $300K; 1/91
		Obtain decision NEPA documentation from EH-25.	Current guidance indicates Laboratory Waste Management EIS may be required. Further clarification needed.
		Upgrade NEPA documentation as required.	Not determined.
III.3.i(8) (a)	Does not apply until new disposal site needed.	Designs for disposal unit address hydrology, geology, and waste characterization.	Not determined.
III.3.i(9) (a)	Operational procedures for disposal facilities have been (***incomplete text; please supply predicate)	Improve procedures to minimize need for long-term control and to meet requirements for closure/post closure and performance assessment.	Not determined.
	No facilities for disposal of mixed waste.	Develop mixed waste landfill.	$5M; 9/93
		Ongoing operating expense.	$1500K/yr, beginning FY93.
III.3.j(1-6)	No closure/post-closure plan.	Prepare plan before closing Area G.	$150K; 10/93
III.3.k(1-4)	Comprehensive porgram exists.	Establish groundwater pathway monitoring.	$100K; 10/93

Table IV, continued
Low-level (and Mixed Low-Level) Waste Implementation Summary
Page 6 of 6

DOE 5820.2A Requirement	Actual Practice	Current Plans	Status/Progress
III.3.1	Have overall QA program but not for LLW.	Develop QA program for LLW in two phases.	Funding request for $115K in FY91, $164K/yr thereafter, which begins FY91 to develop and implement QA program for LLW, mixed LLW, and hazardous waste.
		1. Develop QA program.	9/91
		2. Implement QA program.	9/92
III.3.m	Record-keeping system in place.	Improve record-keeping to include quantity of nuclides, and track wastes through treatment.	$100K; 5/91

3.2.2 Mixed TRU Waste

3.2.2.1 System and Facility Descriptions. Currently identified mixed TRU waste, both newly generated and stored, is summarized in Table V.

3.2.2.2 Current and Future Plans. RCRA permitting activities for mixed waste, including all mixed TRU wastes, will be continued in FY90 and beyond. It is anticipated that the State of New Mexico will obtain EPA authorization to regulate mixed waste in early FY90. Within 6 months of that time, the Laboratory will be required to submit its Part A application covering mixed waste. Mixed TRU waste will continue to be identified, characterized, and stored in compliance with RCRA. Technical assistance from an outside contractor will continue to be obtained to evaluate Laboratory mixed waste compliance with RCRA, and to complete actions necessary to assure continuing compliance. Other planned activities involving mixed TRU waste are described in 3.1.2.2.2.

3.2.2.3 Implementation Requirements. The current status of compliance with DOE Order 5820.2A requirements for TRU and mixed TRU waste is summarized in Table III.

3.2.3 Mixed LLW

3.2.3.1 System and Facility Descriptions

3.2.3.1.1 Overview. Mixed LLW is radioactive waste that is also regulated as chemical waste under RCRA (40 CFR 261). Included are solvents, pyrophoric substances, spray cans, scintillation vials, uranium-contaminated lithium hydride, miscellaneous reagent chemicals, uranium chips and turnings, vacuum pump oil contaminated with mercury, LLW sludge from the TA-50 treatment plant, and other chemically contaminated material.

The State of New Mexico identified sludge from the industrial waste treatment plant at TA-50-1 as a waste stream that should be regulated as mixed LLW because of the presence of trace (ppb to ppm) levels of listed organic solvents. Approximately 400-500 55-gal. drums of this waste are generated annually. The other primary mixed LLW streams are uranium chips and turnings and scintillation vials. Approximately 30-60 drums of each of these wastes are generated annually. Current inventories and projections of mixed LLW at Los Alamos are identified in Table V.

RCRA permit compliance efforts for mixed LLW and associated facilities at Los Alamos were initiated in FY89. These efforts involved obtaining both technical and regulatory assistance to evaluate and identify those Laboratory waste streams and facilities that will eventually require RCRA regulation. Currently, the State of New Mexico still does not have authorization from EPA to regulate mixed wastes, although this authorization is anticipated in the near future.

Table V
Los Alamos Mixed Waste Summary

Waste Name	EPA Waste Code	RAD HLW	RAD TRU	RAD LLW	Annual Gen Rate (m^3/yr)	Est'd Inv At End of 89 If No Treatment	Current Treatment	Planned Treatment	Comments
Lead/Lead Containing Solids	D008			x	5	17	None	TBD onsite	
Lead/Lead Containing Solids	D008		x		2 4	5 4 2	None	None	Disposal at WIPP.
Aqueous Process Wastes	D004 D006 D007 D008		x		3 5	5 6 8	Cement Slab	Cement Stabilization	Disposal at WIPP. Primarily as shielding materal.
	F001-F005							Incineration	Sm. amts of orgsanics can be segregated.
Industrial Liquid WTP Sludge	F002 F003 F005		x			1 0 6 4	Dewatered	Microwave melter if new gen.	No generation planned. Disposal at WIPP
Industrial Liquid WTP Sludge	F002 F003 F005			x	8 0	160	Dewatered	Microwave melter	Investigating option for activated carbon pretreat.ment
Misc Organic/Solvents/Oils/ S. Vials	D001			x	2 0	30	Incin.; Ash Cement	Incineration; ash cement	
	D009								Must pretreat to remove Hg.
Misc Aqueous Corrosives w/organics	F001-F005			x	0.5	2.0	None	TBD	Must verify organic contaminants.
	D002			x					
Reactive solids	D003			x	0.4	0.7	None	TBD	
Misc Metal Contaminated Wastes	D006-D007 D009			x	2.4	8.0	None	TBD	
Depleted U-chips and Turnings	D001			x	3.0	9.0	None	TBD	Investigating Recycle.

TBD = To Be Determined

3.2.3.1.2 Storage. During FY89, all identified low-level mixed wastes continued to be segregated, packaged, and stored either at TA-54, Area L, or Area G. At Area G, these wastes, which are packaged in drums or boxes, are stored on an asphalt pad covered by a tension support structure. The structure currently covers approximately 560 m^2 of surface area. As of the end of FY89, plans has been initiated to expand this storage with the addition of 615 m^2 of area. Also, during FY89, lightning protection and electricity were provided to this storage facility. Continuous air monitors are on order for measuring alpha airborne contamination. At Area L, secondary containment was provided for drums of mixed LLW. Accurate and complete labeling of all stored containers at Area L and G was accomplished. At the end of FY89, 255 m^3 of mixed LLW were in storage.

3.2.3.1.3 Treatment. A scintillation vial crusher was acquired during FY89 to reduce volume and prepare scintillation liquids for eventual incineration. The unit has been installed and operations start up is currently being planned. The proposed new Hazardous Waste Treatment Facility, which will be utilized for both mixed LLW and hazardous wastes, received line item funding approval as a FY90 project. The Conceptual Design Report for the facility was prepared as well.

3.2.3.1.4 Disposal. Currently, Los Alamos does not dispose of mixed LLW. The waste is stored at TA-54, Areas L and G. Los Alamos anticipates that DOE will provide regulatory guidance on the management of mixed waste.

3.2.3.2 Current and Future Plans. Mixed LLW is currently stored at two locations at TA-54. At the end of FY89, 255 m^3 of low-level mixed waste was in storage. In FY90 it is projected that approximately 180 m^3 of low-level mixed waste will be added to storage.

Approximately 230 30-gal. drums of waste scintillation vials are stored at TA-54, Area L. These vials contain low levels of radiation and hazardous materials. A vial crusher will crush the scintillation vials and separate the crushed glass and plastic from the scintillation liquid. This project will significantly reduce the volume of a five-year accumulation of this waste stream and prepare it for future disposal by incineration.

It will be at least five years before the disposal of mixed LLW at Nevada Test Site (NTS) may be possible. Consequently, the Laboratory urgently needs to expand the mixed LLW storage capacity. This effort will include expanding the asphalt storage pad, purchasing and installing additional cover sections. This expansion will provide storage capacity for approximately one or two years of waste generation and will be in RCRA compliance for these mixed LLW.

New efforts planned to be initiated in FY90 include the sampling and analysis of mixed LLW in storage for characterization and an effort to implement a certification program for improved management of these wastes. However, these efforts now may have to be severely limited due to anticipated FY90 funding limitations.

The Treatment/Cold Assembly, Testing, and Storage Facility is scheduled for design in FY91, depending on General Plant Project (GPP) selection and funding. ES&H documentation requirements were completed in FY89.

The Mixed Waste Receiving and Storage Facility is an FY92 funded line item construction project. FY89 activities included the determination of ES&H documentation requirements. Planned activities in FY90 include design efforts which will lead to the conceptual design report and design criteria.

The Hazardous and Mixed LLW Waste Treatment Facility is an FY90 line item construction project. FY89 activities have included ED&H documentation requirements, conceptual design report, design criteria, and organization of the architect/engineer (A/E) selection committee. Planned activities for FY90 include issuing a request for proposal to the A/E firms, continuation of the activities of the A/E selection committee toward an A/E selection, and beginning the Title I design.

RCRA permitting activities for mixed waste, including all mixed LLW, will continue in FY90 and beyond. It is anticipated that the State of New Mexico will obtain EPA authorization to regulate mixed waste in FY90. Within 6 months of that time, the Laboratory will be required to submit its Part A application covering mixed waste. Mixed LLW will continue to be identified, characterized, and stored in compliance with RCRA. To evaluate Laboratory mixed waste compliance with RCRA and to complete actions necessary to assure continuing compliance, we will continue to obtain technical assistance from an outside contractor

3.2.3.3 Implementation Requirements. The current status of compliance with DOE Order 5820.2A requirements for mixed LLW is summarized in Table IV.

3.3 Hazardous Waste Management

3.3.1 Characteristic/Listed (RCRA) Wastes

3.3.1.1 System and Facility Descriptions

3.3.1.1.1 Overview. Various types of nonradioactive RCRA hazardous waste are generated in Laboratory operations. Because the Laboratory's work is R&D and because of the varied origin of these wastes, providing process flow sheets for the entire Laboratory is not practical. Instead, Fig. 22 provides a process flow sheet for the major waste streams produced.

Table VI summarize chemical waste activities for FY89. Volumes of waste handled have increased again this year because of an increased Laboratory awareness of the proper disposal procedure for waste chemicals. In the future, volume increases are expected for asbestos and recycled wastes. The regulations under RCRA encourage recycling of waste materials instead of disposal. As the Laboratory moves in this direction, the volume of recycled waste will increase. A waste minimization study was conducted during FY89

Table VI
Los Alamos Hazardous Waste FY89
Inventory Disposal Summary

Waste Form	Beginning FY89 Storage Volume (m^3)	FY89 Disposals (m^3)	Ending FY89 Storage Volume (m^3)
Inorganics	64.5	223.4	23.4
Organics	86.9	391.6	9.9
Corrosives	45.1	146.3	8.0
Reactives	9.5	4.0	1.3
Oxidizers	6.2	8.4	3.4
Ignitables	28.5	93.1	6.3
Oil	42.6	113.8	2.5
Gas Cylinders	5.4	9.8	36.9
Others	11.7	875.3	—
Suspect H. E.	—	113.4	—
Asbestos	—	227.0	—
Totals	300.4	2206.1	91.7

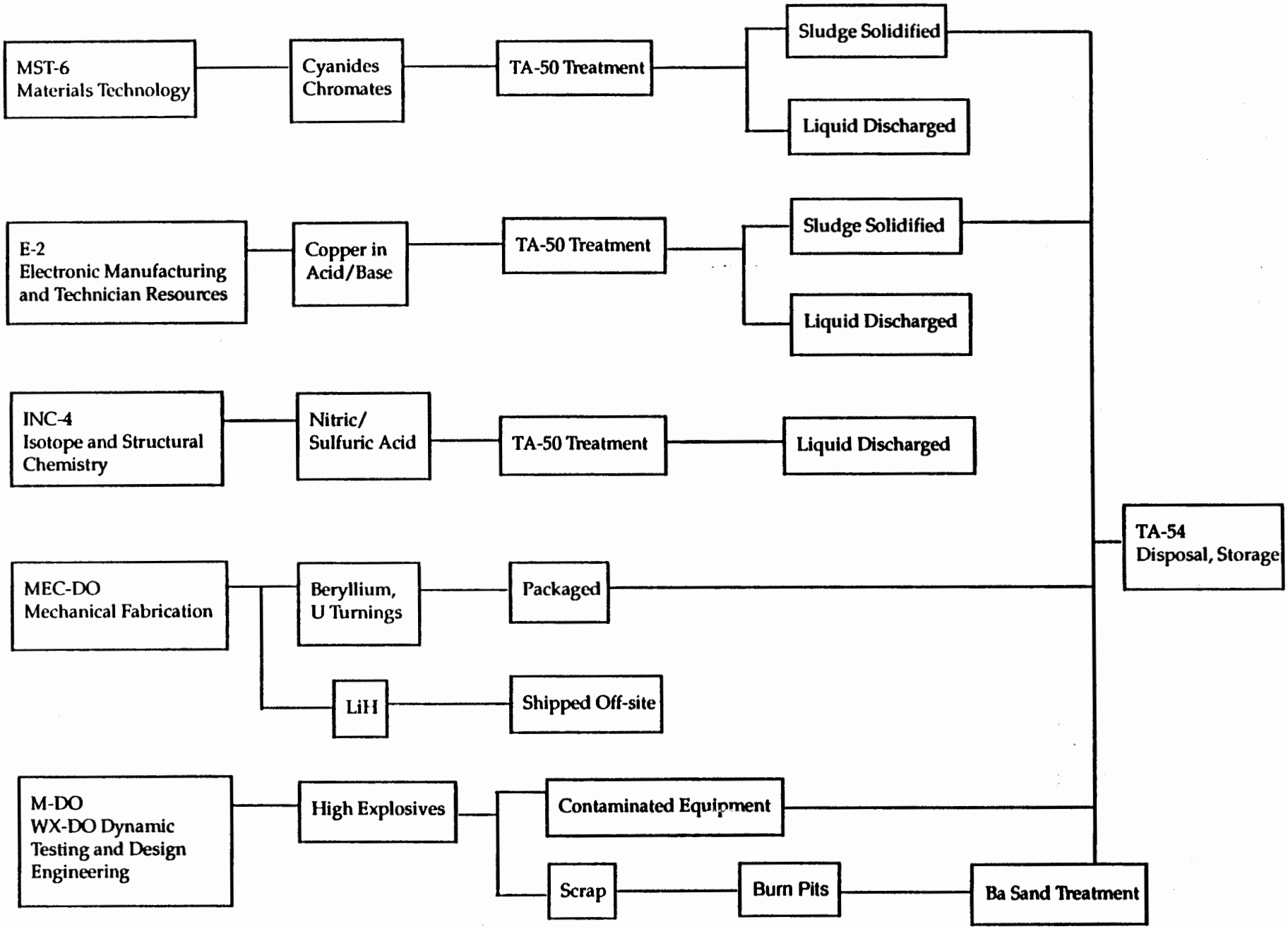

Fig. 22. Flow Sheet for Los Alamos Hazardous Chemical Waste

to identify those waste streams that can be recycled or reused and to evaluate material substitution and practices for material usage to promote additional waste reduction (see also 6.5).

Laboratory facilities in which nonradioactive hazardous wastes have been or are being treated, sorted, or disposed of are shown in Fig. 23.

Major generators of RCRA hazardous wastes are identified below.

Basic and Applied Chemistry Research and Applied Chemistry Research and Development Programs. Primary Laboratory sites for basic and applied chemistry R&D include the Chemistry and Metallurgy Research CMR) Building (TA-3-29), Radiochemistry Laboratory (TA-48), Sigma Building (TA-3-66), and the Health Research Laboratory (TA-43). Typical nonradioactive chemical wastes consist primarily of laboratory reagent chemicals, pump oil, solvents, test samples, and miscellaneous laboratory wastes. Overall, up to several thousand relatively small containers of different acids, bases, organics, inorganics, reactive metals, and other chemicals require disposal every year.

Occasionally, an entire laboratory or research area will require cleanup and disposal of reagent chemicals. In these instances, waste management personnel go to the laboratory and sort, package, and prepare all waste materials for disposal. Generally, the wastes in small bottles, jars, and cans are packaged with absorbent in metal drums for eventual disposal or treatment. Wastes are sorted to ensure that incompatible chemicals are not packaged in the same storage or disposal container.

Electrochemistry Wastes. The Electrochemistry Section of MST-7 at TA-3-66 generates plating solutions containing chromates and cyanides. The Print Circuit Board Shop of MEC-10, Electronic Manufacturing and Technicians Resources Group, at TA-3-40 generates significant quantities of acid or base wastes heavily contaminated with copper.

All electrochemistry wastes require neutralization before final disposal. If the wastes contain cyanide, alkaline chlorination is performed to destroy the cyanide. In either case, a heavy metal hydroxide sludge is formed during treatment. This sludge is solidified with cement and stored at Area L for future disposal. The liquid fraction from a nonlisted waste stream that meets discharge limits, is released to the effluent tank at the treatment plant for radioactive liquid waste. If the liquid is from a listed waste stream, it is put in drums and stored at Area L for either further treatment, such as by evaporation, or for future disposal.

Isotope Separation Wastes. INC-4, the Isotope and Structural Chemistry Group, generates nitric and sulfuric acid wastes. The concentration is generally 7N or higher. Neutralization is done at TA-50. Discharge is currently to the effluent tank at the treatment plant for radioactive liquid waste. When the wiped-film evaporator becomes operational, the discharge may be routed there to eliminate any liquid discharge.

Shops Department Waste. The main shops department, Building TA-3-39, houses most of the versatile machine shop capability at the Laboratory. Parts can be machined from almost any metal, alloy, or other material. These operations generate significant volumes of nonradioactive hazardous wastes including beryllium, lithium hydride, and magnesium

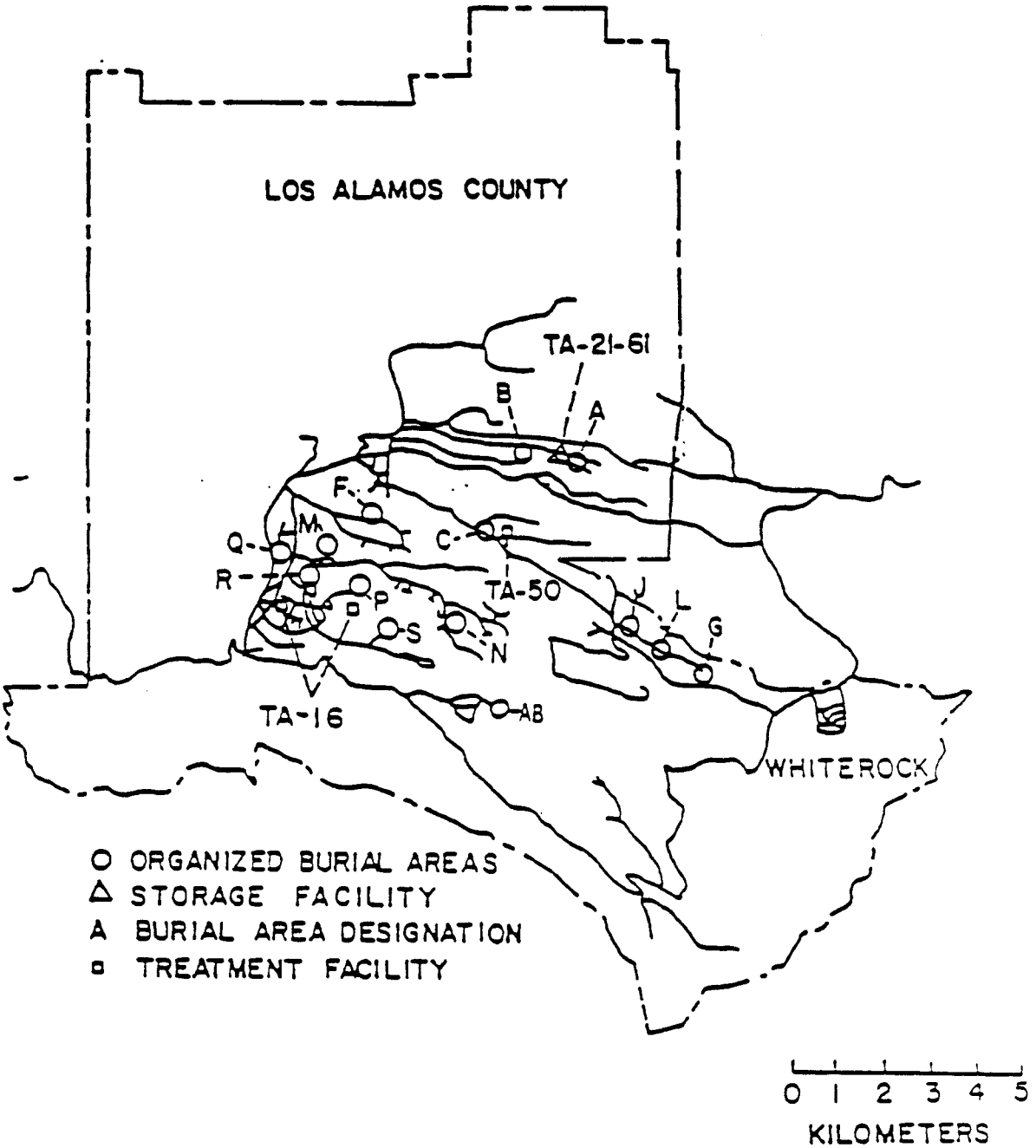

Fig. 23. Locations of Hazardous/Chemical Treatment Facilities

turnings. Toxic wastes, such as beryllium, are packaged in drums and stored or disposed of at Area J or G. Reactive wastes, such as lithium hydride, are packaged, manifested, and shipped off-site for treatment and disposal.

Explosives Wastes. High-explosives (HE) waste is generated by groups in Dynamic Testing (M) and Design Engineering (WX) Divisions during processing and testing various HE materials. Processing includes pressing, machining, and casting HE. Waste is produced as discrete pieces of HE, chips, machine cuttings, and powder. The chips, cuttings, and powder usually are in the form of waterborne suspensions, collected in specially designed accumulating and settling sump tanks. Wastes also consist of materials contaminated with HE: paper, oils, solvents, wood, contaminated machine tools, fixtures, etc. Chemically the wastes consist of HMX, RDX, TNT, PETN, ammonium nitrate, barium nitrate, boric acid, TATB (triaminotrinitrobenzene), nitrocellulose, tetryl, nitroguanidine, and various plastic binders.

Most HE wastes are burned on the pressure filters or sand beds of the burn pits at S-Site, TA-16. Discrete pieces of scrap HE are detonated at other controlled sites. Large items with possible trace quantities of HE contamination, such as milling machines, are disposed of at Area J. Barium contaminated sand and ash generated from these burn operations are treated at TA-54, Area L.

Chemically Contaminated Equipment. Items that contain chemical residuals but which are not considered hazardous waste remain under Laboratory control unless the residual is removed because of liability concerns. Empty drums and gas cylinders are examples. This waste is generated sporadically and unpredictably throughout the Laboratory. Chemically contaminated equipment is packaged and stabilized as necessary for disposal. The items are then buried at Area G or J. All equipment that is considered hazardous waste, such as drums that held an acutely toxic waste, are handled as such.

3.3.1.1.2 Facility Description

3.3.1.1.2.1 Storage. Laboratory TA-54, Area L, is the waste transfer, packaging, and storage unit for accumulating, packaging, and storing chemical wastes (Fig. 24). Located at Area L are concrete containment structures TA-54-31 and -32, and modular storage buildings TA-54-68 and -69. Containers not containing free liquids may be stored, on pallets or otherwise elevated four inches, in a single layer in cleared areas within the fenced portion of Area L. Gas cylinders are stored in cylinder racks in cleared areas also within the fenced portion of Area L or fastened to the perimeter fence, so that the fence acts as the cylinder support and restraint.

These facilities are used for the accumulating, packaging and storing waste containers generated throughout the Laboratory. Hazardous waste containers generated at the various laboratories are routinely delivered to the waste transfer, packaging and storage facilities. Wastes requiring sampling are temporarily stored on the sampling pad, MD-36. Lab pack wastes are stored in the modular storage buildings 54-68 and 54-69. Drums from characterized streams are stored in one of the six identified storage cells on the roofed concrete pad, MD-32.

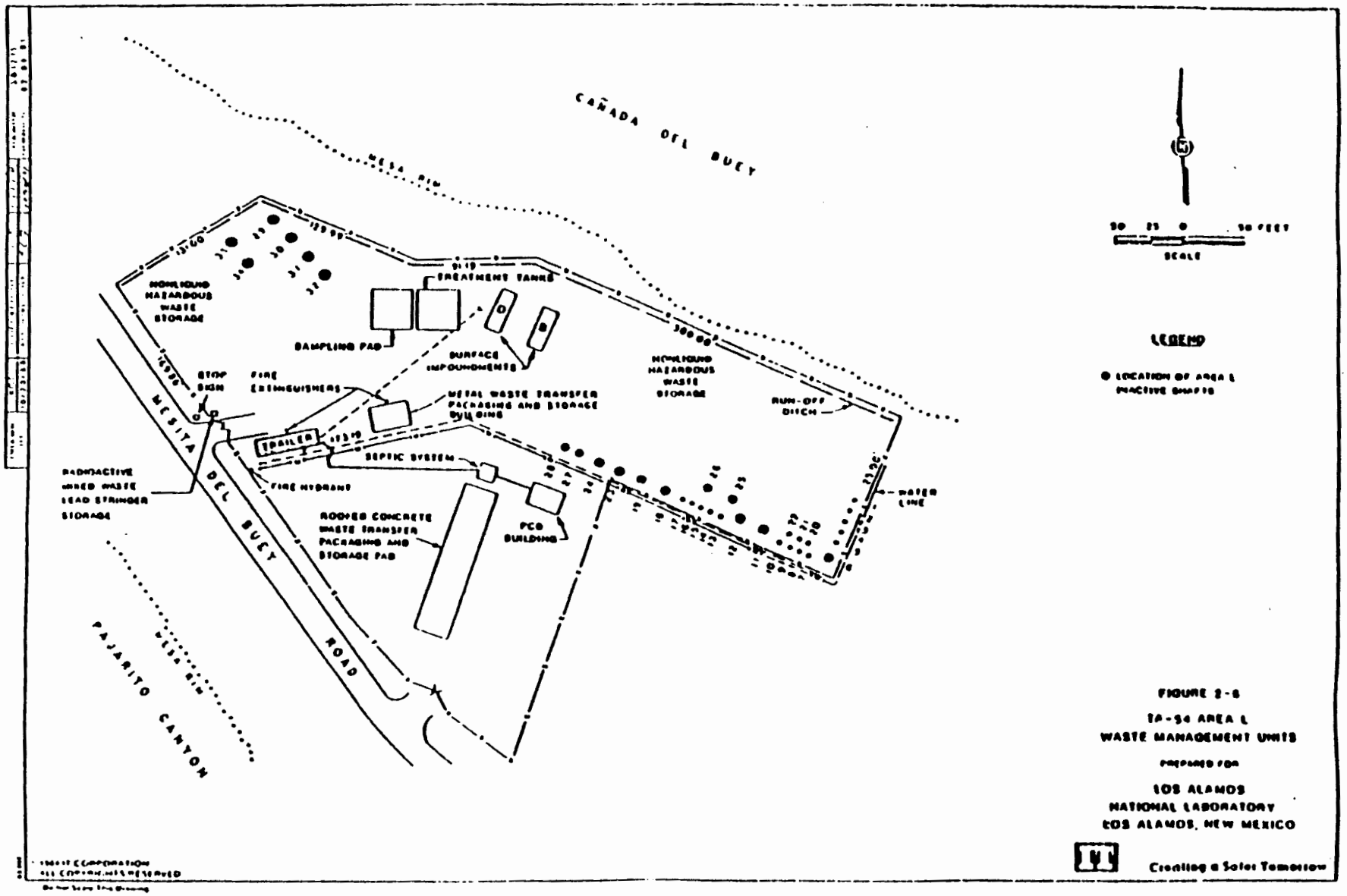

Fig. 24. TA-54, Area L, Plot Plan

3.3.1.1.2.2 Treatment. The following treatment facilities are addressed in the Laboratory's current RCRA Part B permit. This application for permitted facilities was filed with the EPA and NMEID in May, 1985.

- Technical Area 16: industrial incinerator, used to burn HE-contaminated trash and liquids;

- Technical Areas 14, 15, 16, 36, and 39: open burning and open detonation units, used to burn or detonate waste high explosives (HE), HE-contaminated material, and reactives;

- Technical Area 50: batch treatment system and associated waste container storage units; chemical waste incinerator and associated waste container storage area; and,

- Technical Area 54, Area L: Treatment tanks, used for neutralizing, precipitating, oxidizing, and evaporating various wastes.

The various facilities are described in detail in the following sections.

Thermal Treatment Facilities at TA-16. Four types of open burning units are at the TA-16 burning ground: a flash pad, where any HE contamination is removed from excess equipment or scrap generated within the technical area; two burn pads for destruction of solid HE material; a pad with trays in which HE-contaminated waste oil is burned; and two pressure vessels for reacting HE-contaminated sludge.

A 100-foot-square cyclone fence surrounds the flash pad area, which is covered with sand. Material to be flashed is placed on the pad with any necessary additional fuel to maintain the burn until all HE has been reacted. The scrap material is then handled as solid waste.

The two burn pads, each surrounded by a 100-foot-square cyclone fence, are used to destroy solid chunks of excess or off-specification HE and machine turnings. The material is placed on a sand-filled steel table lined with refractory brick, and ignited.

Used oil and/or solvent that may be contaminated with HE is poured into metal trays lined with fire brick. The trays are in a sand-filled metal tray. The oil is ignited using a remotely operated "electric match" Approximately 100 gallons of oil are burned each month.

TA-14 includes one open burning unit that consists of a small burn cage placed in a metal tray. Combustible materials potentially contaminated with experimental HE that cannot be safely transported to the TA-16 incinerator are burned in this cage.

HE-contaminated wash water is collected in sumps at HE fabrication facilities in several technical areas. HE settles out of the wash water, collected in a vacuum truck, and taken to TA-16 for treatment. Any barium used in the formulation process must be precipitated out of the waste water as insoluble barium sulfate. It is collected with the waste HE in a vacuum truck. The collected sludge is gravity-fed from the vacuum truck to one of two pressure vessels buried in the ground. Up to 750 pounds of sludge, estimated

by the depth of the sludge material in the pressure vessel, can be burned at one time. The vessels contain sand and gravel, and a fluid drain connects the base of the cone-shaped vessel to a nearby carbon-filter waste water treatment unit (TA-16-228). Treatment effluent is regulated by an NPDES permit, NM 0028355.

Thermal Treatment Facilities at Technical Areas 14, 15, 36, and 39. Open detonation sites for destruction of excess or waste HE are at TA-14, -15, -36, and -39. These sites are used routinely to detonate scrap HE, failed experimental detonations, unneeded classified explosives shapes, and small quantities of reactive chemicals. These sites consist of detonation points on the open ground, often in a small canyon. Material to be detonated is placed on sand or on a wooden table at the firing point and detonated with a remote firing mechanism. Associated facilities at these sites include bunkers that technical personnel occupy during detonations. Before all firings, nearby roads are checked and kept clear.

Industrial Incinerator at Technical Area 16. A baffled single-chamber industrial incinerator, equipped for combustion of potentially HE-contaminated trash and machine oil, is outdoors in the northeastern part of Technical Area 16. The incinerator can burn 810 pounds per hour of Type Zero trash, as defined by the Incinerator Institute of America. Typically four loads, or 3200 pounds, are incinerated per day. The incinerator burns potentially HE-contaminated paper, cardboard, wooden boxes, etc.; and occasionally a limited volume of potentially HE-contaminated machine oil. The industrial incinerator does not burn wastes other than those permitted by 40 CFR 264.340(b)(i), (ii), (iii), or (iv) [NMHWMR 206.D.8.a(2)(a)(i), (ii), (iii), or (iv)]. Emissions from the incinerator conform to federal and state standards.

Occasionally after flashing or burning, the burn pad sand or surface is contaminated by barium (RCRA waste code D005), a constituent of some HE. Because the burn pad sand may contain EP toxic barium, it is put in drums, stored and treated as a hazardous waste until sampling and analysis are complete. Burn pad sand that is EP toxic for barium is treated at TA-54, Area L, to render is nonhazardous.

Batch Treatment System at TA-50-1. The Batch Treatment System is in Building 1 at TA-50. The system consists of a totally enclosed, vented, 1893-l (500 gal.) pressure vessel equipped with a filtering system, condenser, and vacuum transfer lines (Fig. 25). Total system washdown between batches allows the treatment of incompatible wastes in the facility. Wastes treated in the Batch Treatment System include cyanide, chromate plating solutions, and solutions of acids, bases, and heavy metals.

Although the Batch Treatment System is flexible enough to allow treatment of other wastes that may be generated through new Laboratory projects, three waste streams compose most of the waste to be treated in the system: an acid/base waste that contains copper; a chromate plating waste; and waste cyanide plating solutions.

Chemical Waste Incinerator. Described in detail in Subsection 3.1.2.2.1.4, the CAI has been modified extensively to accept both solid and liquid chemical waste. Originally constructed as a volume-reduction process for TRU solid waste, several additional components were installed in continuing development programs to facilitate the thermal destruction of hazardous

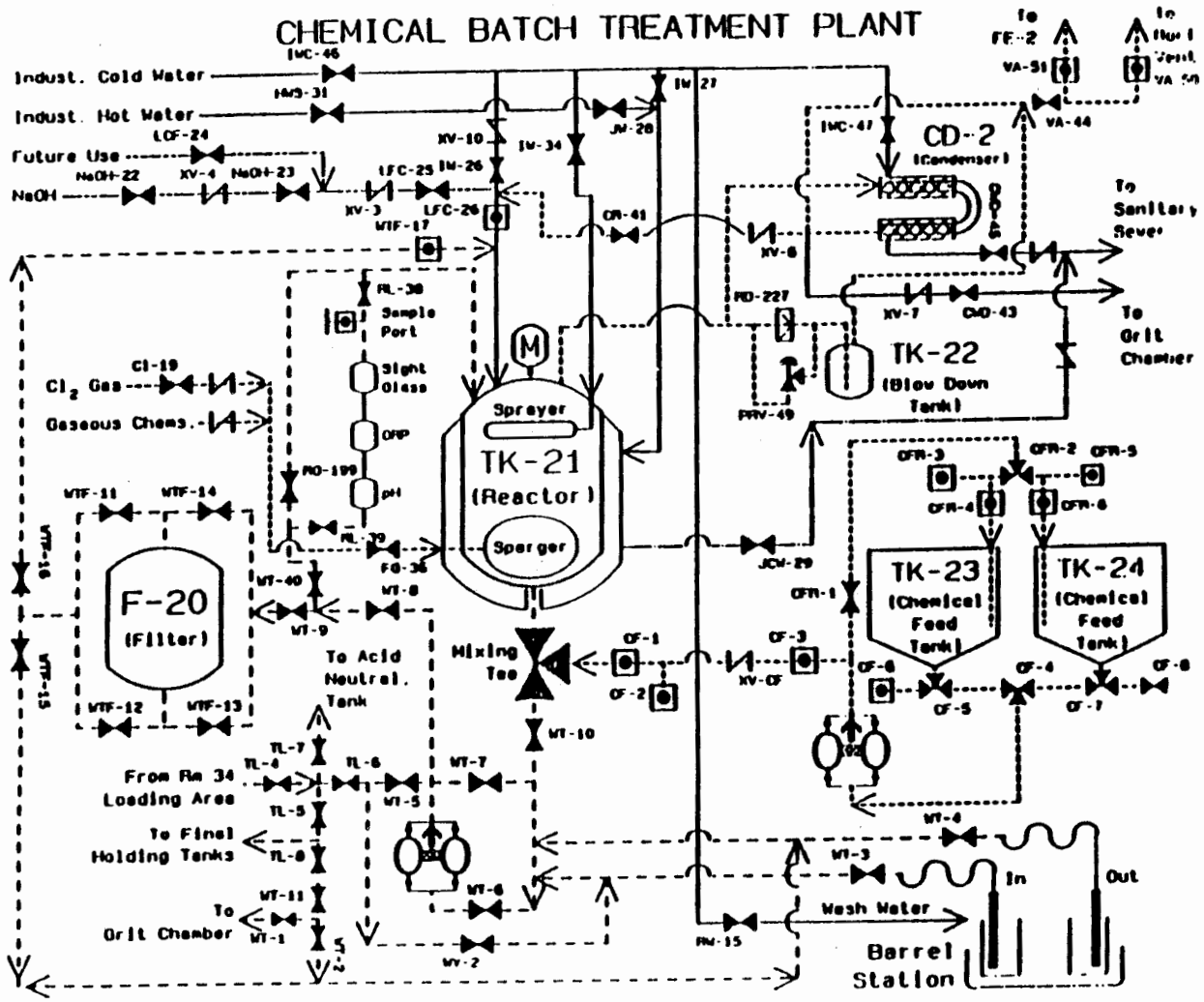

Fig. 25. Flow Diagram of Ba[illegible]ical Treatment System

chemicals. Specific add-ons include a liquid-feed preparation room, high-intensity vortex liquid burner, an activated carbon absorption bed, and a sampling station to accommodate EPA testing. Combined with combustion and off-gas cleanup equipment installed during the TRU development and demonstration program, the CAI can handle a wide range of radioactive, hazardous chemical, or mixed waste feeds. In 1984, the CAI was permitted by EPA Region VI under the provisions of the Toxic Substances Control Act (TSCA) to accept liquid PCBs. In August 1986, NMEID granted interim status for the CAI that permitted incineration of all chemicals with heats of combustion greater than or equal to that of heptachlorobiphenyl.
In September 1986, a RCRA trial burn was conducted, and the final permit was granted in November 1989. Portions of the permit are being appealed.

Described in Subsection 3.1.3.2.1.3, the Low-Level Waste/Hazardous Mixed Waste (LLW/HMW) incinerator is proposed to assume the bulk of chemical waste disposal operations beginning in 1993. Specifically designed to accept a wider range of waste, the combustion chambers and off-gas system will provide the removal efficiency for chemical destruction required by EPA under RCRA regulations. Candidate waste forms for the LLW/HMW incinerator include combustible low-level waste, hazardous chemicals, mixed waste, biological residue, and CEARP wastes. Perceived advantages of the second system include adequate incineration capability to meet long-term needs for regulatory compliance at the Laboratory; reduced risks and liability associated with on-site treatment; separation of TRU and non-TRU waste treatment; and the potential for technology transfer to other DOE sites.

Treatment Tanks at TA-54, Area L. Four 6347-l (1665 gal.), plastic-lined, ten-gauge carbon steel tanks are located at TA-54, Area L. These tanks are used to neutralize, precipitate, and evaporate wastes. The tanks are on a bermed concrete pad (Fig. 26). Ammonium bifluoride and barium sand are common wastes chemically treated in the tanks.

Gas Cylinders. In FY89, approximately 1100 compressed gas cylinders were inventoried at the Laboratory. Of these, 175 were treated by detonation and 250 were disposed of as empty nonregulated containers.

3.3.1.1.2.3 Disposal

Waste Disposal Facilities at TA-54, Area L. TA-54, Area L, with an area of 0.8 hectare (3.0 acres) (Fig. 8), has been the main active chemical waste disposal site at Los Alamos since 1964. From 1964 through May 1975, all chemical wastes were disposed of in one pit at the site. Beginning in June 1975, with the transfer of responsibility for disposal operations to HSE-7, this pit was covered, and shafts were used for waste chemical disposal.

Chemical disposal shafts measured 0.6 m (2 ft) to 2.4 m (8 ft) in diameter and up to 20 m (65 ft) deep. Different shafts were used for different categories of waste chemicals (organics, inorganics, oil, etc.) to ensure that incompatible chemicals would not mix and react. With the new RCRA requirements for double-lined, double-leachate collection landfill units and for ground water monitoring certification, all landfill activities ceased on November 8, 1985. Future landfill designs and locations are being evaluated.

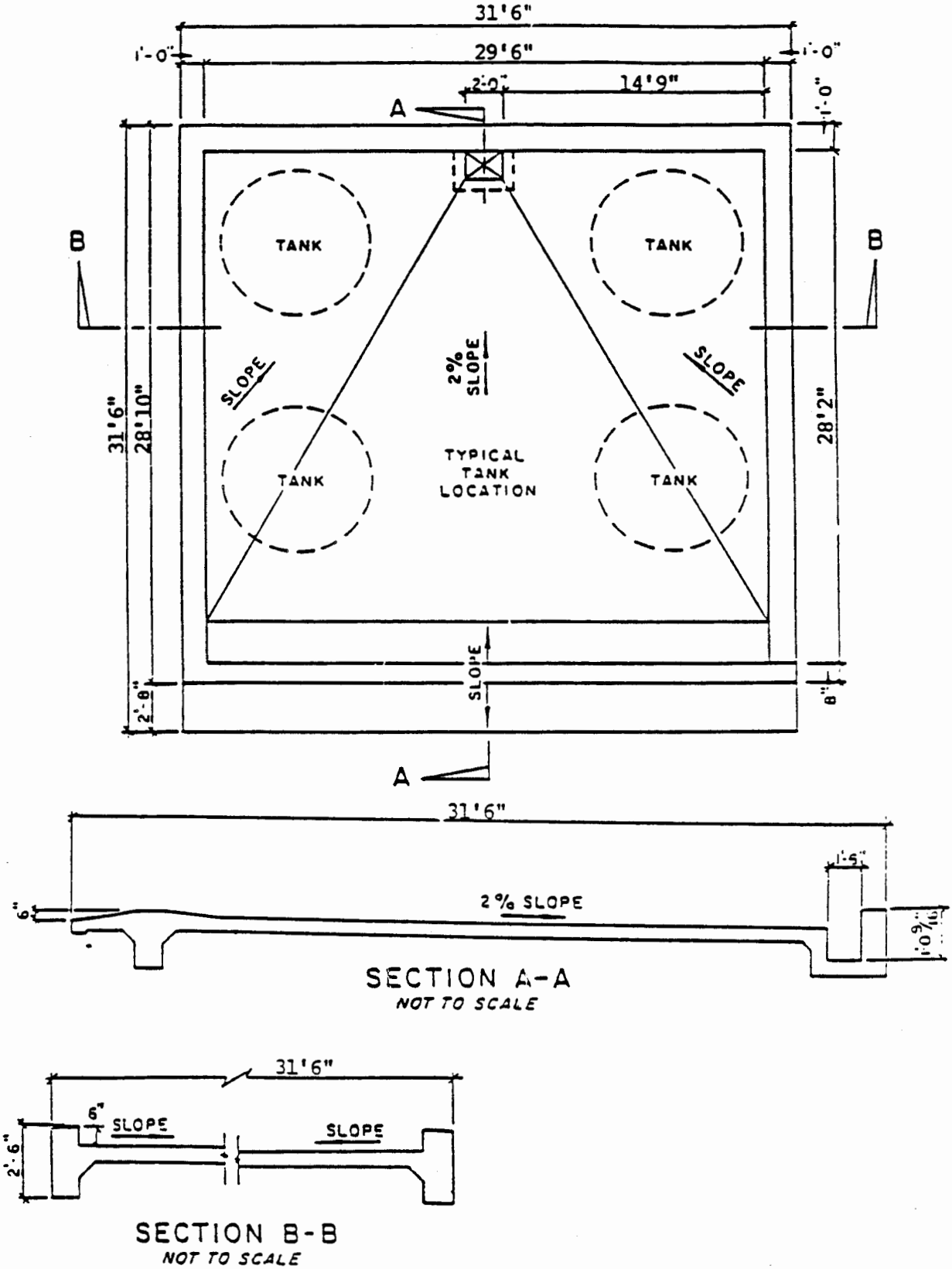

Fig. 26. TA-54, Area L, Treatment Tanks

Two small pits at the site were used for disposal of bulk quantities of treated aqueous waste. The water quickly evaporated from these wastes leaving a salt cake in the pit bottom. When this salt cake was within 1 m (3 ft) of the top, the pit was backfilled. One of the pits was filled between June 1975 and July 1978. This operation was stopped in FY84 at the request of the New Mexico Environmental Improvement Division (NMEID). Considered to be "surface impoundments" by the EPA/NMEID, these facilities will be closed when a closure plan is approved; closure will be under interim authority.

Waste Disposal at TA-16, Area P. Area P has been used since the 1950s as an industrial landfill to dispose of residues resulting from burning HE-contaminated equipment and trash. The landfill is regulated under NMEID Hazardous Waste Management Regulations (HWMR) because residues containing barium exceeding EP toxicity limits (RCRA waste code D005) have been placed in the landfill since 1980.

Area P is regulated under a RCRA Part A Permit. A Part B Permit is not being sought, and the landfill will be closed under interim authority. Area P was recognized as a regulated hazardous waste landfill in September 1984, when two of six samples of the TA-16 thermal treatment residues exceeded the EP toxicity limit for barium. Waste disposal at Area P has been discontinued. The late discovery of the regulatory status and its existence before RCRA regulations have complicated compliance with interim status regulations. The Laboratory has conducted a detailed land survey of Area P and compared the survey with the previous one to determine the extent of the landfill. The probability of the presence of hazardous constituents in the landfill was assessed by determining the use of regulated chemicals at the site. The geology and hydrology of Area P have been investigated by conducting surface surveys and by consulting literature.

TA-16, Area P, is located in a saddle of a short, eastern-trending, narrow mesa. The saddle is near the south rim of Canyon de Valle, just north of Pad 387 at the TA-16 thermal treatment area. The general area is a half-ellipse, roughly 51.8 m (170 ft) in north-south dimension and 122 m (400 ft) in the east-west dimension. Within this area are two areas of fill, one to the west and the second to the east. The estimated landfill volume is 9940 m^3 (351 000 ft^3).

Landfilling progressed from west to east. The west portion was closed by leveling the landfill and covering it with dirt. The leveling overflowed the rim in the northwest quadrant of Area P, as evidenced by the elevation changes determined by the survey. Most of the wastes are located on the steep canyon slope. The landfill depth at the rim is 3.7-4.3 m (12-14 ft), thinning both to the south and down the slope to the north. The cross section indicates that waste deposits reach only 9.1-12.2 m (30-40 ft) back from the rim, extend down the slope, and do not reach the canyon floor. Large items, such as blocks of foundation concrete and pieces of structural steel, have rolled to the canyon floor. A few empty cans were found on the canyon floor. These and other metal items on the canyon floor have probably been there for many years because they are rusted and weathered.

The west portion of the landfill has been revegetated with grasses, wild rose, wormwood, and oak brush. Based on a visual survey, the slope is stable. Occasional protrusions of concrete rubble, pipe, and steel, help bind the mass.

The site shows no evidence of slippage or significant erosion, as would be shown by gully formation or silt deposition at the canyon floor.

The east landfill area was the active portion of the site. Fill has progressed from south to north with cover dirt being spread as the fill advanced. Wastes on the north face are exposed. The covered portion has no appreciable vegetation, and surface drainage cuts through this portion of the landfill. The cross section indicates that the wastes in the east portion of the landfill are on a bench and have not overflowed the bench rim.

Off-site Disposal. Many hazardous chemical waste streams generated by Los Alamos are sent off-site for disposal. Most of this waste is incinerated and only the residual ash is landfilled. The laboratory does not currently landfill hazardous waste. However, certain waste streams are not suitable for incineration. Appropriate disposal options for these wastes are being investigated. When possible, waste is sent off-site for use in fuels programs. The following companies are contracted by the Laboratory for waste disposal.

Aptos Environmental-PCBs, capacitors, and oils
Unison-PCBs (transformers)
Rollins Environmental-Labpacks, bulk waste, and PCB-contaminated oils and capacitors
Chemical Waste Management-Labpacks, bulk organic wastes

Before waste is sent off-site, the disposal facility is inspected by Laboratory personnel and operating records and permits are reviewed. At a minimum, representatives from both HSE-7 and HSE-8 are present during the inspection. All recommendations are sent to HSE-7 Group Leader for consideration.

The volume of waste disposed of off-site in 1989 increased from 1988. The volume of waste to be disposed of in 1990 is again expected to increase primarily due to increased generator awareness. Disposal of compressed gas cylinders will commence in 1990 and will attribute to an overall increase in off-site disposal.

3.3.1.2 Current and Future Plans. An EA for the LLW/mixed LLW incinerator was completed and submitted for review in March 1989. The program is now awaiting completion of the review and consideration of a permit to construct. FY90 activities hinge upon application for an processing of a Permit to Construct by the NMEID and the EPA Region VI. Review of the permits has been delayed by the New Mexico State House Bill 59 which prohibits the NMEID from permitting new waste incinerators until regulations for incinerators are adopted.

A two-phase RD&D program is ongoing for safely handling, sampling, and recontainerizing leaking or damaged compressed gas cylinders containing hazardous gases and/or cylinders containing unknown gases. During the R&D effort, a commercially available technology was identified as suitable for adaptation to a vehicle transportable, skid mounted system. Originally scheduled for FY89, the project was delayed, moving this activity to FY90.

Equipment procurement, modification, demonstration, and documentation of transportable gas cylinder handling, sampling, and recontainerization system will be completed in FY90.

The Hazardous and Mixed LLW Treatment Facility is an FY90 line item construction project. FY89 activities have included the ES&H documentation requirements, conceptual design report, design, criteria, and organization of the AE selection committee. Planned activities for FY90 include a request for proposal to the A/E firms, continuation of the activities of the A/E selection committee toward an A/E selection, and beginning Title I design.

The Waste Oil Storage Facility is an FY91-funded GPP construction project that will be used to bulk organic liquid wastes for off-site shipment. The Laboratory currently disposes of 30 000 gal. of hazardous organic liquids each year that are currently stored and shipped in drums. This facility will increase the Laboratory's hazardous waste storage capacity that can be permitted, reduce analytical costs for these wastes, reduce treatment costs, improve waste handling safety, and reduce spill risks. FY90 activities are limited to completion of an independent assessment required by RCRA regulations. Completion of permitting and equipment purchase is scheduled for FY91, with construction completed in FY92.

The Combustible Chemical and Radioactive Waste Storage/Staging Facility is expected to reach Title III construction in FY90. Titles I and II designs have been completed.

Greater than 90-day storage of RCRA hazardous waste is permitted at TA-54, Area L. In FY89 the inventory of hazardous and nonregulated chemical wastes stored at this facility significantly decreased because of increased off-site disposal efforts. In FY90 inventories at the permitted storage area will remain within permitted storage capacities.

In FY90, sand waste generated from thermal destruction of high-explosive scrap contaminated with soluble barium as barium oxide, barium hydroxide, and barium carbonate will be treated to render it nonhazardous. Ammonium bifluoride also will be treated with calcium chloride and lime to render the fluorine nonhazardous.

The Waste Free Days operation will continue through FY90. This activity involves receiving and packaging hazardous and nonregulated chemical waste at or near the waste generator's site. The wastes are shipped directly from the collection point to the off-site disposal facility by an off-site contractor. This activity specifically targets laboratory clean-outs. The operation will be set up at a number of technical areas throughout the year on a preannounced schedule.

3.3.1.3 Implementation Requirements. The Laboratory is striving for compliance with all applicable Federal and Sate hazardous waste regulations. In August of 1989, TA-54, Area L was inspected by EPA and The State of New Mexico. Several areas of noncompliance were noted. Concern was primarily focused on the waste tracking system. A new waste tracking system has since been developed. This system enables waste to be tracked more completely, and because of built-in checks and balances, the records will be more accurate. The new system was implemented in November 1989. Inadequacies were

also found in the waste collection system. For example, some drums were found to be misnumbered of mislabeled. Waste collection operations have been revised and these types of inconsistencies significantly reduced.

3.3.2 Other Hazardous Wastes

3.3.2.1 System and Facility Descriptions

3.3.2.1.1 Overview. Table VI lists the values of other hazardous chemical waste treated, handled, and disposed of during FY90. An ongoing program for removing asbestos insulation continued to generate large amounts of waste during FY89.

Major components of this waste stream include the following sections.

Asbestos Wastes. Asbestos wastes originate from a wide variety of sources including old pipe insulation, transite board, ceiling insulation, welding curtains, and welders' gloves. The largest generators currently are Pan Am and the Maintenance and Operations Group, ENG-5. Asbestos wastes are packaged in plastic bags or plastic lined cardboard boxes. They are collected and transported to Area G or J for disposal. In FY89, 243.6 m^3 of asbestos was disposed of.

Waste Oil. Oil is used throughout the Laboratory in items ranging in size from several thousand gallon size transformers to several liter size pumps. Some of the oil is PCB and PCB-contaminated. The Waste Management Group handles PCB wastes in any of several ways.

Depending on the level of PCBs present in waste oil, different disposal locations are used. Oil free of PCBs (<5 ppm) is stored for off-site incineration as a waste fuel. Oil with PCB levels between 5 and 50 ppm is sent off-site for incineration. Oil with PCB levels between 50 and 500 ppm is sent off-site for incineration. Oil with PCB levels greater than 500 ppm is stored at TA-21-61 until it can be shipped to an approved incineration facility. All soil, equipment, and other solid materials contaminated with PCB oil are disposed of at Area G. Under a toxic substance control act (TSCA) permit in FY89, 2 056 000 pounds of PCB waste was disposed of at the solid waste disposal site.

Transformer Carcasses - Although the Laboratory's disposal area is permitted for disposal of solid PCB waste, it is not used for such wastes because of space limitations. PCB and PCB-contaminated transformer carcasses are treated by solvent extraction at one of two EPA-approved facilities in the United States and then sent to a smelter. Other PCB wastes are incinerated off-site at an EPA-approved incinerator.

PCB Capacitors - Federal regulations state that small capacitors, such as light ballast and small electronic equipment under 100 in^3, can be placed in local landfills. However, in its commitment to ensure the protection of the public and the environment, the Laboratory sends large and small PCB capacitors off-site for incineration.

Radioactively Contaminated Solid PCB Waste - Radioactively contaminated PCB and PCB-contaminated equipment is drained, flushed, and buried at Area G.

3.3.2.1.2 Facility Description

3.3.2.1.2.1 Storage. Dedicated to storage of PCB materials generated by the Laboratory, Building 61 at TA-21 meets the requirements of Annex III of the February 17, 1980, Federal Register (PCB Disposal and Marking) for PCB storage facilities.

In September 1989, PCB storage operations were moved to a dedicated state-of-the-art PCB building, TA-54. The building has a design storage capacity of 20 000 gal. of waste stored in 55-gal. drums. The facility also has a curbed storage pad with a capacity of 8000 gal. The pad is 16 ft x 60 ft, with a 14 in. curb. Secondary containment on the storage pad is 110% of the total internal volume of the stored PCB waste oil tanks.

3.3.2.1.2.2 Disposal

Waste Disposal Facilities at TA-54, Area J. TA-54, Area J, with an area of approximately 1.1 hectares (2.65 acres), has been used since the early 1960s for burial of equipment wastes potentially contaminated with HE. In recent years, asbestos wastes also have been disposed of at this site. Operation of Area J was transferred to the Waste Management Group at the beginning of FY85. Generating groups certify that all materials currently disposed at Area J are non-RCRA wastes.

One pit in this area was filled in 1966, and a second used since that time was filled and covered at the end of FY84. A third pit and two shafts 1.8 m diameter by 20 m deep (6 ft x 65 ft) were excavated at the site in late FY84 and have since been used for disposal. Pit 4 was excavated in FY 1987 and was placed into service in FY89.

Off-site Disposal. PCB and PCB-contaminated wastes are disposed of by off-site incineration, as noted in 3.3.1.1.4.

3.3.2.2 Current and Future Plans. Hazardous waste generated at the Laboratory will continue to be managed in an environmentally sound manner. A comprehensive plan to identify major waste streams throughout the Laboratory had begun. Future plans take into consideration the need for an asbestos monofill. Continued increases in asbestos waste generation are expected. However, sufficient funding in FY90 has not been allocated for this project.

3.3.2.3 Implementation Requirements. As noted in 3.3.2.2, new State of New Mexico regulations require that a monofill be established and operated to dispose of asbestos wastes. Plans to implement this requirement have been developed; a funding estimate is included in the DOE Five Year Plan. However, to date we have not received that required funding.

4.0 SCHEDULE AND COST SUMMARY

4.1 Milestones

Program milestones are identified in Figures 27 through 32, according to waste category.

4.2 Budget Summary

Waste Management operations funding requirements are identified in the DOE Five Year Plan according to the following subtasks areas: Continuity of Operations, Disposal, Storage, Treatment, and Waste Minimization. Table VII provides a summary listing of FY89 costs and identified needs for FY90 through FY95. Costs/projections listed are totals of operating, capital equipment, GPP, and line item funding.

Current DOE guidance indicates funding levels are inadequate to support all activities required by waste management by FY90. Waste Management activities identified in Table VIII total approximately $5M more than the current funding guidance from DOE for FY90. This shortfall is expected to affect waste management programs and will create numerous regulatory liabilities. The funding shortfall could also jeopardize the existing comprehensive environmental protection programs at Los Alamos. More specifically, regulatory liabilities will surface in treatment, storage, disposal, and waste minimization programs that support the overall waste management programs. Furthermore, a comprehensive generator interface and educational program will not be as effective.

5.0 ENVIRONMENTAL MONITORING PROGRAMS FOR RADIOACTIVE WASTE MANAGEMENT AREAS

5.1 Program Overview

The Laboratory maintains an ongoing environmental surveillance program as required by DOE Order 5400.1 ("General Environmental Protection Program," November 1988). The surveillance program maintains routine monitoring stations for radiation and radioactive and/or materials at locations on Laboratory lands and in the surrounding environment. The goal of the program is to provide ongoing assessments of releases from overall Laboratory operations, including waste management, into the environment.

In addition to overall surveillance activities at the Laboratory, routine monitoring is carried out at 1 active and 12 inactive, low-level radioactive waste management areas under contract to the DOE's Defense Waste Operations Office. This program is carried out to ensure ongoing compliance with DOE Order 5820.2A. The goal of radioactive waste area surveillance is to assess the performance of these areas in containing residual radioactive materials within their boundaries. This program consists of routine surveys of management areas to assess year-to-year integrity of the sites and of

Fig. 27. Milestones for Liquid TRU Waste Management

Milestone	FY-1990												FY-1991				FY-1992				FY-1993				FY-1994			
	O	N	D	J	F	M	A	M	J	J	A	S	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q
1. Replacement Pretreatment Facility for Liquid TRU Wastes																												
Title II Design																												
Construction																												
Operations																												

Fig. 28. Milestones for TRU (and TRU mixed) Solid Waste Management (Page 1 of 2)

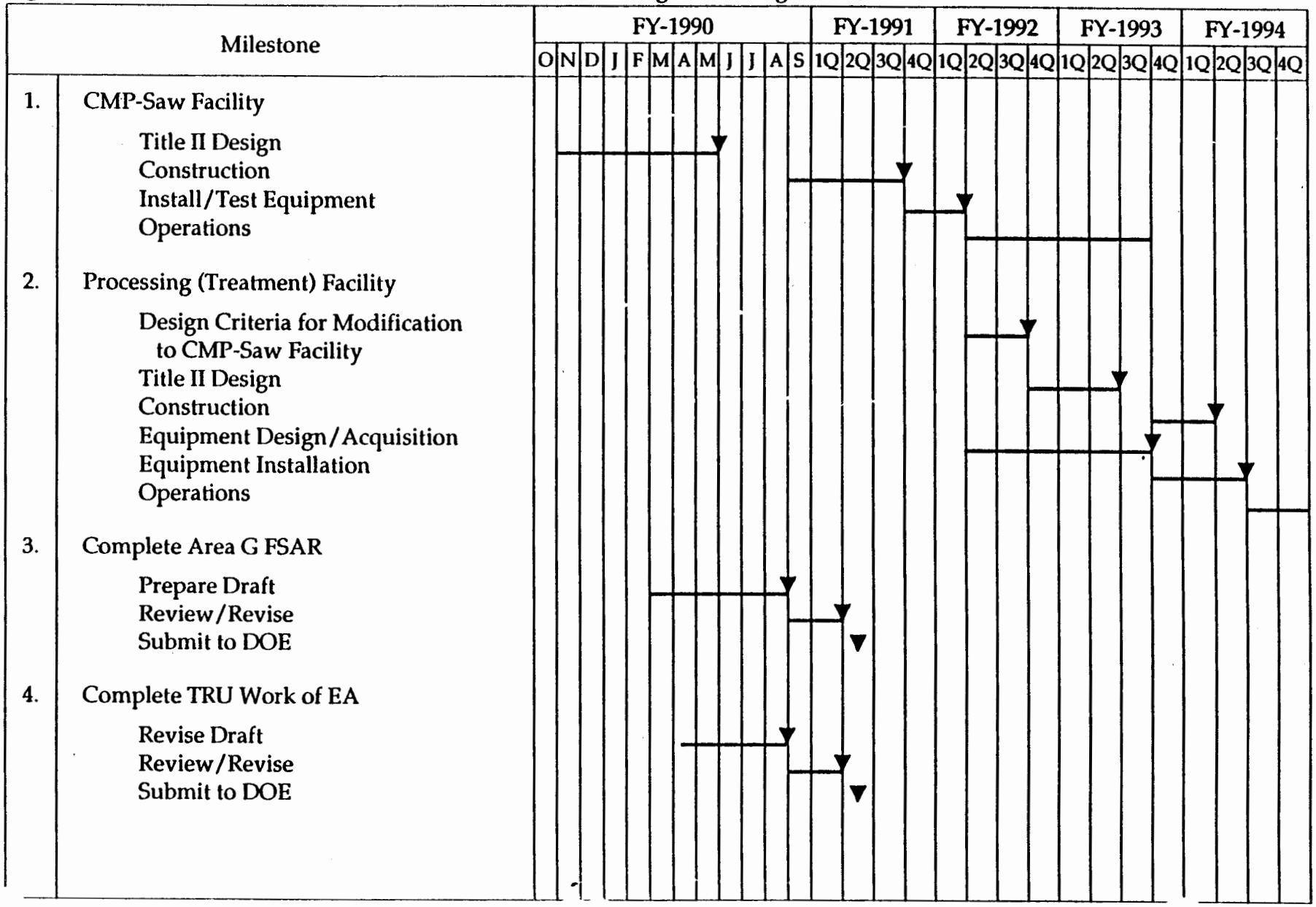

Fig. 28. Milestones for TRU (and TRU mixed) Solid Waste Management (Page 2 of 2)

	Milestone	FY-1990												FY-1991				FY-1992				FY-1993				FY-1994			
		O	N	D	J	F	M	A	M	J	J	A	S	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q
5.	RH-TRU Closeout																												
	Complete Cold System Test																												
	Complete Testing of RH Canister																												
	Initiate Filling of RH Canister with Waste																												
	Initiate Retrieval of Stored RH Waste																												
	Complete Project																												
6.	Restart CAI Operations for TRU Combustible Wastes																												

Fig. 29. Milestones for Low-Level Liquid Waste Management

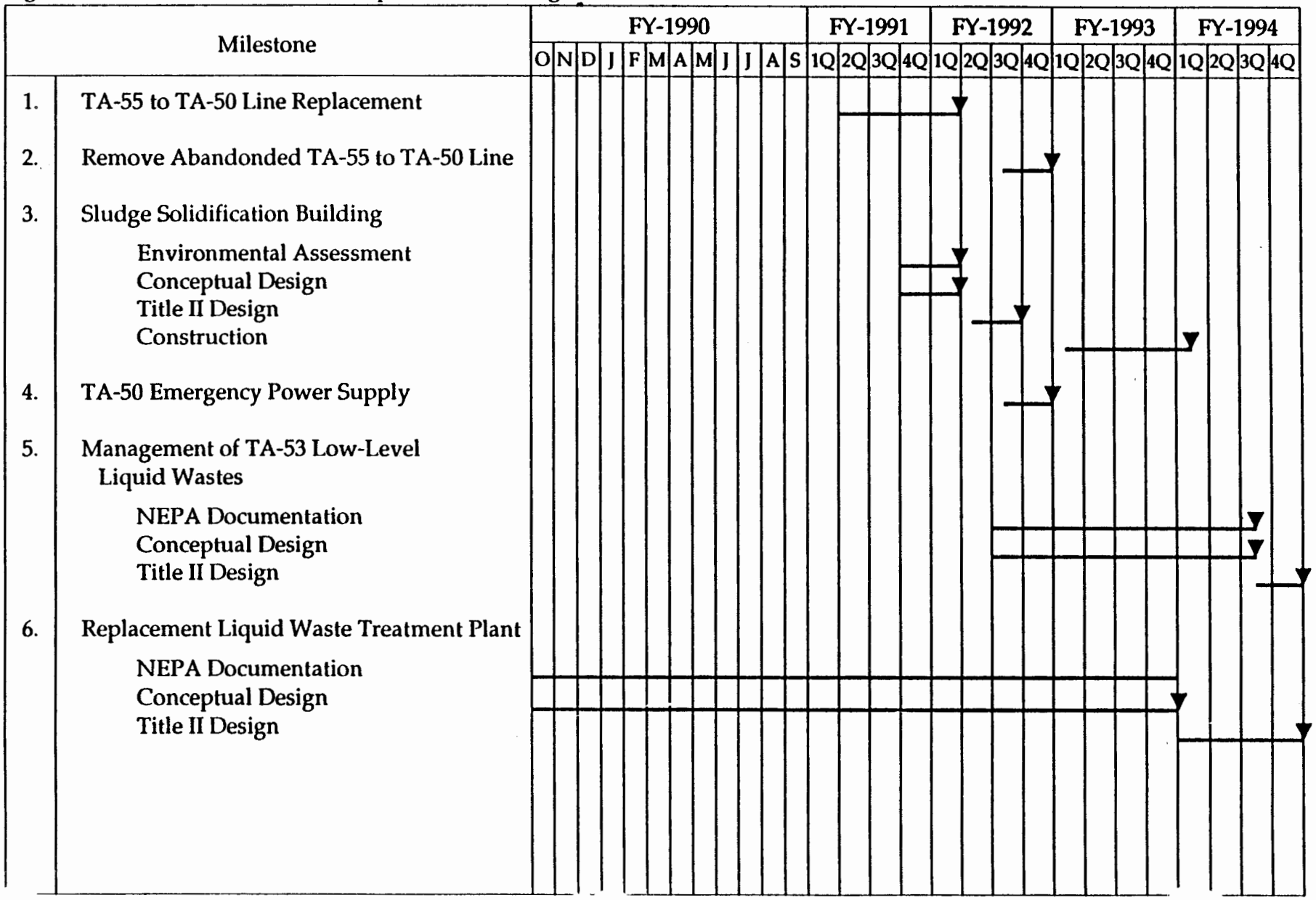

Fig. 30. Milestones for Solid LLW Management (Page 1 of 2)

	Milestone	FY-1990												FY-1991				FY-1992				FY-1993				FY-1994			
		O	N	D	J	F	M	A	M	J	J	A	S	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q
1.	Expand Area G Disposal Site																												
	Construct Fencing																												
	Resite Facilities																												
2.	Radiological Performance Assessment																												
	Complete Assessment																												
	Implement Recommendations																												
	Maintain Assessment																												
3.	Remediate Indian Ruins																												
4.	Construct Radioactive Waste Examination/Remediation Facility																												
5.	Construct New Compaction Facility																												
6.	Study of Waste Stabilization Technologies																												
7.	Study of Alternate Methods of Disposal																												
8.	Systems Performance Assessment																												
	Complete Assessment																												
	Implement Recommendations																												
	Maintain Assessment																												

Fig. 30. Milestones for Solid LLW Management (Page 2 of 2)

	Milestone	FY-1990												FY-1991				FY-1992				FY-1993				FY-1994			
		O	N	D	J	F	M	A	M	J	J	A	S	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q
9.	Implement QA Program																												
10.	LLW/Mixed LLW Incinerator																												
	Design																												
	Construction																												
	Operations																												
11.	LLW Certification																												
	Develop Program																												
	Implement Program																												
	Refine/Maintain Program																												

Fig. 31. Milestone for Mixed LLW Management (Page 1 of 2)

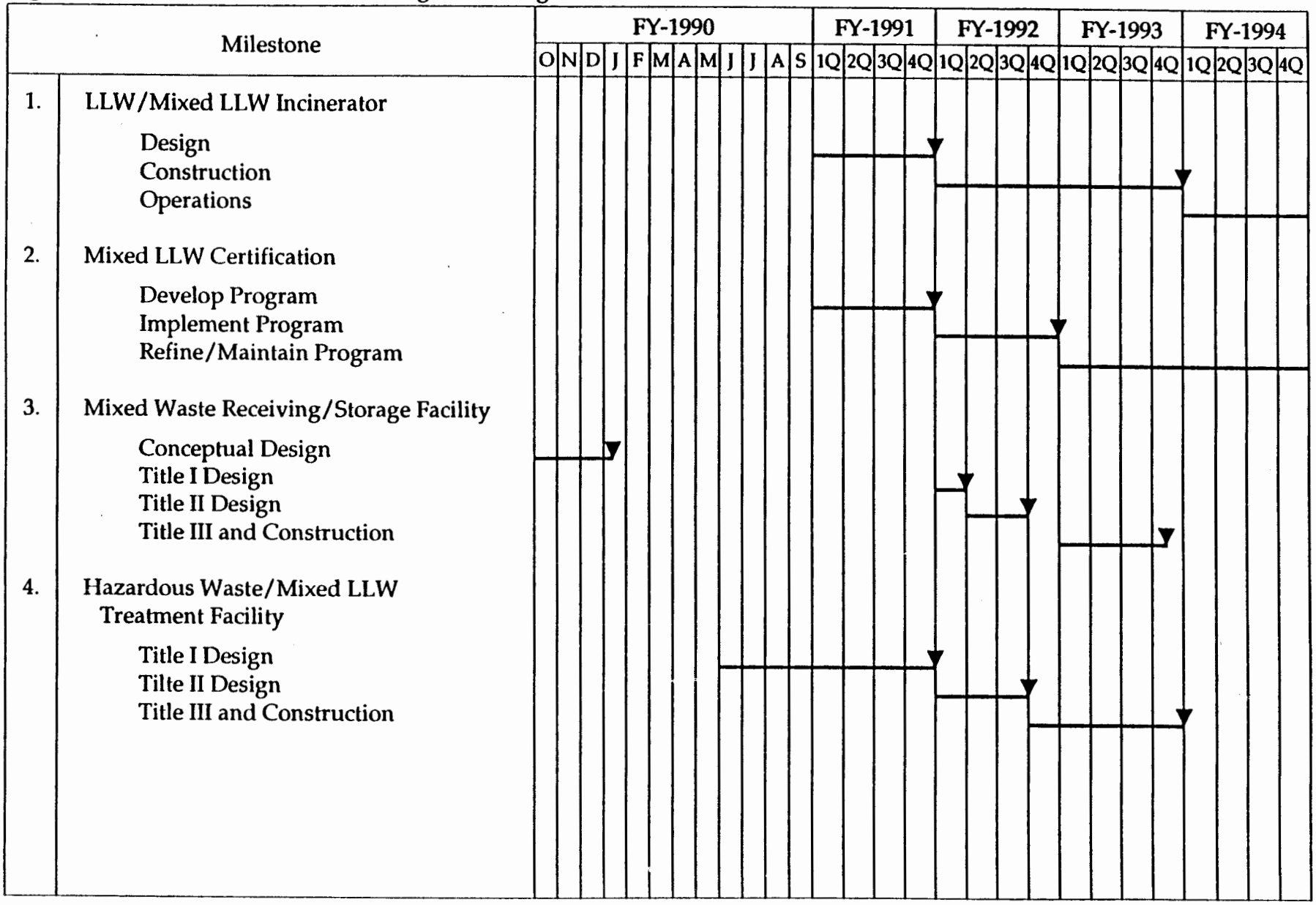

Fig. 31. Milestone for Mixed LLW Management (Page 2 of 2)

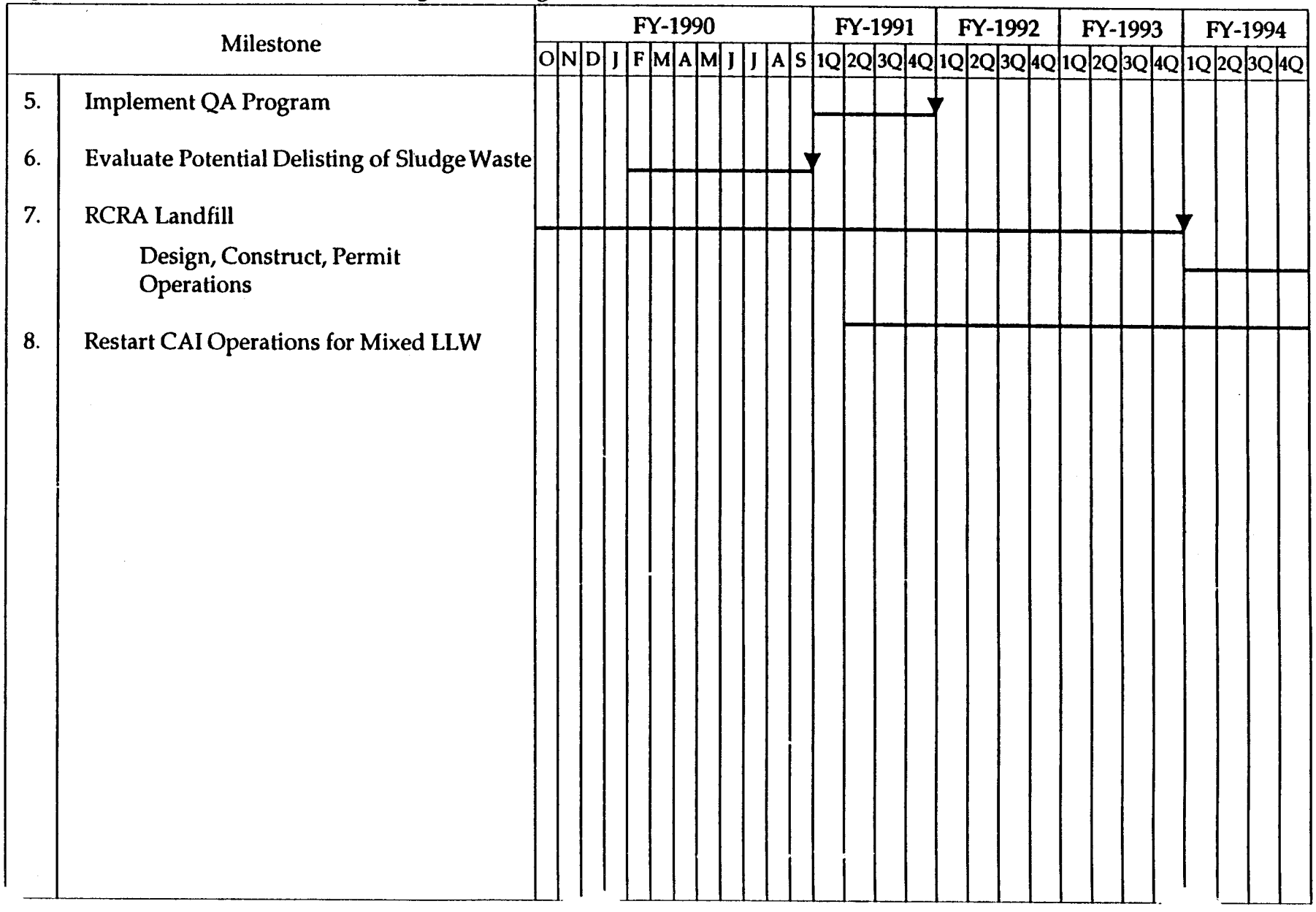

Fig. 32. Milestones for Hazardous Waste Management

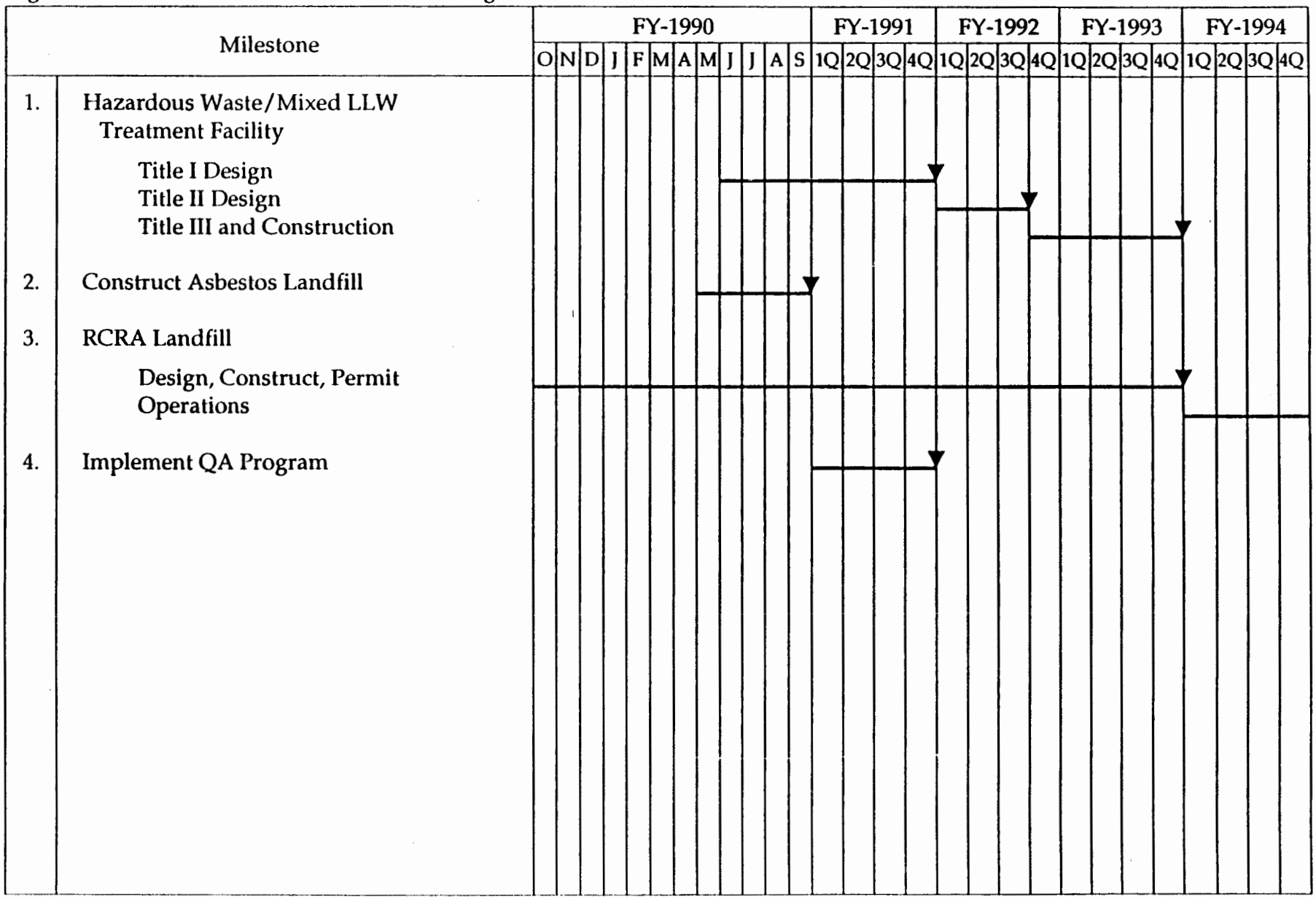

Table VII
Waste Management Costs and Funding Requirements
(page 1 of 4)

DSN	Activity title	Priority	New B&R	Total FY89	Total FY90	Total FY91	Total FY92	Total FY93	Total FY94	Total FY95
	CONTINUITY OF OPERATIONS									
4112	Decontamination	1 B	GF730201	1,110	996	1,770	1,858	1,951	2,048	2,151
4126	Waste management direct support	1 B		0	0	4,355	5,466	6,514	6,413	6,433
3058	Base program	1 B	GF730201	674	751	1,587	1,367	1,429	1,496	1,562
3059	Defense waste management operations	1	GF730101	2,166	1,119	1,540	2,262	1,588	1,667	2,270
4122	Safety analyses reports for new waste management facilities	3	GF730201	0	0	630	1,890	695	730	230
4113	Radioactive liquid waste	1 B	GF730201	777	796	1,357	1,600	1,800	2,000	2,000
3071	Radiological performance assessment for LLW disposal	2	GF730101	100	207	350	450	450	450	450
4121	Waste management NEPA documentation	1 B	GF730201	0	0	2,000	4,600	500	200	200
3105	Waste management technical support	1 B	GF730101	275	308	1,137	786	825	867	910
3061	LLW systems performance assessment	3	GF730101	0	103	185	263	205	205	205
3063	Mixed LLW analysis	1 B	GF730101	0	552	569	569	569	569	569
3060	LLW certification program	2	GF730101	0	343	489	404	905	905	905
3267	Biomonitoring for NPDES permit	1 B	GF730252	0	277	300	300	300	300	300
3268	Septic tank truck	1 B	35GF7302A	0	0	315	0	0	0	0
4123	Filter Test Facility support	2	GF730101	220	243	263	277	277	277	277
4116	State agreement	4	GF730201	0	0	400	900	350	350	350
3057	LLW radiological char. study	2	GF730101	0	104	0	0	0	0	0
3064	Mixed waste management certification	3	GF730101	0	70	191	600	600	600	600
3062	LL/Mixed/Hazardous waste QA program	3	GF730101	0	70	115	164	164	164	164

Table VII, continued
Waste Management Costs and Funding Requirements
(page 2 of 4)

DSN	Activity title	Priority	New B&R	Total FY89	Total FY90	Total FY91	Total FY92	Total FY93	Total FY94	Total FY95
3095	Compacting/Reducing/ Stabilizing LLW planning	3	GF730101	0	104	107	107	0	0	0
4119	TA-54 Indian ruin remediation	2	GF730101	0	0	230	460	230	230	230
4120	Below regulatory limits—alternative study of methods of waste disposal remediation	3	GF730101	0	0	300	450	0	0	0
	Subtotal—continuity of operations			*5,322*	*6,043*	*18,190*	*24,773*	*19,352*	*19,471*	*19,806*
	DISPOSAL									
4106	Radioactive Waste Examination/ Remediation Facility	2	39GF73019	0	0	0	1,200	0	0	0
3056	Asbestos and PCB	1 B	GF730298	425	578	815	1,563	898	898	898
3074	Low-level solid disposal	2	GF730198	939	629	1,402	1,847	1,453	1,453	1,453
3069	TA-54, Area G expansion	2	39GF7301F	575	367	0	0	0	0	0
3081	RCRA landfill operations	3	GF730298	0	0	0	0	1,500	1,500	1,500
41	Sanitary waste water sludge	1 B	GF730298	0	0	200	600	100	100	100
3262	Sanitary landfill	1 B	GF730101	0	0	0	0	100	400	0
	Subtotal—disposal			*1,939*	*1,574*	*2417*	*5,210*	*4,051*	*4,351*	*3,951*
	STORAGE									
3256	Mixed Waste Receiving and Storage Facility	3	39GF7302E	0	0	0	6,640	3,000	0	0
3084	Chemical waste management	1 B	GF730297	1,051	1,260	1,459	2,412	2,312	2,312	2,312
3079	Mixed LLW/TRU waste storage operations	2	GF730197	581	339	1,095	1,527	1,115	1,115	1,115
3086	Waste Oil and Storage Facility	3	39GF7301	0	0	980	50	0	0	0
	Subtotal—storage			*1,632*	*1,599*	*3,534*	*10,629*	*6,427*	*3,427*	*3,427*

Table VII, continued
Waste Management Costs and Funding Requirements
(page 3 of 4)

DSN	Activity title	Priority	New B&R	Total FY89	Total FY90	Total FY91	Total FY92	Total FY93	Total FY94	Total FY95
	TREATMENT									
3088	Chemical waste program	1 B	GF730296	2,529	4,320	4,821	3,878	3,519	3,519	3,519
4114	Radioactive liquid waste	1 B	GF730296	1,515	1,623	1,670	2,000	2,400	2,900	3,500
4111	Thermal destruction program	1 B	GF730296	681	872	1,374	2,282	2,094	2,214	2,432
3104	Defense waste management	1	GF730196	1,800	1,210	3,038	3,900	3,000	3,000	3,000
3099	Thermal destruction—TRU	1 B	GF730296	830	1,253	1,054	1,467	1,526	1,587	1,652
3098	TA-55 to TA-50 liquid waste line replacement	1 B	39GF7302D	0	985	7,000	0	0	0	0
4118	Remove abandoned TA-55 to TA-50 waste lines	2	GF730296	0	0	0	500	0	0	0
3091	Emergency power supply	1 B	39GF7302D	0	0	0	500	0	0	0
3100	TRU Waste Treatment Facility	3	35GF7301D	240	1,002	465	310	0	0	0
3075	Low-level waste compactor system	3	35GF7301D	0	367	750	250	0	0	0
3080	New Radioactive Liquid Waste Treatment Plant	3	39GF730296	0	0	0	500	500	2,000	20,000
3097	Radioactive liquid waste line, TA-53 to TA-50	4	39GF7302D	0	0	0	200	300	5,200	1,057
4107	Oralloy residue treatment and recovery	3	GF730296	0	0	0	1,783	1,200	1,200	1,200
3269	Geothermal site closing	1 B	GF730296	0	70	384	300	1,400	0	0
4117	RH TRU waste closeout	2	GF730252	350	0	350	250	0	0	0
	Subtotal—treatment			*7,945*	*11,702*	*20,906*	*18,120*	*15,939*	*21,620*	*36,360*

Table VII, continued
Waste Management Costs and Funding Requirements
(page 4 of 4)

DSN	Activity title	Priority	New B&R	Total FY89	Total FY90	Total FY91	Total FY92	Total FY93	Total FY94	Total FY95
	WASTE MINIMIZATION									
4124	Implementation	3	GF730252	708	677	756	1,045	924	1,034	1,141
4125	Planning	3	GF730252		181	185	185	185	185	185
	Subtotal—minimization			*708*	*858*	*941*	*1,230*	*1,109*	*1,219*	*1,326*
	Total			**17,546**	**21,776**	**45,988**	**59,962**	**46,878**	**50,088**	**64,870**

Table VIII
Contaminated Facilities Currently In Use
Page 1 of 2

Tech Area (Fig. 2)	Description	Locations Building #	Locations Dwg. #	Contamination Category[a]	Radioactive Contaminant(s)
TA-2	Omega Reactors	1	ENG-R 2409	M	FP, IA
TA-2	Stack Gas Valve	19	ENG-R 2409	M	FP, IA
TA-2	Equipment Building	44	ENG-R 2409	M	FP, IA
TA-2	Cooling Tower	49	ENG-R 2409	M	FP, IA
TA-3	Van de Graaff Lab	16	ENG-R 2414	L	T, IA
TA-3	CMR Building	29	ENG-R 2414	M	TRU, U, FP, IA, T
TA-3	Cryogenics Building	34	ENG-R 2414	L	T
TA-3	Press Building	35	ENG-R 2414	M	U
TA-3	Tech Shop, Room 42	39	ENG-R 2414	L	U
TA-3	Physics Laboratories	40	ENG-R 2414	L	T, TRU, FP, IA
TA-3	Source Storage Building	65	ENG-R 2414	L	Ra
TA-3	Sigma Building	66	ENG-R 2414	L	U
TA-3	Tech Shops	102	ENG-R 2414	L	U
TA-3	Rolling Mill Building	141	ENG-R 2414	L	U
TA-3	Liquid Waste Storage Facility	154	ENG-R 2414	M	TRU, U, FP, IA
TA-3	Shop Storage Facility	164	ENG-R 2414	S	TRU, U
TA-8	Betatron Building	23	ENG-R 2422	M	IA, FP, TRU, U
TA-8	Isotope Building	24	ENG-R 2422	S	IA
TA-8	Radiation Laboratory	26	ENG-R 2422	S	IA
TA-8	Nondestruct. Test Facility	70	ENG-R 2422	L	U
TA-9	Lab. Building (Rooms 119 & 120)	21	ENG-R 2424	L	T
TA-16	Assembly Building	410	ENG-R 2441	S	TRU, U, T
TA-16	Rest House	411	ENG-R 2441	S	TRU, U, T
TA-18	Assembly Bldg. (Kiva 1)	23	ENG-R 2446	M	U, IA
TA-18	Vault	26	ENG-R 2446	M	U, TRU
TA-18	Assembly Bldg. (Kiva 2)	32	ENG-R 2446	M	TRU, U, IA
TA-18	Assembly Bldg. (Kiva 3)	116	ENG-R 2446	M	TRU, U, IA
Ta-18	Reactor Subassembly Bldg.	129	ENG-R 2446	L	U

Table VIII
Contaminated Facilities Currently In Use
Page 2 of 2

Tech Area (Fig, 2)	Description	Location Bldg. #	Location Dwg. #	Contamination Category[a]	Radioactive Contaminant(s)
TA-18	Dynam. Crit. Assay Facil.	168	ENG-R 2446	M	U, FP, IA
TA-21	All Laboratory Buildings	–	ENG-R 5113	S-H	U, Pu, T, FP
TA-35	Laboratory Buildings	2	ENG-R 2462	S-H	FP, Pu, T
TA-35	Phase Separator Pit	3	ENG-R 5117	H	Am, FP, T, IA
TA-46	Lab Building (Ducts and Drains)	1	ENG-R 2480	M	U
TA-46	Test Cells No. 1 & 2	16	ENG-R 2480	M	U
TA-48	Laboratory Building	1	ENG-R 2483	H	TRU, U, FP, IA, T
TA-50	Waste Management Facilities	–	ENG-R 2493	M	TRU, U, FP, IA, T
TA-53	Accelerator Building	3	ENG-R 2500	L	IA
TA-54	Waste Disposal Site	–	ENG-R 5131	M	All
TA-55	Plutonium Facility	4		H	TRU
TA-59	Occupational Health	1		L	All

[a] H, M, and L indicate high, medium, and low levels of contamination.

DOE recommended classification criteria applied with addition of Suspect (S) category for facilities in which health physics surveys do not indicate contamination; however, a more intensive survey is advisable if a facility is removed or used for other purposes.

detailed surveys of one or two sites each year to provide more details knowledge about each site over a several year cycle. Reports on the results of these surveillance activities are released periodically.[12]

Samples for the low-level radioactive waste area surveillance program are collected from several media, including air, external penetrating radiation, ground and surface waters, soil and sediment, and vegetation. This sampling is carried out as an adjunct to the routine, site-wide sampling program.[13] Sampling locations are situated where residual radionuclides from the waste areas can be expected to be mobilized. Sampling and analytical procedures follow those carried out for the routine sampling operations.[14-15] Overall, more than 25 000 analyses for chemical and radiochemical constituents were carried out for environmental surveillance at the Laboratory during 1988

5.2 Environmental Status of Radioactive Waste Management at Los Alamos

A network of 92 thermoluminescent dosimeter (TLD) locations monitors external radiation levels at the Laboratory's low-level radioactive waste management areas these waste management areas are controlled-access areas and are not accessible to the general public. Averages at all sites but Management Area X have been larger than average off-site values. However, the ranges at most sites greatly overlap the ranges of values found at off-site stations. The extremes occur at Management Area G, the active radioactive waste area, and Management Area T, an inactive waste area, and are the result of past and present radioactive waste management activities. Elevated levels at Area G result from ongoing handling and storage of radioactive wastes prior to burial. A holding tank for radioactive liquid wastes and buried wastes from past operations have resulted in the high measurements at Area T.

Six air monitoring Stations have been maintained at the active radioactive waste management site Area G, TA-54, since 1984. These six stations are operated in the same manner as the air monitoring stations in the Laboratory's routine surveillance program.

Concentrations of airborne radionuclides at Area G tend to be higher than those found in off-site stations within 4 km of the Laboratory boundary. However, the differences are only statistically significant at one or two stations within Area G for a given radionuclide.

Monitoring of deep and shallow ground waters near waste management areas is carried out as part of the routine, site-wide surveillance program. Measurable amounts of radioactivity have been found in shallow aquifers in several canyons. This residual radioactivity is attributable principally to past and present discharges of liquid effluents with residual radionuclides into Acid-Pueblo, DP-Los Alamos, Sandia, and Mortandad canyons. Lesser contributions may be due to run-off from management areas A, B, T, U, and V into DP-Los Alamos canyon, and Area C into Mortandad Canyon. The shallow aquifer in Pajarito Canyon is unaffected by Laboratory operations, including those at Area G to the north. Sampling results indicate that the deep, potable aquifer has not been affected by waste management operations at the Laboratory.

The estimated 50-year committed dose to individual members of the public from waste management operations at the Laboratory of 0.12 mrem/yr effective dose equivalent is 0.12% of the DOE's standard of 100 mrem/yr for all pathways from waste management operations. The current waste management operations contribute only a small amount of the off-site dose received as a result of Laboratory operations and easily achieve the performance goals of DOE order 5820.2A.

5.3 Environmental Status of Hazardous Waste Management at Los Alamos

In response to a NMEID Compliance Order, a significant amount of work was initially done in 1985 and 1986 at Areas L and G and in adjacent Canyons to investigate the hydrogeology of the area and to determine the potential for hazardous waste constituent migration from the land disposal units to the regional aquifer. Chemical data from the core and pore gas analyses (and information obtained from vadose zone characterization) indicate that vapor phase migration is the dominant transport mechanism in these areas. This conclusion is based on the limited migration of metals and the presence of volatile organic vapors at depths of up to 100 ft. Metals contamination from the land disposal units was detected in only two samples at Area L. As a result of this early work, further investigations at these sites have continued.

Regulations under the Clean Water Act set water quality standards and effluent limitations. The two primary programs at the Laboratory to comply with the Clean water Act are the National Pollutant Discharge Elimination System (NPDES) and the Spill Prevention Control and Countermeasure (SPCC) program. The NPDES requires permits for nonradioactive constituents at all point source discharges. A single NPDES permit for the Laboratory authorizes liquid efluent sewage treatment outfalls. The Laboratory was within limits set by the NPDES permit in about 95 and 98% of the analyses done on samples collected for compliance monitoring at sanitary and industrial waste discharges, respectively. Chronically noncompliant discharges are being upgraded under and EPA/DOE Federal Facility Compliance Agreement.

Another NPDES permit authorizes liquid effluent discharge from the Fenton Hill Geothermal Project. This permit for a single outfall was issued to regulate the discharge of mineral-laden water from the recycle loop of the geothermal wells.

The SPCC program provides guidance for spill prevention, response, and cleanup of spills and requires preparation of an SPCC plan. The Laboratory has many elements that are required in an SPCC plan and has adopted a Laboratory-wide formal SPCC plan. During 1988, engineering designs were prepared for the provision of secondary containment structures at seven existing sites with major spill potential. All new construction is designed and constructed to anticipate potential spill problems.

The municipal and industrial water supply for the Laboratory and community is from 16 deep wells and 1 gallery (collection system fed be springs). The wells range in depth from 265 to 942 m (869 to 3090 ft).

The chemical quality of the water met EPA's National Interim Primary Drinking Water Standards (40 CFR 141) in 1988.

5.4 Future Directions

The Laboratory is currently reevaluating its surveillance program for the low-level radioactive waste management areas in light of the requirements of DOE Order 5820.2A. With the expansion of Area G, we are in the process of developing a more intense surveillance program for this, the active waste management area. We are also evaluating whether we will need to have more intense sampling around individual TRU waste storage sites at Area G. The surveillance program will sink several shallow boreholes in the vicinity of old pits at Area G in order to be able to better quantify the rates of migration, if any, from the waste sites into the adjacent tuff.

In addition, the Laboratory's surveillance program is initiating a radiological performance assessment of current and future waste management activities in accordance with DOE Order 5820.2A. This assessment will allow a judgement of whether the Laboratory's anticipated waste management activities can continue to meet DOE's performance goals for the protection of the public and will serve as a tool to aid in optimizing these activities.

6.0 RELATED WASTE MANAGEMENT ACTIVITIES

6.1 Decontamination and Decommissioning

6.1.1 Decontamination and Decommissioning: Identification and Description of Contaminated Facilities.

A ten-year decontamination/decommissioning (D&D) site plan was prepared for the Laboratory during 1977. From FY78-86, the following D&D work was done.

TA	FACILITY	ACTION
TA-42	Plutonium Incinerator Laboratory	Decommissioned
TA-21-153	Filter Building	Decommissioned
TA-35-2	Room 12A, Tritium Laboratory	Decontaminated
TA-35-7	Filter Building	Decontaminated
TA-35-43	Contaminated sodium tanks	Entombed
TA-35-2	LAPRE reactor vessel	Decontaminated
TA-21-2, -3, -4, and -150	Plutonium facilities	Decontaminated
TA-3	Old liquid waste collection system from TA-3 to TA-50	Partially decommissioned
TA-2	Water Boiler External Structures	Decommissioned
TA-4 & -5	Explosive test areas	Decontaminated

Excess contaminated facilities currently available for decommissioning and/or decontamination are described in the following sections.

TA-35, LAPRE Reactor Vessel. The vessel that housed the Los Alamos Power Reactor Experiment (LAPRE) II Reactor is buried under a paved area south of TA-35-2. It is activated and contains small amounts of uranium. It is excess and should be removed and buried at the disposal site for radioactive waste. The location has been marked, and no detectable radiation levels exist at the pavement surface. This site also is identified as radioactive waste burial Area X. The DOE Surplus Facilities Management Program (SFMP) provided site characterization funding in FY89 and will provide removal funding in FY90.

TA-2, Water Boiler Reactor. This experimental reactor was defueled in 1974, making the reactor and associated liquid and gaseous waste systems available for decommissioning. The reactor fuel form was enriched uranium-uranyl-nitrate solution, and the reactor vessel is highly contaminated with uranium, induced activity, and long-lived fission products. Gaseous waste transfer systems are moderately contaminated with fission products. The massive concrete biological radiation shields have low levels of induced activity.

Phase I, decommissioning the external structures, effluent stack lines, and delay tanks was done in FY85-86. Phase II, removal of the reactor vessel, biological shield, and interior equipment began in FY89, also with funding from DOE SFMP, and will be completed in FY90.

TA-52, UHTREX Reactor Facility. The Ultra-High-Temperature Reactor Experiment (UHTREX) is located at TA-52. The site is in limited use by the Energy Division. There are two main buildings. Building RD-1 is a composite, rectangular building with maximum dimensions of 40 m x 26 m (132 ft x 85 ft). It consists of the containment area and the areas outside the containment, which are the ground floor level, the operations level, and the basement level. The reactor was defueled around 1970. The building has hot-water heating; evaporative cooling and ventilation; electric, water, and sewer services, sanitary facilities; a fire detection system; a telephone conduit system; and a paging system. A vacuum cleaning system, breathing-air system, compressed-air system, and air-sampling system are also provided in some areas. Portions of the reactor are contaminated with fission products and induced radioactivity.

UHTREX auxiliary facilities also included in decommissioning plans are as follows:

TA	Facility
TA-52-2	Neutralizing and pumping station
TA-52-14	Filter pit
TA-52-15	Heat dump facility
TA-52-16	Heat dump pad

The exhaust stack (TA-52-7) will be removed after completion of the decommissioning work. Decommissioning operations on this facility began in FY88 and will end in FY90 with funding from the DOE SFMP.

TA-21, South End of Buildings 3 and 4. These two areas of TA-21, consisting of about 1000 m^2 (10 760 ft^2) of usable floor space, became available for decontamination in late FY84 when enriched uranium recovery operations ended. These uranium-contaminated structures and process systems received some safe-shutdown attention in FY88. Mothballing these buildings and/or continuing maintenance and surveillance over three to five years are expected until SFMP funding becomes available.

TA-3 CMR Building Wing 9. Phasing out the hot cells program at CMR Wing 9 has been in progress for several years. Spent fuel and fuel samples that have undergone storage and analysis at the facility are shipped to other locations: to SRP earlier for reprocessing and to Hanford more recently for disposal. DOE SFMP funding will permit removal of highly contaminated gloveboxed in FY90.

TA-35-3. Seven large tanks, associated ducts, and pipes at TA-35-3 are excess. They are contaminated with ^{90}Sr, ^{90}Y, ^{137}Cs, and ^{241}Am. Plans are to remove these tanks and decommission the structure with SFMP funding in FY93.

Facilities In Use. Radioactively contaminated facilities currently in use at Los Alamos are listed in Table VIII. Other Los Alamos land areas contaminated with radioactivity are listed in Table IX.

6.1.2 Projection of Waste Volumes from D&D Activities. Waste buried from D&D projects in recent years has amounted to about 33.5% of the total buried radioactive waste during this period (Table X). In CY89, about 12.5% of the total buried radioactive waste was from D&D projects.

6.1.3 D&D Plans and Priorities

The Decontamination/Decommissioning Site Plan describes facilities that are either surplus or expected to become programmatically inactive. The plan identifies, describes and justifies these as projects, addresses project alternatives, estimates D&D costs, and ranks projects according to priority. Entire surplus buildings with or without surplus equipment items, on-site land areas and building portions are considered as facilities. Currently, anticipated D&D wastes from future projects are identified in Table XI.

6.2 Training

On-the-job training and orientation are provided to all personnel in facility operations, equipment use, safety equipment, and emergency plans. This training is supplemented by radiation protection classes, classes in radioactive waste transportation and packaging, and applicable RCRA/OSHA training. Safety films and lectures are also provided quarterly. Training records are maintained in the files of the HSE Division Training Coordinator.

Table IX
Other Contaminated Areas

Identification/Description (Fig. 2)	Surface Area (acres)	Estimated radioactivity	Principal Radionuclides
Underground pits used for liquid disposal			
near TA-21-164 (Area U)	0.3	H	Po, Ac, Ra
TA-21-20 (dismantled laundry) between TA-21-14 and Waste Disposal Area B (Area V)	1.0	M	Pu, U
near TA-33-86 (Area K)	0.003	L	H-3
Outfall and disposal areas for liquid effluent			
TA-21 and DP-Los Alamos Canyon	11.1 (est.)	L	Pu, U, H3
TA-50, Mortandad Canyon, and Ten Site Canyon	2.2 (est.)	L	Pu
TA-53 lagoons	2.0	L	H-3
Septic Tanks			
TA-21, TA-33, TA-41, and TA-46			
Underground contaminated drain lines (Ref: Dwg. Eng-R 2404 and others in Ref. 12)			
HRL to ULR-60	Unknown	L	Pu, FP
Miscellaneous lines at TA-21	Unknown	H	Pu, Am, U
Miscellaneous lines at TA-3, SM-29	Unknown	H	Pu, Am, U
Jemez Rd., TA-3-703 manhole	Unknown	M	Pu, Am, U
Miscellaneous			
Dirt bunkers (4) at Ta-15-44, 45, E, and I-J firing points	Unknown	L	U
Underground chamber TA-33-29	0.7	L	Po (decayed)

Table X
Sources of Los Alamos Waste Volumes Buried (m^3)

Calendar year	Routine wastes (m^3)	D&D (m^3)	Total Volume (m^3)
77	2358	352	3710
78	2003	5501	7504
79	2214	2656	4870
80	2588	2167	4755
81	2883	2656	5539
82	2489	2046	4535
83	4264	1112	5376
85	3817	2832	6649
86	4467	0	4467
87	3563	163	3726
88	4306	394	4700
89	5574	796	6370
Total	**43484**	**21873**	**65357**

Table XI
Present and Future Los Alamos D&D Wastes

Tech Area	Project	FY	TRU Volume	LLW (m^3)	Type
TA-33-86	Decontamination of high-pressure tritium facility	89-90	0	100-200	Line removal, septic tank, and room equipment
TA-52	Decontamination of UHTREX reactor area	89-90	0	200-400	Steel vessels, piping
TA-36	LAPRE reactor	90	0	100-200	Steel vessels, piping, soil
TA-2-1	Decommissioning of water boiler reactor (Phase II)	89-90	0	200-400	Biological shield piping, conrete
TA-21-3, 4	Decommissioning of enriched uranium processing facility	88-93	100-200	1000-2000	Gloveboxes, hood piping, ducts, equipment
TA-3-29 (Wing 9)	Decommissioning of Wing 9, hot cell facility	90	25-50	1000-2000	Duct, piping, concrete, equipment

6.3 Safety and Emergency Preparedness

Emergency plans exist for each waste facility as a stand-alone document or as part of an SOP. HSE-Division and Laboratory-wide plans have also been prepared for large-scale accidents. These plans include the agreements made with external agencies, such as the local police department and hospital, and notification procedures for reporting an unusual occurrence as defined by DOE. The Laboratory has an Emergency Coordinator for large-scale incidents. An HSE-Division coordinator and on-call group personnel are also available during nonworking hours.

6.4 Quality Assurance

6.4.1 Program Overview

Quality assurance has become an integral part of all waste management activities. Specific procedures have been developed for the TRU Waste Certification Plan, the design and construction of new waste management facilities, the operation of existing waste management facilities, and the instruments and analysis techniques used for environmental surveillance. These procedures comply with DOE/AL Order 5700.6B. When non-conformances are found in an area, the appropriate corrective actions are taken.

Waste Management packages, transports, analyzes, monitors, processes, and appropriately disposes of radioactively and chemically contaminated wastes. Waste Management also does research, development, and demonstration studies to improve waste treatment methods, and performs decontamination and decommissioning. Developed using the basic requirements of ANSI/ASME NQA-1, the Waste Management Group quality assurance program plan (QAPP) defines the responsibilities, authorities, and requirements for the five sections in Waste Management currently covered by the quality assurance (QA) program.

6.4.2 Radioactive Waste

The TRU Waste Certification QA plan was developed specifically to meet the requirements of WIPP/DOE-120, "QA Requirements for Certification of TRU Waste for Shipment to the Waste Isolation Pilot Plant." WIPP/DOE-120 is modeled after ANSI/ASME NQA-1-1986.

The TRU Waste Certification QA plan is described fully in Section 3.0 of the Los Alamos TRU Waste Certification Plan (WCP-HSE7-CP-01) and applies only to the Los Alamos TRU Waste Certification Program. Reference to the requested quality related procedures may be defined in the waste generator's attachment to the Certification Plan, the generator's QAPP, or operating procedures, or may be quoted directly from Section 3.0 of the Certification Plan.

As noted in 3.1.3.2.2, Table IV, and Figure 30, a specific QA plan for LLW is scheduled to be developed during FY91. A closely parallel effort is the LLW certification program, identified to be developed in FY91 and

implemented during FY92. Funding for these activities is included in the Five Year Plan (DSN 3062 and 3060).

6.4.3 Mixed Waste

Quality assurance requirements for mixed TRU waste are included in the TRU waste certification program described above.

Quality assurance specific to mixed LLW will be implemented in parallel with the program identified above for LLW (see Fig. 31). Funding for these activities is included in the Five Year Plan (DSN 3062)

6.5 Waste Minimization

6.5.1 Program Description

In 1988, the Laboratory formed a section in HSE-7 to deal with efforts in waste minimization covering all categories of waste. The Generator Interface Section is composed of technical staff members who meet with generating groups and assist them in minimizing the waste generated in their operations. They also take the lead in minimization issues. They provide technical and engineering assistance, training and education, and support for temporary storage and disposal of hazardous waste. This section currently has two staff members, with one more scheduled to join in FY90. An initial Laboratory Waste Minimization Plan was developed and approved during FY89.

The Laboratory has several current and planned programs to minimize the waste generated by specific types of operations at the Laboratory.

Hazardous Waste Coordinators. The Laboratory has started a system of hazardous waste coordinators, who are members of groups that generate hazardous waste. They have specific responsibilities for dealing with waste, including temporary storage, inspection, and initiating disposal of hazardous waste. They also find waste-generating activities that can be minimized and work with the Generator Interface Section to resolve minimization problems. Efforts in FY90 will focus on strengthening and educating the coordinator system in the responsibilities and methods of waste management and minimization.

Education, Training, and Communication. The key to waste minimization is the education of the generators and those responsible for handling the waste. The Waste Generator Interface Team will continue to provide training, technical bulletins, and engineering support for minimization efforts.

Monitored Radioactive Liquid Waste Collection. A program to monitor the source of radioactive liquid waste and to discuss radioactive waste collection with the generating groups produced a 50% decrease in the amount of low-level radioactive waste that was generated. The awareness of the problem created a more conscientious effort to prevent unnecessary contamination of materials.

Certification of TRU Waste. Characterizing TRU waste for certification also raised awareness of what constituted a waste and decreased the waste generated by more than 50%.

6.5.2 New Initiatives

Ranking of Waste Streams. The Waste Interface Team will conduct an analysis of major waste generating operations and prioritize the waste streams by severity of hazard and volume. This information will then define which generating systems must be addressed first. Some streams have already been given high priority and are addressed in this section.

Purchasing Discipline. During FY90, the Laboratory will begin a policy of purchasing discipline. This policy will limit the number of people who can purchase chemicals and will require that they learn the economics of purchasing discipline.

Continuing Minimization of TRU Waste, Mixed Waste, and Low-Level Waste By Segregation. The Laboratory will continue its policy of minimizing the generation of radioactive wastes by segregation.

Continuing Conservation And Wastewater Discharge Policy. A new Laboratory policy specifies that all new system installations that use cooling water will make use of recirculating systems whenever possible. This policy is designed to reduce the amount of water used at the Laboratory.

Engineering Applications Research For Replacing And Recovering Halogenated Solvent. The Waste Generator Interface Team will begin research into the use of substitutes for halogenated hydrocarbons. This research will focus on the applicability of substitutes to specific uses, applications, and situations.

Paper Recycling. Beginning January 2, 1990, the Laboratory will begin recycling the waste paper it generates. The goal is to recycle 50% of the Laboratory's waste paper.

Gas Cylinder And Laboratory Chemical Recycling. The Waste Generator Interface Team is designing a system to recirculate gas cylinders and useable Laboratory chemicals within the Laboratory.

Recycling Depleted ^{238}U. There is a modification to the Ames process that is environmentally sound and shows promise in recycling uranium and thallium. The Waste Generator Interface Team is working with the patent holder on this potential solution for recycling the 1500 gal. of depleted ^{238}U.

Recovering Photographic Silver. The Laboratory continues to add electrolytic silver recovery systems to operations dealing with photographic development.

Machine Coolants. The Laboratory now recycles 100% of the machine coolants used in machine shop operations.

Recycle Used Oil. The Laboratory will continue to recycle used motor oil through Pan Am salvage.

6.6 Inspections and Audits

All equipment used in waste activities is routinely inspected. At Areas G and L, all pits, shafts, and fences are also inspected for any signs of damage or site intrusion. The incineration facility has an active inspection program

for tankage, piping, process components and waste containers being held for treatment. The program for the liquid waste treatment facility is under development and will be activated in the next year. All other facilities have an active inspection program.

6.7 Records and Reporting

Daily operating records are generated and maintained in accordance with DOE Orders 1324.2A and 5820.2A, as well as all other applicable Federal and State regulations. The following information is recorded as it becomes available:

- Description and quantity of each waste received and the method and date of storage or disposal;
- Reports and results of inspections and audits;
- Reports of unusual occurrences; and
- Monitoring, testing, and analytical data.

Reports required are the following:

- Biennial USEPA/NMEID Hazardous Waste Generation and Management Report;
- Monthly activity report to DOE/LAAO;
- Annual report of radionuclides discharged in liquid effluents;
- Monthly progress report for the Defense Operations Program;
- Annual reports on Laboratory LLW and TRU operations; and
- Ad hoc data requests from sources such as DOE/AL, the State of New Mexico, WIPP, and other DOE facilities; and Congressional personnel.

The laboratory maintains ongoing records for tracking RCRA, TSCA, nonregulated chemical wastes, and mixed wastes; training records; various records to satisfy DOE Orders 5489.2A. 5480.5, and 5484.1 and to satisfy EPA regulations; radioactive Solid Waste Disposal Forms; and Certified Waste Storage Records for TRU waste. Except for inspection and audit reports, all records will be retained permanently. Inspection and audit records are held for three years.

6.8 Unusual Occurrences

Unusual occurrences are reported to DOE according to the existing notification schedule. No unusual occurrences in waste management occurred in FY89.

6.9 Closure and Post-Closure

General Closure/Post-Closure Information. This plan identifies all steps necessary to close a facility at the end of its operating life or to partially close a facility at any point during its intended operating life. Waste treatment, storage, and disposal operations at the Laboratory consist of chemical treatment, compaction, size reduction, controlled air incineration, storage, and landfill disposal.

Closure Performance Standard. The closure plans are designed to

- Protect human health and the environment and
- Prevent waste, waste constituents, leachate, from contaminating the ground, surface waters, or atmosphere.

Partial and Final Closure. Except as indicated below, the Laboratory's hazardous waste facilities are to be closed in the year 2100. All on-site hazardous wastes will be recycled, treated, and/or disposed of before closure.

Treatment facilities may be partially closed to upgrade facilities so that they can handle new wastes or use new technology. Closure of individual landfill shafts or pits at Area G for radioactive waste is ongoing and is performed as they are filled. Closure plans have been submitted to the EPA and NMEID for the following areas:

TA-3-102	Closure of >90 day storage facility
TA-16, Area P	Closure of chemical landfill facility
TA-22-24	Closure of >90 day storage facility
TA-35, Surface Impoundments	Closure of surface impoundments (Project initiated 1989.)
TA-40-2	Closure of >90 day storage facility
TA-40-SDS	Closure of thermal treatment facility
TA-54, Area H	Closure of chemical landfill facility
TA-54, Area L	Closure of chemical landfill facility

(Area L will continue as a storage/treatment site.)

TA-54, Area G Closure of chemical landfill facility
(Area G will continue as a radioactive LLW landfill for the next 25-30 years.)

These closures will be done within the next five years. All other closure plans for chemical facilities are provided in the RCRA Part B permit application.

Ground-Water Monitoring. In accordance with the provisions of hazardous chemical waste regulations, the Laboratory has applied for a ground-water monitoring waiver for TA-54. Ground water monitoring is applicable only to the Laboratory's landfill operations. The waiver request is based on the determination that average annual precipitation is equaled or exceeded by runoff and evapotranspiration resulting in negative percolation rates.

Personnel Protection. Good industrial hygiene practices must be followed during all phases of closure and post-closure to protect employees from exposure to waste constituents. Normal Laboratory operating procedures require that the Laboratory's Industrial Hygiene Group, HSE-5, and Radiation Protection Group, HSE-1, survey a site before personnel entry and specify protective clothing and respiratory protection equipment.

Post-Closure Care Office. Contact the following concerning the facility during the post-closure care period:

Area Manager
Los Alamos Area Office
U.S. Department of Energy
Los Alamos, New Mexico 87544
(505) 667-5105

Security. Low-level radioactive wastes have been handled and buried at TA-54. TA-54 will therefore be under the permanent care of the DOE or other authorized federal agency. Fences and site security will be maintained in perpetuity to prohibit public access and to meet DOE requirements for radiation protection.

REFERENCES

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2. Los Alamos National Laboratory, The Laboratory Manual, Chapter 1, Health and Safety.

3. L. A. Stretz, L. C. Borduin, W. E. Draper, R. A. Koenig, and J. M. Newmyer, "Radioactive Waste Incinerator Studies at the Los Alamos Scientific Laboratory," American Nuclear Society Annual Meeting, Las Vegas, Nevada (1980).

4. J. L. Warren and A. E. Dross, "Final TRU-Waste Inventory Work-Off Plan," Los Alamos National Laboratory report LA-UR-862932 (December 1986).

5. L. A. Emelity, C. W. Christenson, and W. H. Kline, "Operational Practices in the Treatment of Low- and Intermediate-Level Radioactive Wastes: Argonne and Los Alamos Laboratories, United States of America," Proceedings of Symposium on Practices in the Treatment of Low- and Intermediate-Level Radioactive Wastes 187 (IAEA, Vienna, 1966).

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7. L. A. Emelity and C. W. Christenson, "Processing of Plutonium Contaminated Liquid Wastes at Los Alamos," Symposium on Safety in Plutonium Handling Facilities, Rocky Flats Division, DOW Chemical Company, Golden, Colorado (1971).

8. L. A. Emelity, J. R. Buchholz, and P. E. McGinnis, "Review of Radioactive Liquid Waste Management at Los Alamos," Symposium on Management of Low-Level Radioactive Waste, Atlanta, Georgia (1977).

9. C. W. Christenson and L. A. Emelity, "Chemical Treatment and Cement Fixation of Radioactive Waste," 42nd Annual Conference on the WPCA, Fallas, Texas (1969).

10. L. A. Emelity and C. W. Christenson, "Replacement of an Old Treatment Plant, a Design Based on Experience," Symposium on Developments in the Management of Low-Level and Intermediate-Level Radioactive Wastes, IAEA, Aixen-Provence, France (1970).

11. Los Alamos National Laboratory Manual, "On-Site Transportation."

12. Environmental Science Group, Environmental Surveillance Group, Health and Environmental Chemistry Group, Waste Management Group, "Environmental Surveillance of Low-Level Radioactive Waste Management Areas at Los Alamos During 1986," Los Alamos National Laboratory Report LA-UR-87-4121 (December 1987).

13. Environmental Surveillance Group, "Environmental Surveillance at Los Alamos During 1988," Los Alamos National Laboratory Report LA-11628-ENV (June 1989).

14. Environmental Surveillance Group, "Quality Assurance Project Plans," Los Alamos National Laboratory Report LA-UR-1076 (February 1987).

15. M. A. Gautier, E. S. Gladney, M. Phillips, and B. T. O'Malley, "Quality Assurance for Health and Environmental Chemistry: 1988," Los Alamos National Laboratory Report LA-11637-MS (October 1989)

Appendix I

Waste Management Documentation Requirements

1. Chapter I: High-Level Waste

The Laboratory does not generate, store, treat, or dispose of high-level waste. Consequently, there are no documentation requirements.

2. Chapter II: Transuranic Waste

a. Paragraph 3c (3)

Los Alamos National Laboratory, "Los Alamos TRU Waste Certification Plan for Newly Generated TRU Waste," Revision 4 (October 1988). See attached table for identification and status of Plan Attachments that address specific TRU waste streams.

b. Paragraph 3g (2) (h)

We have not yet issued, and have no current schedule to prepare, a closure plan for TRU interim storage facilities. Preparation is pending future negotiation with the State of New Mexico/Environmental Protection Agency following receipt by the State of mixed waste authorization, and resolution of WIPP operating schedules.

c. Paragraph 3 (i)

Buried Transuranic Contaminated Waste Program activities at Los Alamos have been incorporated into the overall Environmental Restoration (ER) program. As such, supporting documentation includes the following:

- Comprehensive Environmental Assessment and Response Program Phase I Report, submitted to EPA October 1987.
- Solid Waste Management Units Report, submitted to EPA December 1988.
- Installation Waste Plan, in preparation, with an anticipated submission date to EPA on September 1990.

3. Chapter III: Low-Level Wastes

a. Paragraph 3b (1)

W. J. Wenzel, W. D. Purtyman, J. M. Dewart, and J. C. Rodgers, " Los Alamos Low-Level Waste Performance Assessment Status," Los Alamos National Laboratory Report LA-10768-MS (June 1986).

A revised and extensively more detailed radiological performance assessment is currently underway. See 3.1.2.2.3, Table IV, and 4.1, Figure 30, for schedule of completion.

b. Paragraph 3e (1)

Low-Level Solid Waste Disposal

Los Alamos National Laboratory, The Laboratory Manual, Chapter 1, Administrative Requirement 10-2, "Low-Level Radioactive Solid Waste" (October 1988).

Revised acceptance criteria will be developed following completion of the radiological performance assessment. See 3.1.2.2.3, Table IV, for schedule of completion.

Low-Level Liquid Waste Treatment

Los Alamos National Laboratory, The Laboratory Manual, Chapter 1, Administrative Requirement 10-1, "Radioactive Liquid Waste" (October 1988).

c. Paragraph 3e (3)

See 3.1.2.2.3, Table IV, and 4.1, Figure 30, for schedule of developing and implementing low-level certification program.

d. Paragraph 3g (2)

Not applicable.

e. Paragraph 3i (4) (d)

Not anticipated. Not applicable.

f. Paragraph 3i (8)

No new disposal sites are anticipated. Current active sites covered under Laboratory EIS.

U.S. Department of Energy, "Final Environmental Impact Statement, Los Alamos Scientific Laboratory Site, Los Alamos, New Mexico" DOE/EIS-0018 (December 1979).

g. Paragraph 3j (1)

Closure plans not yet developed. See 3.1.2.2.3, Table IV for schedule.

4. Decommissioning of Radioactively Contaminated Facilities

a. Paragraph 3a (1)

Jurisdictional program responsibility for all contaminated facilities has not yet been documented, but will be addressed through implementation of Chapter 5 of DOE Order 5820.2A.

b. Paragraph 3c (1)

Post-operational documentation for decontamination/ decommissioning is maintained in the Laboratory's Engineering Department. The schedule for decommissioning contaminated facilities is cited in the Laboratory's Five Year Plan.

c. Paragraph 3d (3)

Decommissioning Project Plans for current projects include:

1. TA-52 UTHREX Reactor Decommissioning Project Management Plan, issued February 1989.

2. TA-2 Water Boiler Reactor Decommissioning Project Management Plan, issued June 1989.

The project management plan for decommissioning the LAPRE II Reactor will be completed in FY90.

d. Paragraph 3d (5)

Final radiological and chemical survey reports and project final reports for the three projects listed in paragraph 2d (3) have not been issued. They will be completed in FY90.

Table A-1
LANL TRU Waste Certification Plan Attachments Status
September 30, 1989

	Attachments	Waste Form	Effective Date	Status of Waste Streams
#1	WCP-HSE7-AT-01, R3 Size Reduction Facility (TA-50)	001	September 7, 1988	Certified TRU waste per WACCC field audit (May 1987).
#2	WCP-HSE7-AT-02, R1 Liquid Waste Treatment (TA-50)	002	March 1986	Certified TRU waste per WACCC field audit (May 1987). R2 at WACCC.
#3	TRU-MST12-CPA-03, R00 MST-DIV-Combustible/Noncumbustible (TA-55)	004, 005	July 1988	Certified TRU waste per WACCC field audit (March 1989/W89-3).
#4	ANC-QP-1-5, R1 CLS-Combustible/Noncombustible (CMR)	004, 005	July 1987	Certified TRU waste per WACCC field audit (March 1989/W89-3).
#5	WCP-HSE7-AT-05, RA Stored Waste (TA-54)	002, 003, 004, 005	TBD	Rough Draft of RB
#6	TRU-MST12-CPA-06, R00 MST-DIV-Process Residue (TA-55)	006	August 1987	Certified TRU waste per WACCC field audit (March 1989/W89-3).
#7	TRU-MST14-CPA-07, R0 Remote and contact handled wastes from hot cell operations (CMR)	007, 004, 005	October 1987	R1 to.WACCC for approval.
#8	WCP-HSE7-AT-08, R0 Cemented Incinerator Ash (TA-50, TDF)	008	TBD	TBD
#9	TRU-MST12-CPA-09, R00 MST-DIV-PU-238 Combustible/ Noncombustible (TA-55)	004, 005	TBD	TBD (may be incorporated into Attachment #3).
#10	WCP-ITRI-ATT-01, R1 Inhalation Toxicology Research Institute (ITRI)	004, 005	September 1984	No waste received at this time (not approved by the WACCC).
#11	TBD			
#12	WCP-HSE7-AT-12 CMP Saw	TBD	TBD	TBD
#13	WCP-HSE7-AT-13 Dewatered Sludge (TA-50)	003	TBD	Rough draft of R0.

TBD = To be defined/developed

APPENDIX C

Maps of Topography, Wetlands, and Drainage Patterns for Los Alamos County

WETLANDS MAPPING

1.0 Introduction

Four federal agencies are principally involved with wetland identification and delineation: Army Corps of Engineers (COE), Environmental Protection Agency (EPA), Fish and Wildlife Service (FWS), and Soil Conservation Service (SCS). The COE and EPA are responsible for making jurisdictional determinations of wetlands regulated under Section 404 of the Clean Water Act. Under Section 404, the Secretary of the Army, acting through the Chief of Engineers, is authorized to issue permits for the discharge of dredged or fill materials into the waters of the United States, including wetlands. The FWS has been involved in a nationwide identification of wetlands through the National Wetlands Inventory (NWI). The SCS becomes involved with determinations through the "swampbusters" provision of the Food Security Act of 1985 (Army Corps of Engineers et al. 1989).

Under the Resource Conservation and Recovery Act (RCRA) and the Hazardous and Solid Waste Amendments (HWSA) Module of Los Alamos National Laboratory's (Laboratory's) operating permit, the EPA required a determination of all wetlands within the watershed of lands owned by the US Department of Energy (DOE). Consequently, a project to map and characterize those wetlands was undertaken. The wetlands mapping was done by the FWS in accordance with the NWI. This inventory includes all wetlands and deepwater habitats throughout the United States, including rivers, lakes, streams, marshes, bogs, and ponds. The NWI meets four long-range objectives set forth by the FWS: (1) to describe ecological units that have certain homogeneous natural attributes, (2) to arrange these units in a system that will aid decisions about resource management, (3) to furnish units for inventory and mapping, and (4) to provide uniformity in concepts and terminology throughout the United States (Illinois Department of Conservation 1988).

Under Section 404 of the Clean Water Act, a wetland is defined as "those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions." Wetlands include swamps, marshes, bogs, and similar areas. This definition emphasizes hydrology, vegetation, and saturated soils. In addition, Section 404 regulates other "waters of the United States" such as open water areas, mud flats, coral reefs, riffle and pool complexes, vegetated shallows, and other aquatic habitats.

The FWS, in cooperation with other federal and state agencies, private organizations, and individuals, developed a wetlands definition for conducting an inventory of the nation's wetlands. This definition was published by Cowardin et al. (1979). In the NWI, wetlands are defined as "lands transitional between aquatic and terrestrial systems where the water table is usually at or near the surface, or the land is covered by shallow water." In addition, the definition requires that the land support predominantly hydrophytes and that the substrate be undrained hydric soils (Federal Manual for Identifying and Delineating Jurisdictional Wetlands, 1989).

2.0 National Wetlands Inventory Maps

The NWI maps produced by the FWS are designed only to provide guidance and are not meant to define the limits of proprietary jurisdiction or to establish the geographic scope. The maps are prepared primarily by stereoscopic analysis of high-altitude aerial photographs. Wetlands are identified on the photographs based on vegetation, visible hydrology, and geography.

The NWI mapping protocol is hierarchical and structured around a combination of ecological, hydrological, and substrate characteristics, which is consistent throughout the United States. The system consists of five components: marine (open ocean and associated coastline); estuarine (salt marshes and ponds); lacustrine (lakes and deep ponds); riverine (rivers, creeks, streams); and palustrine (shallow ponds, marshes, swamps, bogs). The system proceeds in a hierarchical manner through subsystem, class, and subclass. There are also modifiers that describe the degree of wetness (water regime), water chemistry, soil, and man-made changes (diking, draining, etc.).

At Los Alamos, the wetlands mapping was done by personnel in FWS Region 2, Albuquerque, New Mexico, using US Geological Survey quadrangle maps as base maps and infrared high-altitude aerial maps. To cover all the watershed dissecting the Laboratory, five quadrangles were mapped (Frijoles, White Rock, Guaje, Valle Toledo, and Puye). In addition to the watershed of the Laboratory proper, the Seven Springs quadrangle, the location of the Fenton Hill Geothermal Site, was mapped.

3.0 Results

The NWI maps are broad in scope and are meant to provide guidance but not proprietary jurisdiction. The NWI maps all wetlands without emphasis on any particular type or location and is not restricted to wetlands regulated by federal, state, or local regulatory agencies. The aerial maps typically reflect conditions during the specific year and season they were taken. A detailed on-the-ground and historical analysis of single sites is being undertaken by personnel in the Environmental Protection Group (HSE-8) to delineate and characterize individual wetlands.

No perennial streams traverse the Laboratory lands. Wetlands within the boundaries are primarily within two classifications: palustrine and riverine. Large palustrine wetlands (ponds and marshes) were identified in Sandia, Pajarito, and Pueblo canyons and small ones in other parts of the Laboratory. Wetlands within Sandia and Pueblo canyons are primarily maintained by effluent releases. Ephemeral and intermittent stream beds that traverse the Laboratory were classified as temporarily flooded riverine wetlands.

4.0 Future Studies

Because the NWI maps are broad in scope and are not restricted to wetlands regulated by federal, state, or local regulatory agencies, a more detailed delineation of each wetland has

been undertaken to determine jurisdictional status. During the summer of 1990, palustrine wetlands in Pajarito and Sandia canyons were characterized and delineated. In addition, use of the wetlands by various plant and animal species is being monitored. Because of the importance of these palustrine wetlands to diversity in plant and animal life, they will continue to be monitored for more than 1 year to provide baseline data to determine change related to Laboratory activities.

In addition to monitoring the palustrine wetlands, riverine wetlands throughout the Laboratory will be characterized and delineated within the next 5 years as part of the environmental restoration (ER) RCRA facility work plans. Most wetland mapping will be associated the the ER operable unit for the canyons system. The first step in characterization is to make an inspection of each canyon system from the headwaters to the Rio Grande, mapping small wetlands and delineating the boundaries.

REFERENCES

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User's Guide. National Wetlands Inventory, 1985. National Wetlands Inventory, Information and Legend for Map Products.

APPENDIX D

100-Year Floodplain Map for Los Alamos National Laboratory

100-YEAR FLOODPLAIN MAPS
FOR LOS ALAMOS NATIONAL LABORATORY

The requirement to define all 100-year floodplains for major watersheds within Los Alamos National Laboratory (Laboratory) was formally established in May 1990 by the Hazardous and Solid Waste Amendments (HSWA) of the Resource Conservation and Recovery Act (RCRA) operating permit. Since 100-year floodplain maps do not exist, the Laboratory must generate them for the entire facility. The computational methodology used to define these floodplains conforms to all requirements specified in 40 CFR 270.14(b)(11)(iii). The US Army Corps of Engineers (COE) Hydrologic Engineering Center (HEC) computer models HEC-1 (Flood Hydrograph Package) and HEC-2 (Surface Water Profiles) have been used to complete this task. These models are recognized as standard industrial and regulatory compliance tools for ungaged watersheds.

The HEC-1 computer code simulates the rainfall-runoff process in a given watershed and produces a stream discharge hydrograph in response to a single-storm hyetograph. The HEC-2 model utilizes the peak discharge from this hydrograph, along with known floodplain geometry, to hydraulically compute water surface profiles. These computed profiles at numerous cross sections along a stream channel define the 100-year floodplain. The HEC-2 model input data consist of digitized stream channel topographic information that has been automatically extracted from the Laboratory's AUTOGIS MOSS mapping system using software developed specifically for this task. After the HEC-2 simulations had been completed, the 100-year floodplain definitions for each major watershed were automatically entered back into the MOSS system. The floodplain definitions are specified in standard New Mexico state plane map coordinates.

A single map is enclosed with a scale of 1:2000 showing all 100-year floodplain areas; however, scale maps at 1:400, or smaller, will be developed using the MOSS system. Floodplain definitions will be archived into the MOSS mapping system for future reference. In addition, a comprehensive report will document individual HEC-1 and HEC-2 model input data for each watershed. Explanations of data utilized in these simulations will be documented, and all assumptions will be justified by citing the professional literature. All appropriate records, including model input data files, will be maintained in the Environmental Restoration (ER) Program Facility for Information Management, Analysis, and Display (FIMAD) for future reference and will be made available to the Department of Energy (DOE), Environmental Protection Agency (EPA), and the New Mexico Environmental Improvement Division (NMEID).

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US Army Corps of Engineers, 1981, HEC-1 Flood Hydrograph Package, "Users' Manual for Computer Program 723-X6-L2010," The Hydrologic Engineering Center, Davis, California.

US Army Corps of Engineers, 1982, HEC-2 Water Surface Profiles, "Users Manual for Computer Program 723-X6-L202A," The Hydrologic Engineering Center, Davis, California.

Table D-1. Major Watersheds Draining the Eastern Boundary of Los Alamos National Laboratory

NAME	LABORATORY FACILITIES WITHIN WATERSHED
BARRANCAS CANYON	None, crosses DOE land
BAYO CANYON	None, crosses DOE land
LOS ALAMOS CANYON Pueblo Canyon Tributary	Historic Sites; TAs-2, -41, -43, -21, and water supply wells
SANDIA CANYON	TAs-3, -53, municipal landfill and water supply wells
MORTANDAD CANYON	TAs-48, -55, -42, -50, -35, and -5
CAÑADA DEL BUEY	TAs-5, -52, -46, -51, -54, and water supply wells
PAJARITO CANYON Two-Mile Canyon Tributary Three-Mile Canyon Tributary	TAs-6, -8, -9, -22, -40, -58, -3, -59, -18, -36, -54, -51, -52, -46, and a water supply well
WATER CANYON Cañon del Valle Tributary Potrillo Canyon Tributary Fence Canyon Tributary	TAs-16, -28, -11, -37, -9, -14, -15, and -36
ANCHO CANYON Tributary at State Route 4 Tributary near Rio Grande	TAs-33 and -49
CHAQUEHUI CANYON	TA-33

APPENDIX E

Well Locations in Los Alamos County and Adjacent Locales

(Large-scale map enclosed.)

APPENDIX F

Action Level Criteria for Determining Further Actions for, or the Presence of, Releases from Solid Waste Management Units at Los Alamos National Laboratory

The following are the health and environmental assessment action level criteria tables discussed in Section 3.5.2.2. Table F-1 presents the maximum contaminant levels (MCLs) promulgated under the Safe Drinking Water Act. Table F-2 presents human-health-based criteria for systemic toxicants (EPA 1989).

TABLE F-1 MAXIMUM CONTAMINANT LEVELS (MCLs) PROMULGATED UNDER THE SAFE DRINKING WATER ACT *

Chemical	CAS No.	MCL (mg/l)
Arsenic	7440-38-2	0.05
Barium	7440-39-3	1.0
Benzene	71-343-2	0.005
Cadmium	7440-43-9	0.01
Carbon tetrachloride	56-23-5	0.005
Chromium (hexavalent)	7440-47-3	0.05
2,4-Dichlorophenoxy acetic acid	94-75-7	0.1
1,4-Dichlorobenzene	106-46-7	0.075
1,2-Dichloroethane	107-06-2	0.005
1,1-Dichloroethylene	75-35-4	0.007
Endrin	72-20-8	0.0002
Fluoride	—	4
Lindane	58-89-9	0.004
Lead	7439-92-1	0.05
Mercury	7439-97-6	0.002
Methoxychlor	72-43-5	0.1
Nitrate	—	10
Selenium	7782-49-2	0.01
Silver	7440-22-4	0.05
Toxaphene	8001-35-2	0.005
1,1,1-Trichloroethane	71-55-6	0.2
Trichloroethylene	79-01-6	0.005
2,4,5-Trichlorophenoxy acetic acid	93-76-5	0.01
Vinyl chloride	75-01-4	0.002

* These criteria are subject to change and will be confirmed by the regulatory agency before use.

TABLE F-2 HEALTH-BASED CRITERIA FOR CARCINOGENS[1]

Constituent	CAS No.	Class (A, B, C)[2]	Oral Exposure Route RSD[3]			Inhalation Exposure Route RSD[3]	
			CSF (mg/kg/day)$^{-1}$	Soil (mg/kg)	Water (µg/l)	CSF (mg/kg/day)$^{-1}$	Air (µg/m^3)
Acrylamide[4]	79-06-1	B	3.85E+00	1.82E-01	9.09E-03	3.85E+00	9.09E-04
Acrylonitrile	107-13-1	B	5.4E-01	1.30E+00	6.5E-02	2.4E-01	1.5E-02
Aldrin	309-00-2	B	1.7E+01	4.1E-02	2.1E-03	1.7E-01	2.1E-04
Aniline[4]	62-53-3	C	2.6E-02	2.7E-+02	1.3E+01	2.59E-02	1.35E+00
Arsenic[4]	7440-38-2	A	–	–	See MCL	1.51E-01	2.32E-04
Benz(a)anthracene[4]	56-55-3	B	3.12E+00	2.24E-01	1.12E-01	3.12+00	1.12E-03
Benzene[4]	71-43-2	A	2.9E-02	2.4E+01	See MCL	2.9E-02	1.2E-01
Benzidine	92-87-5	A	2.3E+02	3.0E-03	1.5E-04	2.3E+02	1.5E-05
Benzo(a)pyrene[4]	50-32-8	B	1.15E+01	6.09E-02	3.04E-03	1.15E+01	3.04E-04
Beryllium[4]	7440-41-7	B	4.90+00	1.43E-01	7.14E-03	8.40E+00	4.17E-04
Bis(2-chloroethyl) ether	111-44-4	B	1.1E+00	6.4E-01	3.2E-02	1.1E+00	3.2E-03
Bis(chloromethyl) ether (BCME)[4]	542-88-1	A	9.45E+00	7.41E-02	3.70E-03	9.45E+00	3.70E-04
Bis(2-ethylhexyl) phthalate	117-81-7	B	8.4E-03	8.3E+01	4.2E+00	–	–
Cadmium	7440-43-9	B	—	—	See MCL	7.8E+00	4.5E-04
Carbon tetrachloride	56-23-5	B	1.3E-01	5.4E+00	See MCL	1.3E-01	2.7E-02
Chlordane	57-74-9	B	1.3E+00	5.4E-01	2.7E-02	1.3E+00	2.7E-03
1-Chloro-2, 3-epoxypropane (Epichlorohydrin)	106-89-8	B	9.9E-03	7.1E+01	3.5E-00	4.8E-03	7.3E-01
Chloroform	67-66-3	B	6.1E-03	1.1E+02	5.7E+00	8.1E-02	4.3E-02
Chloromethyl methyl ether[4] (CMME)	107-30-2	A	9.45E+00	7.41E-02	3.70E-03	9.45E+00	3.70E-04
Chromium (hexavalent)	7440-47-3	A	—	—	See MCL	4.1E+01	8.5E-05
DDD	72-54-8	B	2.4E-01	2.9E+00	1.5E-01	—	—
DDE	72-55-9	B	3.4E-01	2.1E+00	1.0E-01	—	—
DDT	50-29-3	B	3.4E-01	2.1E+00	1.0E-01	3.4E-01	1.0E-02
Dibenz(a,h) anthracene[4]	53-70-3	B	4.90E+01	1.43E-02	7.14E-04	4.90E+01	7.14E-05
1.2-Dibromo-3-chloropropane[4] (DBCP)	96-12-8	B	2.21E+01	3.17E+02	1.58E-03	2.21E+01	1.58E-04
1-2-D promoethane	106-93-4	B	—	—	—	7.6E-01	4.6E-03
Dibutylnitrosamine	924-16-3	B	5.40E+00	1.30E-01	6.48E-03	5.40E+00	5.48E-04
1-2-D chloroethane	107-06-2	B	9.1E-02	7.7E+00	See MCL	9.1E-02	3.8E-02
1-1-Dichloroethylene	75-35-4	C	6.0E-01	1.2E+01	See MCL	1.2E+00	2.9E-02
Dichloromethane (Methylene chloride)	75-09-2	B	7.5E-03	9.3E+01	4.7E+00	1.4E-02	2.5E-01
1-3-Dichloropropene	542-75-6	B	1.8E-01	3.9E+00	1.9E-01	—	—
Dieldrin	60-57-1	B	1.6E+01	4.4E-02	2.2E-03	1.6E+01	2.2E-04
Diethylnitrosamine	55-18-5	B	1.5E+02	4.6E-03	2.3E-04	1.5E+02	2.3E-05
Diethylstilbestrol[4] (DES)	56-53-1	A	4.90E+02	1.43E-03	7.14E-05	4.90E+02	7.14E-06
2.4-Dinitrotoleane	121-14-2	B	3.08E-01	2.27E+00	1.14E-01	—	1.14E-01
1.4-Dioxane	123-91-1	B	4.90E-03	1.43E+02	7.14E+00	4.90E-03	7.14E-01
1.2-Diphenylhydrazine	122-66-7	B	8.0E-01	8.8E-01	4.4E-02	8.0E-01	4.4E-03
Ethylene oxide[4]	75-21-8	B	3.50E-01	2.00E+00	1.00E-01	3.5E-01	1.00E-02

TABLE F-2 (continued)

Constituent	CAS No.	Class (A, B, C)[2]	Oral Exposure Route RSD[3]			Inhalation Exposure Route RSD[3]	
			CSF $(mg/kg/day)^{-1}$	Soil (mg/kg)	Water (µg/l)	CSF $(mg/kg/day)^{-1}$	Air (µg/m^3)
Heptachlor	76-44-8	B	4.5E+00	1.6E-01	7.8E-03	4.5E+00	7.8E-04
Heptachlor epoxide	1024-57-3	B	9.1E+00	7.7E-02	3.8E-03	9.1E+00	3.8E-04
Hexachlorobenzene[4]	118-74-1	B	1.72E+00	4.07E-01	2.03E-02	1.72E-02	2.03E-01
Hexachlorobuta-diene	87-68-3	C	7.8E-02	9.0E+01	4.5E+00	7.8E-02	4.5E-01
Hexachlorodibenzo-p-dioxin	19408-74-3	B	6.2E+03	1.1E-04	5.6E-06	6.2E+03	5.6E-07
Hexachloroethane	67-72-1	C	1.4E-02	5.0E+02	2.5E+01	1.4E-02	2.5E+00
Hydrazine	302-01-2	B	3.0E+00	2.3E-01	1.2E-02	1.02E+01	3.43E-04
Hydrazine sulfate	10034-93-2	B	3.0E+00	2.3E-01	1.2E-02	—	—
Lindane (gamma-hexachlorocyclo-hexane)[4]	58-89-9	C	1.3E+00	5.4E+00	See MCL	1.3E+00	2.7E-02
3-Methyl-cholanthrene[4]	56-49-5	B	9.45E+00	7.41E-02	3.70E-03	9.45E+00	3.70E-04
4.4-Methylene-bis-(2-chloroaniline)[4]	101-14-4	B	1.65E-01	4.24E+00	2.12E-01	1.65-01	2.12E-02
Nickel[4]	1440-02-0	A	—	—	—	8.40E-01	4.17E-03
Nickel (refinery dust)	7440-02-0	A	—	—	—	8.4E-01	4.2E-03
Nickel subsulfide	12035-72-2	A	—	—	—	1.7E+00	2.1E-03
2-Nitropropane[4]	79-46-9	B	9.45E+00	7.41E-02	3.70E-03	9.45E+00	3.70E-04
N-Nitrosodi-ethanolamine	1116-54-7	B	2.8E+00	2.5E-01	1.3E-02	—	—
N-Nitrosodimethyl-amine (Dimethyl-nitrosamine)	62-75-9	B	5.1E+01	1.4E-02	6.9E-04	5.1E+01	6.9E-05
N-Nitrosodi-N-propylamine	621-64-7	B	7.0E+00	1.0E-01	5.0E-03	—	—
N-Nitroso-N-methylethylamine	10595-95-6	B	2.2E+01	3.2E-02	1.6E-03	—	—
N-Nitroso-N-methyl urea[4]	684-93-5	B	3.01E+02	2.33E-03	1.16E-04	3.01E+02	1.16E-05
N-Nitroso-pyrrolidine	930-55-2	B	2.1E+00	3.3E-01	1.7E-02	2.1E+00	1.7E-03
PCBs	1336-36-2	B	7.7E+00	9.1E-02	4.5E-03	—	—
Pentachloronitro-benzene[4]	82-68-8	C	2.56E-01	2.73E+01	1.37E+00	2.56E-01	1.37E-01
Perchloroethylene (Tetrachloro-ethylene)	127-18-4	C	5.1E-02	1.4E+02	6.9E+00	2.5E-01	1.4E-01
Pronamide (Kerb)[4]	23950-58-5	C	—	—	—	—	2E+00
Reserpine[4]	50-55-5	B	1.05E+01	6.67E-02	3.33E-03	1.05E+01	3.33E-04
Styrene	100-42-5	B	3.0E-02	2.3E+01	1.2E+00	2.0E-03	1.8E+00
1, 1, 2, 2-Tetrachloroethane	79-34-5	C	2.00E-01	3.50E+01	1.75E+00	2.00E-01	1.75E-01
Thiourea[4]	62-56-6	B	1.93E+00	3.63E-01	5.18E-02	1.93E+00	5.18E-03
Toxaphene	8001-35-2	B	1.1E+00	6.4E-01	See MCL	1.1E+00	3.2E-03
1, 1, 2-Trichloroethane	79-00-5	C	5.7E-02	1.2E+02	6.1E+00	5.7E-02	6.1E-01
Trichloroethylene	79-01-6	B	1.1E-02	6.4E+01	See MCL	1.3E-02	2.7E-01
2, 4, 6-Trichlorophenol	88-06-2	B	2.0E-02	3.5E+01	1.8E+00	2.0E-02	1.8E-01

1 These criteria are subject to change and will be confirmed by the regulatory agency before use.
2 The EPA carcinogen classification system is discussed in 51 FR33992-34003 (Guidelines for Carcinogen Risk Assessment)
3 See Chapter 3.5 for the appropriate intake assumptions used to derive these criteria.
4 Indicates criteria undergoing EPA review.

TABLE F-3 HEALTH-BASED CRITERIA FOR SYSTEMIC TOXICANTS[1]

Constituent	CAS No	RfD[2] (mg/kg/day)	Soil (mg/kg)	Water (µg/l)	Air (µg/m³)
Acetone	67-64-1	1E-01	8E+03	4E+03	—
Acetonitrite	75-05-8	6E-03	5E+02	2E+02	—
Acetoprenone	98-86-2	1E-01	8E+03	4E+03	—
Aldicarb	116-06-3	1E-03	8E+01	4E+01	5E+00
Aldrin	309-00-2	3E-05	2E+00	1E+00	—
Allyl alcohol	107-18-6	5E-03	4E+02	2E+02	—
Aluminum phosphide	20859-73-8	4E-04	3E+01	1E+01	—
Antimony	7440-36-0	4E-04	3E+01	1E+01	—
Barium	7440-39-3	5E-02	4E+03	See MCL	—
Barium cyanide	542-62-1	7E-02	6E+03	2E+03	—
Benzidine	92-87-5	2E-03	2E+02	7E+01	—
Beryllium	7440-41-7	5E-03	4E+02	2E+02	—
Bis(2-ethylhexyl) phthalate	117-81-7	2E-02	2E+03	7E+02	—
Bromodichloromethane	75-27-4	2E-02	2E+03	7E+02	7E+01
Bromoform	75-25-2	2E-02	2E+03	7E+02	—
Bromomethane	74-83-9	4E-04	3E+01	1E+01	—
Calcium cyanide	592-01-8	4E-02	3E+03	1E+03	—
Carbon disulfide	75-15-0	1E-01	8E+03	4E+03	—
Carbon tetrachloride	56-23-5	7E-04	6E+01	See MCL	—
Chlordane	57-74-9	5E-05	4E+00	2E+00	—
Chlorine cyanide	506-77-4	5E-02	4E+03	2E+03	—
Chlorobenzene	108-90-7	3E-02	2E+03	1E+03	—
1-Chloro-2,3 epoxypropane (Epichlorohydrin)	106-89-8	2E-03	2E+02	7E+01	—
Chloroform	67-66-3	1E-02	8E+02	4E+02	—
Chromium (III)	16065-83-1	1E+00	8E+04	4E+04	
Chromium (VI)	7440-47-3	5E-03	4E+02	See MCL	—
Copper cyanide	544-92-3	5E-03	4E+02	2E+02	—
Cresols	1319-77-3	5E-02	4E+03	2E+03	—
Crotonaldehyde	123-73-9	1E-02	8E+02	4E+02	—
Cyanide		2E-02	2E+03	7E+02	—
Cyanogen	460-19-5	4E-02	3E+03	1E+03	—
2,4-D	94-75-7	1E-02	8E+02	See MCL	—
DDT	50-29-3	5E-04	4E+01	2E+01	—
Di-n-butylphthalate	84-74-2	1E-01	8E+03	4E+0	—
Dichlorodifluoro-methane	75-71-8	2E-01	2E+04	7E+03	—
1.1-Dichloroethylene	75-35-4	9E-03	7E+02	See MCL	—
Dichloromethane (Methylene chloride)	75-09-2	6E-02	5E+03	2E+03	—
2.4-Dichlorophenol	120-83-2	3E-03	2E+02	1E+02	1E+01
1.3-Dichloropropene	26952-23-8	3E-04	2E+01	1E+01	—
Dieldrin	60-57-1	5E-05	4E+00	2E+00	—
Diethyl phthalate	84-66-2	8E-01	6E+04	3E+04	—
Dimethoate	60-51-5	2E-02	2E+03	7E+02	—
2.4-Dinitrophenol	51-28-5	2E-03	2E+02	7E+01	7E+00
Dinoseb	88-85-7	1E-03	8E+01	4E+01	—
Diphenylamine	127-39-4	3E-02	2E+03	1E+03	—
Disulfoton	298-04-4	4E-05	3E+00	1E+00	—
Endosulfan	115-29-7	5E-05	4E+00	2E+00	2E-01
Endothal	145-73-3	2E-02	2E+03	7E+02	—
Endrin	72-20-8	3E-04	2E+01	See MCL	1E+00

TABLE F-3 (continued)

Constituent	CAS No	RfD2 (mg/kg/day)	Soil (mg/kg)	Water (µg/l)	Air (µg/m3)
Ethylbenzene	100-41-4	1E-01	8E+03	4E+03	—
Heptachlor	76-44-8	5E-04	4E+01	2E+01	—
Heptachlor epoxide	1024-57-8	1E-05	8E-01	4E-01	—
Hexachlorobuta-diene	87-68-3	2E-03	2E+02	7E+01	—
Hexachlorocyclo-pentadiene	77-47-4	7E-03	6E+02	2E+02	—
Hexachloroethane	67-72-1	1E-03	8E+01	4E+01	—
Hydrogen cyanide	74-90-8	2E-02	2E+03	7E+02	—
Hydrogen sulfide	7783-06-4	3E-03	2E+02	1E+02	—
Isobutyl alcohol	78-83-1	3E-01	2E+04	1E+04	1E+03
Isophorone	78-59-1	2E-01	2E+04	7E+03	—
Lindane (hexa-chlorocyclohexane)	58-89-9	3E-04	2E+01	See MCL	—
Maleic hydrazide	108-31-6	5E-01	4E+04	2E+04	—
Methacrylonitrile	126-98-7	1E-04	8E+00	4E+00	—
Methomyl	16752-77-5	3E-02	2E+03	1E+03	—
Methyl ethyl ketone	78-93-3	5E-02	4E+03	2E+03	—
Methylisobutyl-ketone	108-10-01	5E-02	4E+03	2E+03	—
Methyl mercury	22967-92-6	3E-04	2E+01	1E+01	—
Methyl parathion	298-00-0	3E-04	2E+01	1E+-01	1E+00
Nickel	7440-02-0	2E-02	2E+03	7E+02	—
Nitric oxide	10101-43-9	1E-01	8E+03	4E+03	—
Nitrobenzene	98-95-3	5E-04	4E+01	2E+01	—
Nitrogen dioxide	10102-44-0	1E-00	8E+04	4E+04	—
Octamethylpyro-phosphoramide	152-16-9	2E-03	2E+02	7E+01	—
Parathion	56-38-2	3E-04	2E+01	1E+01	—
Pentachlorobenzene	608-93-5	8E-04	6E+01	3E+01	3E+00
Pentachloronitro-benzene	82-68-8	3E-03	2E+02	1E+02	—
Pentachlorophenol	87-86-5	3E-02	2E+03	1E+03	1E+02
Perchloroethylene (Tetrachloro-ethylene)	127-18-4	1E-02	8E+02	4E+02	—
Phenol	108-95-2	4E-02	3E+03	1E+03	—
Phenyl mercuric acetate	62-38-4	8E-05	6E+00	3E+00	—
Phosphine	7803-51-2	3E-04	2E+01	1E+01	—
Potassium cyanide	151-50-8	5E-02	4E+03	2E+03	—
Potassium silver cyanide	506-61-6	2E-01	2E+04	7E+03	—
Pronamide (Kerb)	23950-58-5	8E-02	6E+03	3E+03	—
Pyrodine	110-86-1	1E-03	8E+01	4E+01	—
Selenious Acid	7782-49-2	3E-03	2E+02	See MCL	—
Selenourea	630-10-4	5E-03	4E+02	2E+02	—
Silver	7440-22-4	3E-03	2E+02	See MCL	—
Silver cyanide	506-64-9	1E-01	8E+03	4E+03	—
Silvex (2,4,5-TP)	93-72-1	8E-03	6E+02	3E+02	—
Sodium cyanide	143-33-9	4E-02	3E+03	1E+03	—
Strychnine	57-24-9	3E-04	2E+01	1E+01	—
Styrene	100-42-5	2E-01	2E+04	7E+03	—

TABLE F-3 (continued)

Constituent	CAS No	RfD2 (mg/kg/day)	Soil (mg/kg)	Water (µg/l)	Air (µg/m3)
1,2,4,5-Tetrachlorobenzene	95-94-3	3E-04	2E+01	1E+01	1E+00
2,3,4,6-Tetrachlorophenol	58-90-2	3E-02	2E+03	1E+03	1E+02
Tetraethyl lead	78-00-2	1E-07	8E-03	4E-03	4E-04
Thallic oxide	1314-32-5	4E-04	3E+01	1E+01	—
Thallium acetate	563-68-8	5E-04	4E+01	2E+01	—
Thallium carbonate	6533-73-9	4E-04	3E+01	1E+01	—
Thallium chloride	7791-12-0	4E-04	3E+01	1E+01	—
Thallium nitrate	10102-45-1	5E-04	4E+01	2E+01	—
Thallium selenite	12039-52-0	5E-04	4E+01	2E+01	—
Thallium sulfate	10031-59-1	3E-04	2E+01	1E+01	—
Thiram	137-26-8	5E-03	4E+02	2E+02	—
Toluene	108-88-3	3E-01	2E+04	1E+04	—
1,2,4-Trichlorobenzene	120-82-1	2E-02	2E+03	7E+02	—
1,1,1-Trichloroethane	71-55-6	9E-02	7E+03	See MCL	—
1,1,2-Trichloroethane	79-00-5	2E-01	2E+04	7E+03	—
Trichloromono-fluoromethane	75-69-4	3E-01	2E+04	1E+04	—
2,4,5-Trichlorophenol	95-95-4	1E-01	8E+03	4E+03	4E+02
2,4,5-Trichloro-phenoxy acetic acid (2,4,5-T)	93-76-5	3E-03	2E+02	See MCL	—
1,1,2-Trichloropropane	598-77-6	5E-03	4E+02	2E+02	—
1,2,3-Trichloropropane	96-18-4	1E-03	8E+01	4E+01	—
Vanadium pentoxide	1314-62-1	2E-02	2E+03	7E+02	—
Warfarin	81-81-2	3E-04	2E+01	1E+01	—
Xylene (total)	1330-20-7	2E+00	2E+05	7E+04	—
Zinc cyanide	557-21-1	5E-02	4E+03	2E+03	—
Zinc phosphide	1314-84-7	3E-04	2E+01	1E+01	—

1 These criteria are subject to change and will be confirmed by the regulatory agency before use.
2 See Chapter 3.5 for the appropriate intake assumptions used to derive these criteria.

REFERENCES

EPA (Environmental Protection Agency) 1989. "Identification and Listing of Hazardous Wastes," Code of Federal Regulations, Protection of Environment, Title 40, Part 261, Washington, DC.

APPENDIX G

Data Sheets for Solid Waste Management Units at Los Alamos National Laboratory

ABBREVIATIONS

ORG	Organics
INORG	Inorganics
RAD	Radionuclides
HE	High Explosives
SOLV	Solvents
PHOCHEM	Photo Chemicals
BA	Barium
BE	Beryllium
PB	Lead
PCB	Polychlorinated Byphenyl
PET	Petroleum Products
CR	Chromium
LI	Lithium
CAUST	Caustic
AG	Silver
HG	Mercury
CD	Cadmium
F	Fluorine

CONTROL ACTIONS

CARBC; IC	Clean-to-Acceptable Risk-Based Criteria; Institutional Controls
IS; IC	In-Place Stabilization; Institutional Controls

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Abbreviations

Potential Contaminants and Control Actions i

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CANYONS

Task #: AL-LA-1
ADS #: 1049

Release Site: C-0-001 GUAJE CANYON

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-0-001	278,000	CARBC;IC	HE, ORG, INORG, METALS

Release Site: C-0-002 RENDIJA CANYON

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-0-002	31,500	CARBC;IC	HE, ORG, INORG, METALS

Release Site: C-0-003 BARRANCA CANYON

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-0-003	489,000	CARBC;IC	HE, ORG, INORG, METALS

Release Site: C-0-004 BAYO CANYON

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-0-004	685,240	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: C-0-005 ACID/PUEBLO CANYON

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-0-005	703,760	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: C-0-006 DP/LOS ALAMOS CANYON

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-0-006	1,148,240	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: C-0-007 SANDIA CANYON

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-0-007	533,376	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: C-0-008 MORTANDAD CANYON

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-0-008	870,440	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: C-0-009 CANADA DEL BUEY

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-0-009	704,000	CARBC;IC	RAD, HE, ORG, INORG, METALS

Release Site: C-0-010 TWO MILE CANYON

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-0-010	207,424	CARBC;IC	RAD, HE, ORG, INORG, METALS

Release Site: C-0-011 PAJARITO CANYON

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-0-011	1,074,160	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: C-0-012 THREE MILE CANYON

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-0-012	107,000	CARBC;IC	RAD, HE, ORG, INORG, METALS

Release Site: C-0-013 POTRILLO CANYON

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-0-013	629,680	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: C-0-014 CANON DE VALLE

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-0-014	333,000	CARBC;IC	RAD, HE, ORG, INORG, METALS

Release Site: C-0-015 FENCE CANYON

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-0-015	194,000	CARBC;IC	RAD, HE, ORG, INORG, METALS

Release Site: C-0-016 WATER CANYON

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-0-016	1,185,280	CARBC;IC	RAD, HE, ORG, INORG, METALS

Release Site: C-0-017 INDIO CANYON

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-0-017	342,000	CARBC;IC	RAD, HE, ORG, INORG, METALS

Release Site: C-0-018 ANCHO CANYON

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-0-018	296,000	CARBC;IC	RAD, HE, ORG, INORG, METALS

Release Site: C-0-019 CHAQUEHUI CANYON

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-0-019	185,000	CARBC;IC	RAD, HE, ORG, INORG, METALS

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ADS #: 1071

Release Site: 0-001, SURFACE IMPOUNDMENTS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
0-001, MORTANDAD CANYON	8,418	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: 0-003, DECOMMISSIONED CONTAINER STORAGE AREA

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
0-003, TA-0-1051	2	CARBC;IC	ORG, INORG, METALS

Release Site: 0-004, ACTIVE CONTAINER STORAGE AREA

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
0-004	1	CARBC;IC	ORG, INORG, METALS, SOLV

Release Site: 0-005, MORTANDAD CANYON

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
0-005, MORTANDAD CANYON	15	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: 0-008, NORTH MESA SURFACE DISPOSAL

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
0-008, NORTH MESA	17	CARBC;IC	ORG, INORG, METALS

Release Site: 0-010, SURFACE DISPOSAL

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
0-010, SOUTH OF MDA-B	4,034	CARBC;IC	ORG, INORG, METALS

Release Site: 0-011, MORTAR IMPACT AREAS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
0-011(a), RENDIJA CANYON	2,020	CARBC;IC	HE, ORG, INORG, METALS
0-011(b), RENDIJA CANYON	2,020	CARBC;IC	HE, ORG, INORG, METALS
0-011(c), RENDIJA CANYON	2,020	CARBC;IC	HE, ORG, INORG, METALS
0-011(d), BARRANCA CANYON	2,020	CARBC;IC	HE, ORG, INORG, METALS
0-011(e), 37-MM CANYON	2,020	CARBC;IC	HE, ORG, INORG, METALS

Release Site: 0-012, WESTERN STEAM PLANT

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
0-012, TA-0-1051	5	CARBC;IC	ORG, INORG, METALS, BIOCIDES, CR

Release Site: 0-015, ACTIVE FIRING RANGE

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
0-015, TA-0-1078	405	CARBC;IC	ORG, INORG, METALS, PB

Release Site: 0-016, INACTIVE FIRING RANGE

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
0-016	808	CARBC;IC	ORG, INORG, METALS, PB

Release Site: 0-017, WASTE LINES

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
0-017	283	CARBC;IC	RAD, ORG, INORG, METALS, ACIDS

Release Site: 0-018, ACTIVE WASTEWATER TREATMENT PLANTS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
0-018(a), PUEBLO	2,814	CARBC;IC	RAD, ORG, INORG, METALS, SOLV
0-018(b), BAYO	2,926	CARBC;IC	RAD, ORG, INORG, METALS, SOLV

Release Site: 0-019, CENTRAL WASTEWATER TREATMENT PLANT

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
0-019, CENTRAL WWTP	1,676	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: 0-024, CISTERN

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
0-024, BARRANCA MESA	5	CARBC;IC	ORG, INORG, METALS

Release Site: 0-025, TANK MESA LANDFILL

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
0-025, TANK MESA	116	CARBC;IC	ORG, INORG, METALS

Release Site: 0-026, GUN MOUNT LANDFILL

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
0-026, NORTH MESA	21	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: 0-027, DP ROAD STORAGE AREA

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
0-027, NORTH OF DP ROAD	966	CARBC;IC	ORG, INORG, METALS, PET

Release Site: 0-028, LOS ALAMOS COUNTY RECREATION AREAS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
0-028(a), LOS ALAMOS COUNTY GOLF COURSE	56,550	CARBC;IC	RAD, ORG, INORG, METALS
0-028(b), NORTH MESA RD. ATHLETIC FIELDS	37,700	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: 0-029, LEAKAGE FROM PCB TRANSFORMERS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
0-029(a), TA-0-1105	1	CARBC;IC	ORG, INORG, METALS, PCB
0-029(b), TA-0-1104	1	CARBC;IC	ORG, INORG, METALS, PCB
0-029(c), TA-0-234	1	CARBC;IC	ORG, INORG, METALS, PCB

Release Site: 0-030, SEPTIC SYSTEMS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
0-030(a), N OF DP ROAD	5	CARBC;IC	ORG, INORG, METALS, SOLV
0-030(b), TANK NO.1	56	CARBC;IC	ORG, INORG, METALS, SOLV
0-030(c), TANK NO.1A	5	CARBC;IC	ORG, INORG, METALS, SOLV
0-030(d), TANK NO.2	5	CARBC;IC	ORG, INORG, METALS, SOLV
0-030(e), TANKS NO.4 AND 4A	5	CARBC;IC	ORG, INORG, METALS, SOLV

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
0-030(f), TANK NO.5	5	CARBC;IC	ORG, INORG, METALS, SOLV
0-030(g), TANK NO.6	5	CARBC;IC	ORG, INORG, METALS, SOLV
0-030(h), TANK NO.7	5	CARBC;IC	ORG, INORG, METALS, SOLV
0-030(i), TANK NO.8	5	CARBC;IC	ORG, INORG, METALS, SOLV
0-030(j), W OF CENTRAL WWTP	5	CARBC;IC	ORG, INORG, METALS, SOLV
0-030(k), E OF CENTRAL WWTP	5	CARBC;IC	ORG, INORG, METALS, SOLV
0-030(l), 120 7TH STREET	5	CARBC;IC	ORG, INORG, METALS, SOLV
0-030(m), NEAR 120 7TH STREET	5	CARBC;IC	ORG, INORG, METALS, SOLV

Release Site: 0-031, SOIL CONTAMINATION BENEATH FORMER SERVICE STATIONS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
0-031(a)	230	CARBC;IC	ORG, INORG, METALS, PET
0-031(b)	230	CARBC;IC	ORG, INORG, METALS, PET

Release Site: 0-032, SOIL CONTAMINATION BENEATH FORMER MOTORPOOL FACILITY

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
0-032	2,918	CARBC;IC	ORG, INORG, METALS

Release Site: 0-033, SOIL CONTAMINATION BENEATH FORMER ZIA WAREHOUSES

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
0-033, ZIA WAREHOUSES	1,043	CARBC;IC	ORG, INORG, METALS, SOLV, PET

Release Site: 19-001 SEPTIC SYSTEM

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
19-001, TA-19-6	4	CARBC;IC	ORG, INORG, METALS, SOLV

Release Site: 19-002, SURFACE DISPOSAL

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
19-002, N OF TA-19-1	74	CARBC;IC	ORG, INORG, METALS

Release Site: 19-003 DRAINLINE AND OUTFALL

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
19-003, TA-19-1	1	CARBC;IC	ORG, INORG, METALS, SOLV

Release Site: 26-001, CANYONSIDE DISPOSAL AREA

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
26-001, NEAR TA-26-1	111	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: 26-002, SUMP SYSTEM

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
26-002(a), TA-26-6	5	CARBC;IC	RAD, ORG, INORG, METALS
26-002(b), NEAR TA-26-1	1	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: 26-003, SEPTIC SYSTEM

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
26-003, TA-26-5	9	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: 73-001, INACTIVE AIRPORT LANDFILL

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
73-001(a), LANDFILL	1,070	IS;IC	RAD, HE, ORG, INORG, METALS, PCB
73-001(b), OIL PIT	4	IS;IC	ORG, INORG, METALS, PET
73-001(c), BUNKER DISPOSAL	171	IS;IC	HE, ORG, INORG, METALS
73-001(d), BATCH PLANT PITS	4	IS;IC	ORG, INORG, METALS

Release Site: 73-002, AIRPORT INCINERATOR/SURFACE DISPOSAL

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
73-002, TA-73-2	2,019	CARBC;IC	ORG, INORG, METALS

Release Site: 73-003 GARBAGE TRUCK AND CAN CLEANING

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
73-003, NEAR TA-73-2	8	CARBC;IC	ORG, INORG, METALS, SOLV

Release Site: 73-004 INACTIVE SEPTIC SYSTEMS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
73-004(a), W OF TA-73-2	22	CARBC;IC	ORG, INORG, METALS, SOLV
73-004(b), NW OF TA-73-2	11	CARBC;IC	ORG, INORG, METALS, SOLV
73-004(c), NORTH OF CONTROL TOWER	22	CARBC;IC	ORG, INORG, METALS, SOLV
73-004(d), AIRPORT LANDFILL	22	CARBC;IC	ORG, INORG, METALS, SOLV

Release Site: 73-005, SURFACE DISPOSAL

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
73-005, S OF AIRPORT	750	CARBC;IC	ORG, INORG, METALS

Release Site: 73-006, AIRPORT BUILDING DRAINS AND OUTFALLS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
73-006, INCINERATOR DRAINS	926	CARBC;IC	HE, ORG, INORG, METALS

Release Site: C-19-001 TA-19,1,2,3,4,5,7 BUILDINGS (REMOVED)

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-19-001	2,222	CARBC;IC	RAD, ORG, INORG, METALS

TA-1

Task #: AL-LA-11
ADS #: 1078

Release Site: 1-001 SEPTIC SYSTEMS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
1-001(a)	13	CARBC;IC	RAD, ORG, INORG, METALS
1-001(b)	8	CARBC;IC	RAD, ORG, INORG, METALS
1-001(c)	4	CARBC;IC	RAD, ORG, INORG, METALS
1-001(d)	4	CARBC;IC	RAD, ORG, INORG, METALS
1-001(e)	6	CARBC;IC	RAD, ORG, INORG, METALS
1-001(f)	18	CARBC;IC	RAD, ORG, INORG, METALS
1-001(g)	2	CARBC;IC	RAD, ORG, INORG, METALS
1-001(h)	11	CARBC;IC	ORG, INORG, METALS
1-001(i)	3	CARBC;IC	RAD, ORG, INORG, METALS
1-001(j)	2	CARBC;IC	ORG, INORG, METALS
1-001(k)	2	CARBC;IC	RAD, ORG, INORG, METALS
1-001(l)	2	CARBC;IC	RAD, ORG, INORG, METALS
1-001(m)	2	CARBC;IC	ORG, INORG, METALS
1-001(n)	5	CARBC;IC	RAD, ORG, INORG, METALS
1-001(o)	3	CARBC;IC	RAD, ORG, INORG, METALS
1-001(p)	5	CARBC;IC	RAD, ORG, INORG, METALS
1-001(q)	5	CARBC;IC	ORG, INORG, METALS
1-001(r)	4	CARBC;IC	ORG, INORG, METALS
1-001(s)	29	CARBC;IC	RAD, ORG, INORG, METALS
1-001(t)	24	CARBC;IC	RAD, ORG, INORG, METALS
1-001(u)	2	CARBC;IC	RAD, ORG, INORG, METALS
1-001(v)	1	CARBC;IC	ORG, INORG, METALS
1-001(w)	2	CARBC;IC	ORG, INORG, METALS

Release Site: 1-002 ACID WASTE LINES, OUTFALLS, AND RECEIVING CANYON

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
1-002	24,925	CARBC;IC	RAD, ORG, INORG, METALS, SOLV

Release Site: 1-003 LANDFILL AND SURFACE DUMPS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
1-003(a) BAILEY	74,080	CARBC;IC	RAD, ORG, INORG, METALS, SOLV
1-003(b) EAST	926	CARBC;IC	RAD, ORG, INORG, METALS
1-003(c) WEST	926	CARBC;IC	RAD, ORG, INORG, METALS
1-003(d) PAINT CAN	926	CARBC;IC	RAD, ORG, INORG, METALS, SOLV
1-003(e) INN	926	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: 1-004 INCINERATORS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
1-004(a) TA-1-146	37	CARBC;IC	ORG, INORG, METALS
1-004(b) TA-1-147	37	CARBC;IC	ORG, INORG, METALS

Release Site: 1-005 BENCH-SCALE INCINERATOR

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
1-005	4	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: 1-006 DRAIN LINES AND OUTFALLS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
1-006(a) BUILDING DRAINS	13	CARBC;IC	RAD, ORG, INORG, METALS
1-006(b) STORM DRAINS	143	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: 1-007 SUBSURFACE SOIL CONTAMINATION

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
1-007(a)	2,616	CARBC;IC	RAD, ORG, INORG, METALS
1-007(b)	244	CARBC;IC	RAD, ORG, INORG, METALS

TA's 10, 31, 32, 45

Task #: AL-LA-15
ADS #: 1079

Release Site: 10-001 FIRING SITES

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
10-001(a)	162,963	CARBC;IC	RAD, HE, ORG, INORG, METALS, PB
10-001(b)	162,963	CARBC;IC	RAD, HE, ORG, INORG, METALS, PB
10-001(c)	162,963	CARBC;IC	RAD, HE, ORG, INORG, METALS, PB
10-001(d)	162,963	CARBC;IC	RAD, HE, ORG, INORG, METALS, PB
10-001(e)	72,222	CARBC;IC	RAD, HE, ORG, INORG, METALS, PB

Release Site: 10-002 DISPOSAL PITS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
10-002(a)	30	CARBC;IC	RAD, ORG, INORG, METALS, ACIDS
10-002(b)	56	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: 10-003 LIQUID DISPOSAL COMPLEX

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
10-003(a)	1	CARBC;IC	RAD, ORG, INORG, METALS, ACIDS
10-003(b)	1	CARBC;IC	RAD, ORG, INORG, METALS, ACIDS
10-003(c)	1	CARBC;IC	RAD, ORG, INORG, METALS, ACIDS
10-003(d)	1	CARBC;IC	RAD, ORG, INORG, METALS, ACIDS
10-003(e)	1	CARBC;IC	RAD, ORG, INORG, METALS, ACIDS
10-003(f)	1	CARBC;IC	RAD, ORG, INORG, METALS, ACIDS
10-003(g)	4	CARBC;IC	RAD, ORG, INORG, METALS, ACIDS
10-003(h)	4	CARBC;IC	RAD, ORG, INORG, METALS, ACIDS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
10-003(i)	1	CARBC;IC	RAD, ORG, INORG, METALS, ACIDS
10-003(j)	1	CARBC;IC	RAD, ORG, INORG, METALS, ACIDS
10-003(k)	1	CARBC;IC	RAD, ORG, INORG, METALS, ACIDS
10-003(l)	1	CARBC;IC	RAD, ORG, INORG, METALS, ACIDS
10-003(m)	2	CARBC;IC	RAD, ORG, INORG, METALS, ACIDS
10-003(n)	19	CARBC;IC	RAD, ORG, INORG, METALS, ACIDS
10-003(o)	1	CARBC;IC	RAD, ORG, INORG, METALS, ACIDS

Release Site: 10-004 SEPTIC SYSTEMS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
10-004(a)	50	CARBC;IC	RAD, ORG, INORG, METALS, ACIDS
10-004(b)	17	CARBC;IC	RAD, ORG, INORG, METALS, ACIDS

Release Site: 10-005 SURFACE DISPOSAL AREA

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
10-005	4	CARBC;IC	RAD, ORG, INORG, METALS, PB

Release Site: 10-006 BURN SITES

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
10-006	481	CARBC;IC	RAD, HE, ORG, INORG, METALS

Release Site: 10-007 LANDFILL

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
10-007	7,407	CARBC;IC	ORG, INORG, METALS

Release Site: 31-001 SEPTIC SYSTEM

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
31-001	78	CARBC;IC	ORG, INORG, METALS

Release Site: 32-001 INCINERATOR

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
32-001	1	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: 32-002 SEPTIC SYSTEM

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
32-002(a)	16	CARBC;IC	RAD, ORG, INORG, METALS
32-002(b)	23	CARBC;IC	RAD, ORG, INORG, METALS, SOLV

Release Site: 45-001 RAD WASTE TREATMENT FACILITY

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
45-001	26	CARBC;IC	RAD, HE, ORG, INORG, METALS, SOLV

Release Site: 45-002 VEHICLE DECONTAMINATION FACILITY

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
45-002	2	CARBC;IC	RAD, ORG, INORG, METALS, PET

Release Site: 45-003 DECOMMISSIONED WASTE LINES

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
45-003	3,058	CARBC;IC	RAD, ORG, INORG, METALS, ACIDS

Release Site: 45-004 SEPTIC SYSTEM OUTFALL

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
45-004	12	CARBC;IC	RAD, ORG, INORG, METALS, SOLV

Release Site: C-31-001 TA-31-2,3,4,5,6,7 BUILDINGS (REMOVED)

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-31-001	2,222	CARBC;IC	RAD, HE, ORG, INORG, METALS

Release Site: C-32-001 TA-32-1,2,3,5,12,13 BUILDINGS (REMOVED)

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-32-001	2,222	CARBC;IC	RAD, HE, ORG, INORG, METALS

Release Site: C-45-001, TA-45 FORMER PARKING LOT

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-45-001	111	CARBC;IC	RAD, ORG, INORG, METALS

TA's 11, 12, 13, 16, 24, 25, 37

Task #: AL-LA-12
ADS #: 1082

Release Site: 11-001 FIRING PITS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
11-001(a) TA-11-14	77	CARBC;IC	RAD, HE, ORG, INORG, METALS, BA
11-001(b) TA-11-2	77	CARBC;IC	RAD, HE, ORG, INORG, METALS, BA
11-001(c) TA-11-15	77	CARBC;IC	RAD, HE, ORG, INORG, METALS, BA

Release Site: 11-002 OPEN BURNING AREA AND PIT

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
11-002	19	CARBC;IC	RAD, HE, ORG, INORG, METALS

Release Site: 11-003 GUN FIRING IMPACT AREAS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
11-003(a) TA-11-2,-3	23	CARBC;IC	HE, ORG, INORG, METALS
11-003(b) TA-11-24	1	CARBC;IC	HE, ORG, INORG, METALS

Release Site: 11-004 DROP TOWER COMPLEX

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
11-004(a)	392,003	CARBC;IC	RAD, HE, ORG, INORG, METALS, BE

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
11-004(b)	392,003	CARBC;IC	RAD, HE, ORG, INORG, METALS, BE
11-004(c)	392,003	CARBC;IC	RAD, HE, ORG, INORG, METALS, BE
11-004(d)	392,003	CARBC;IC	RAD, HE, ORG, INORG, METALS, BE
11-004(e)	392,003	CARBC;IC	RAD, HE, ORG, INORG, METALS, BE
11-004(f)	392,003	CARBC;IC	RAD, HE, ORG, INORG, METALS, BE

Release Site: 11-005 SEPTIC SYSTEMS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
11-005(a) TA-11-30	3	CARBC;IC	HE, ORG, INORG, METALS, PHOCHEM
11-005(b) TA-11-43	2	CARBC;IC	HE, ORG, INORG, METALS
11-005(c) TA-11-2	1	CARBC;IC	HE, ORG, INORG, METALS

Release Site: 11-006 SUMPS AND CATCH BASIN SYSTEMS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
11-006(a)	1	CARBC;IC	RAD, HE, ORG, INORG, METALS
11-006(b)	1	CARBC;IC	RAD, HE, ORG, INORG, METALS, BE, BA
11-006(c)	1	CARBC;IC	RAD, HE, ORG, INORG, METALS, BE, BA
11-006(d)	1	CARBC;IC	RAD, HE, ORG, INORG, METALS, BE, BA

Release Site: 11-007 SURFACE DISPOSAL AREA

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
11-007	139	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: 11-008 BONEYARD

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
11-008	4	CARBC;IC	RAD, HE, ORG, INORG, METALS

Release Site: 11-009 MATERIAL DISPOSAL AREA S

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
11-009	22	CARBC;IC	HE, ORG, INORG, METALS

Release Site: 11-010 WASTE STORAGE AREA

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
11-010(a) TA-11-36	74	CARBC;IC	HE, ORG, INORG, METALS
11-010(b) TA-11-34	1	CARBC;IC	HE, ORG, INORG, METALS

Release Site: 11-011 DRAINLINES AND OUTFALLS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
11-011(a)	185	CARBC;IC	HE, ORG, INORG, METALS
11-011(b)	1	CARBC;IC	HE, ORG, INORG, METALS
11-011(c)	1	CARBC;IC	HE, ORG, INORG, METALS
11-011(d)	2	CARBC;IC	HE, ORG, INORG, METALS

Release Site: 12-004 SOURCE EXPERIMENT

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
12-004(a) SHELTER & LEAD POT	335	CARBC;IC	RAD, HE, ORG, INORG, METALS
12-004(b) AL. PIPE	1	CARBC;IC	RAD, HE, ORG, INORG, METALS

Release Site: 13-001 FIRING SITE

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
13-001	7,272	CARBC;IC	RAD, HE, ORG, INORG, METALS

Release Site: 13-002 COVERED AND OPEN LANDFILLS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
13-002	46	CARBC;IC	RAD, HE, ORG, INORG, METALS

Release Site: 13-003 SEPTIC SYSTEM

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
13-003(a), TANK	1	CARBC;IC	ORG, INORG, METALS
13-003(b), DRAIN FIELD	56	CARBC;IC	ORG, INORG, METALS

Release Site: 13-004 BURNING PITS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
13-004	185	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: 16-001 DRY WELLS/TANK

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
16-001(a)	1	CARBC;IC	ORG, INORG, METALS, SOLV
16-001(b)	1	CARBC;IC	ORG, INORG, METALS, SOLV
16-001(c)	1	CARBC;IC	ORG, INORG, METALS, SOLV
16-001(d)	1	CARBC;IC	ORG, INORG, METALS, SOLV
16-001(e)	4	CARBC;IC	ORG, INORG, METALS, SOLV

Release Site: 16-003 ACTIVE HE SUMPS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
16-003(a)	1	CARBC;IC	RAD, HE, ORG, INORG, METALS, BA
16-003(b)	1	CARBC;IC	HE, ORG, INORG, METALS, SOLV, BA
16-003(c)	1	CARBC;IC	HE, ORG, INORG, METALS, SOLV, BA
16-003(d)	2	CARBC;IC	HE, ORG, INORG, METALS, SOLV, BA
16-003(e)	2	CARBC;IC	HE, ORG, INORG, METALS, BA
16-003(f)	2	CARBC;IC	HE, ORG, INORG, METALS, BA
16-003(g)	2	CARBC;IC	HE, ORG, INORG, METALS, BA
16-003(h)	1	CARBC;IC	HE, ORG, INORG, METALS, BA
16-003(i)	1	CARBC;IC	HE, ORG, INORG, METALS, BA
16-003(j)	1	CARBC;IC	HE, ORG, INORG, METALS, BA
16-003(k)	10	CARBC;IC	HE, ORG, INORG, METALS, SOLV, BA
16-003(l)	2	CARBC;IC	HE, ORG, INORG, METALS
16-003(m)	2	CARBC;IC	HE, ORG, INORG, METALS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
16-003(n)	1	CARBC;IC	HE, ORG, INORG, METALS, SOLV, BA
16-003(o)	3	CARBC;IC	HE, ORG, INORG, METALS, SOLV, BA
16-003(p)	1	CARBC;IC	HE, ORG, INORG, METALS, BA
16-003(q)	1	CARBC;IC	HE, ORG, INORG, METALS, BA

Release Site: 16-004 SANITARY WASTE TREATMENT PLANT

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
16-004(a)	12	CARBC;IC	RAD, ORG, INORG, METALS, SOLV
16-004(b)	46	CARBC;IC	RAD, ORG, INORG, METALS, SOLV
16-004(c)	6	CARBC;IC	RAD, ORG, INORG, METALS, SOLV
16-004(d)	9	CARBC;IC	RAD, ORG, INORG, METALS, SOLV
16-004(e)	1	CARBC;IC	RAD, ORG, INORG, METALS, SOLV
16-004(f)	9	CARBC;IC	RAD, ORG, INORG, METALS, SOLV

Release Site: 16-005 DECOMMISSIONED SEPTIC TANKS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
16-005(a)	10	CARBC;IC	ORG, INORG, METALS
16-005(b)	1	CARBC;IC	ORG, INORG, METALS
16-005(c)	1	CARBC;IC	ORG, INORG, METALS
16-005(d)	1	CARBC;IC	ORG, INORG, METALS
16-005(e)	1	CARBC;IC	ORG, INORG, METALS
16-005(f)	3	CARBC;IC	HE, ORG, INORG, METALS, BA
16-005(g)	1	CARBC;IC	ORG, INORG, METALS,
16-005(h)	1	CARBC;IC	HE, ORG, INORG, METALS, SOLV
16-005(i)	1	CARBC;IC	ORG, INORG, METALS,
16-005(j)	2	CARBC;IC	ORG, INORG, METALS, SOLV, PHOCHEM
16-005(k)	1	CARBC;IC	ORG, INORG, METALS,
16-005(l)	1	CARBC;IC	ORG, INORG, METALS
16-005(m)	1	CARBC;IC	HE, ORG, INORG, METALS

Release Site: 16-009 DECOMMISSIONED BURN AREA

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
16-009(a)	185	CARBC;IC	HE, ORG, INORG, METALS, BA
16-009(b)	185	CARBC;IC	HE, ORG, INORG, METALS, BA

Release Site: 16-010 ACTIVE/INACTIVE BURN AND TREATMENT AREAS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
16-010(a)	185	CARBC;IC	RAD, HE, ORG, INORG, METALS, BA
16-010(b)	185	CARBC;IC	RAD, HE, ORG, INORG, METALS, BA
16-010(c)	4	CARBC;IC	RAD, HE, ORG, INORG, METALS, BA
16-010(d)	7	CARBC;IC	RAD, HE, ORG, INORG, METALS, BA
16-010(e)	1	CARBC;IC	RAD, HE, ORG, INORG, METALS, BA
16-010(f)	1	CARBC;IC	RAD, HE, ORG, INORG, METALS, BA
16-010(g)	7	CARBC;IC	RAD, HE, ORG, INORG, METALS, BA
16-010(h)	9	CARBC;IC	RAD, HE, ORG, INORG, METALS, BA
16-010(i)	3	CARBC;IC	RAD, HE, ORG, INORG, METALS, BA
16-010(j)	3	CARBC;IC	RAD, HE, ORG, INORG, METALS, BA
16-010(k)	9	CARBC;IC	RAD, HE, ORG, INORG, METALS, BA
16-010(l)	9	CARBC;IC	RAD, HE, ORG, INORG, METALS, BA
16-010(m)	9	CARBC;IC	RAD, HE, ORG, INORG, METALS, BA
16-010(n)	9	CARBC;IC	RAD, HE, ORG, INORG, METALS, BA

Release Site: 16-011 INCINERATORS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
16-011	21	CARBC;IC	HE, ORG, INORG, METALS, SOLV, PET

Release Site: 16-012 WASTE STORAGE AREAS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
16-012(a)	7	CARBC;IC	HE, ORG, INORG, METALS
16-012(a2)	46	CARBC;IC	RAD, HE, ORG, INORG, METALS
16-012(b)	7	CARBC;IC	HE, ORG, INORG, METALS
16-012(c)	7	CARBC;IC	HE, ORG, INORG, METALS
16-012(d)	1	CARBC;IC	HE, ORG, INORG, METALS, SOLV
16-012(e)	7	CARBC;IC	HE, ORG, INORG, METALS
16-012(f)	7	CARBC;IC	HE, ORG, INORG, METALS
16-012(g)	7	CARBC;IC	HE, ORG, INORG, METALS
16-012(h)	7	CARBC;IC	HE, ORG, INORG, METALS
16-012(i)	1	CARBC;IC	ORG, INORG, METALS, SOLV, BA
16-012(j)	1	CARBC;IC	HE, ORG, INORG, METALS, SOLV
16-012(k)	7	CARBC;IC	HE, ORG, INORG, METALS
16-012(l)	1	CARBC;IC	ORG, INORG, METALS, SOLV
16-012(m)	1	CARBC;IC	ORG, INORG, METALS, SOLV
16-012(n)	1	CARBC;IC	ORG, INORG, METALS, SOLV
16-012(o)	7	CARBC;IC	HE, ORG, INORG, METALS
16-012(p)	46	CARBC;IC	HE, ORG, INORG, METALS, BA
16-012(q)	7	CARBC;IC	HE, ORG, INORG, METALS
16-012(r)	7	CARBC;IC	HE, ORG, INORG, METALS
16-012(s)	7	CARBC;IC	HE, ORG, INORG, METALS
16-012(t)	1	CARBC;IC	ORG, INORG, METALS, SOLV
16-012(u)	1	CARBC;IC	HE, ORG, INORG, METALS
16-012(v)	7	CARBC;IC	HE, ORG, INORG, METALS
16-012(w)	7	CARBC;IC	HE, ORG, INORG, METALS
16-012(x)	1	CARBC;IC	HE, ORG, INORG, METALS, SOLV
16-012(y)	7	CARBC;IC	HE, ORG, INORG, METALS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
16-012(z)	7	CARBC;IC	HE, ORG, INORG, METALS

Release Site: 16-013 DECOMMISSIONED WASTE STORAGE AREAS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
16-013	7	CARBC;IC	ORG, INORG, METALS, SOLV

Release Site: 16-015 LAUNDRY AND STEAM WASHING

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
16-015(a)	2	CARBC;IC	HE, ORG, INORG, METALS
16-015(b)	2	CARBC;IC	HE, ORG, INORG, METALS
16-015(d)	1	CARBC;IC	HE, ORG, INORG, METALS
16-105(c)	1	CARBC;IC	HE, ORG, INORG, METALS

Release Site: 16-016 LANDFILL/SURFACE DISPOSAL

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
16-016(a)	37	CARBC;IC	HE, ORG, INORG, METALS, BA
16-016(b)	23	CARBC;IC	HE, ORG, INORG, METALS
16-016(c)	28	CARBC;IC	HE, ORG, INORG, METALS
16-016(d)	7	CARBC;IC	HE, ORG, INORG, METALS
16-016(e)	7	CARBC;IC	HE, ORG, INORG, METALS
16-016(f)	7	CARBC;IC	HE, ORG, INORG, METALS
16-016(g)	23	CARBC;IC	HE, ORG, INORG, METALS

Release Site: 16-017 WORLD WAR II HE COMPLEX

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
16-017	926	CARBC;IC	HE, ORG, INORG, METALS

Release Site: 16-018 MATERIAL DISPOSAL AREA P

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
16-018	216,509	IS;IC	RAD, HE, ORG, INORG, METALS, PB, BA

Release Site: 16-019 MATERIAL DISPOSAL AREA R

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
16-019	73,245	IS;IC	RAD, HE, ORG, INORG, METALS, BA

Release Site: 16-020 SILVER RECOVERY/OUTFALL REGION

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
16-020	137	CARBC;IC	ORG, INORG, METALS, AG, PHOCHEM

Release Site: 16-021 OPERATIONAL RELEASES

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
16-021(a)	1	CARBC;IC	ORG, INORG, METALS
16-021(b)	1	CARBC;IC	ORG, INORG, METALS, PET

Release Site: 16-022 LEAKING UNDERGROUND STORAGE TANKS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
16-022(a)	1	CARBC;IC	ORG, INORG, METALS, PET
16-022(b)	1	CARBC;IC	ORG, INORG, METALS, PET

Release Site: 16-023 DECOMMISSIONED INCINERATOR

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
16-023(a)	25	CARBC;IC	HE, ORG, INORG, METALS
16-023(b)	25	CARBC;IC	HE, ORG, INORG, METALS

Release Site: 16-024 SOIL CONTAMINATION FROM DECOMMISSIONED BUILDING

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
16-024(a)	4	CARBC;IC	RAD, HE, ORG, INORG, METALS
16-024(b)	4	CARBC;IC	RAD, HE, ORG, INORG, METALS
16-024(c)	11	CARBC;IC	RAD, HE, ORG, INORG, METALS
16-024(d)	11	CARBC;IC	RAD, HE, ORG, INORG, METALS
16-024(e)	23	CARBC;IC	RAD, HE, ORG, INORG, METALS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
16-024(f)	4	CARBC;IC	RAD, HE, ORG, INORG, METALS
16-024(g)	4	CARBC;IC	RAD, HE, ORG, INORG, METALS
16-024(h)	4	CARBC;IC	RAD, HE, ORG, INORG, METALS, BA
16-024(i)	4	CARBC;IC	RAD, HE, ORG, INORG, METALS
16-024(j)	4	CARBC;IC	RAD, HE, ORG, INORG, METALS
16-024(k)	4	CARBC;IC	RAD, HE, ORG, INORG, METALS
16-024(l)	4	CARBC;IC	RAD, HE, ORG, INORG, METALS
16-024(m)	4	CARBC;IC	RAD, HE, ORG, INORG, METALS
16-024(n)	4	CARBC;IC	RAD, HE, ORG, INORG, METALS
16-024(o)	4	CARBC;IC	RAD, HE, ORG, INORG, METALS
16-024(p)	11	CARBC;IC	RAD, HE, ORG, INORG, METALS
16-024(q)	11	CARBC;IC	RAD, HE, ORG, INORG, METALS
16-024(r)	19	CARBC;IC	RAD, HE, ORG, INORG, METALS
16-024(s)	4	CARBC;IC	RAD, HE, ORG, INORG, METALS
16-024(t)	4	CARBC;IC	RAD, HE, ORG, INORG, METALS
16-024(u)	4	CARBC;IC	RAD, HE, ORG, INORG, METALS
16-024(v)	7	CARBC;IC	RAD, HE, ORG, INORG, METALS

Release Site: 16-025 SOIL CONTAMINATION FROM DECOMMISSIONED HE FACILITIES

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
16-025(a)	67	CARBC;IC	RAD, HE, ORG, INORG, METALS
16-025(a2)	42	CARBC;IC	RAD, HE, ORG, INORG, METALS
16-025(b)	12	CARBC;IC	RAD, HE, ORG, INORG, METALS
16-025(b2)	12	CARBC;IC	RAD, HE, ORG, INORG, METALS
16-025(c)	11	CARBC;IC	RAD, HE, ORG, INORG, METALS
16-025(c2)	12	CARBC;IC	RAD, HE, ORG, INORG, METALS
16-025(d)	17	CARBC;IC	RAD, HE, ORG, INORG, METALS
16-025(d2)	12	CARBC;IC	RAD, HE, ORG, INORG, METALS
16-025(e)	23	CARBC;IC	RAD, HE, ORG, INORG, METALS
16-025(e2)	12	CARBC;IC	RAD, HE, ORG, INORG, METALS
16-025(f)	28	CARBC;IC	RAD, HE, ORG, INORG, METALS
16-025(f2)	35	CARBC;IC	HE, ORG, INORG, METALS
16-025(g)	9	CARBC;IC	RAD, HE, ORG, INORG, METALS
16-025(g2)	35	CARBC;IC	HE, ORG, INORG, METALS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
16-025(h)	9	CARBC;IC	RAD, HE, ORG, INORG, METALS
16-025(h2)	35	CARBC;IC	HE, ORG, INORG, METALS
16-025(i)	11	CARBC;IC	RAD, HE, ORG, INORG, METALS
16-025(j)	12	CARBC;IC	RAD, HE, ORG, INORG, METALS
16-025(k)	23	CARBC;IC	RAD, HE, ORG, INORG, METALS
16-025(l)	139	CARBC;IC	RAD, HE, ORG, INORG, METALS
16-025(m)	7	CARBC;IC	RAD, HE, ORG, INORG, METALS
16-025(n)	7	CARBC;IC	RAD, HE, ORG, INORG, METALS
16-025(o)	4	CARBC;IC	RAD, HE, ORG, INORG, METALS
16-025(p)	46	CARBC;IC	RAD, HE, ORG, INORG, METALS
16-025(q)	46	CARBC;IC	RAD, HE, ORG, INORG, METALS
16-025(r)	46	CARBC;IC	RAD, HE, ORG, INORG, METALS
16-025(s)	11	CARBC;IC	RAD, HE, ORG, INORG, METALS
16-025(t)	93	CARBC;IC	RAD, HE, ORG, INORG, METALS
16-025(u)	556	CARBC;IC	RAD, HE, ORG, INORG, METALS
16-025(v)	46	CARBC;IC	RAD, HE, ORG, INORG, METALS
16-025(w)	1	CARBC;IC	RAD, HE, ORG, INORG, METALS
16-025(x)	12	CARBC;IC	RAD, HE, ORG, INORG, METALS
16-025(y)	46	CARBC;IC	RAD, HE, ORG, INORG, METALS
16-025(z)	12	CARBC;IC	RAD, HE, ORG, INORG, METALS

Release Site: 16-026 INACTIVE OUTFALLS FROM BUILDING DRAINS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
16-026(a)	2	CARBC;IC	RAD, ORG, INORG, METALS, SOLV, BA
16-026(a2)	2	CARBC;IC	RAD, ORG, INORG, METALS
16-026(b)	2	CARBC;IC	RAD, HE, ORG, INORG, METALS, SOLV
16-026(b2)	2	CARBC;IC	RAD, ORG, INORG, METALS
16-026(c)	2	CARBC;IC	RAD,HE,ORG,INORG,METALS,SOLV,BA
16-026(c2)	2	CARBC;IC	RAD, ORG, INORG, METALS, SOLV
16-026(d)	2	CARBC;IC	RAD, HE, ORG, INORG, METALS, BA
16-026(d2)	2	CARBC;IC	RAD, ORG, INORG, METALS
16-026(e)	2	CARBC;IC	RAD,HE,ORG,INORG,METALS,SOLV,BA
16-026(e2)	2	CARBC;IC	RAD, ORG, INORG, METALS
16-026(f)	2	CARBC;IC	RAD, HE, ORG, INORG, METALS, BA

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
16-026(f2)	2	CARBC;IC	RAD, ORG, INORG, METALS
16-026(g)	2	CARBC;IC	RAD, ORG, INORG, METALS, PET
16-026(g2)	2	CARBC;IC	RAD, ORG, INORG, METALS
16-026(h)	2	CARBC;IC	RAD, ORG, INORG, METALS
16-026(h2)	2	CARBC;IC	RAD, HE, ORG, INORG, METALS
16-026(i)	2	CARBC;IC	RAD, HE, ORG, INORG, METALS
16-026(i2)	2	CARBC;IC	RAD, ORG, INORG, METALS, BA
16-026(j)	2	CARBC;IC	RAD, HE, ORG, INORG, METALS
16-026(j2)	2	CARBC;IC	RAD, HE, ORG, INORG, METALS, BA
16-026(k)	2	CARBC;IC	RAD, ORG, INORG, METALS
16-026(k2)	2	CARBC;IC	RAD, HE, ORG, INORG, METALS, BA
16-026(l)	2	CARBC;IC	RAD, HE, ORG, INORG, METALS
16-026(m)	2	CARBC;IC	RAD, HE, ORG, INORG, METALS, BA
16-026(n)	2	CARBC;IC	RAD, HE, ORG, INORG, METALS, BA
16-026(o)	2	CARBC;IC	RAD, HE, ORG, INORG, METALS, BA
16-026(p)	2	CARBC;IC	RAD, HE, ORG, INORG, METALS, BA
16-026(q)	2	CARBC;IC	RAD, HE, ORG, INORG, METALS
16-026(r)	2	CARBC;IC	RAD, ORG, INORG, METALS, PET
16-026(s)	2	CARBC;IC	RAD, ORG, INORG, METALS, SOLV, PET
16-026(t)	2	CARBC;IC	RAD, ORG, INORG, METALS
16-026(u)	2	CARBC;IC	RAD, ORG, INORG, METALS
16-026(v)	2	CARBC;IC	RAD,HE,ORG,INORG,METALS,SOLV,BA,HG
16-026(w)	2	CARBC;IC	RAD, HE, ORG, INORG, METALS
16-026(x)	2	CARBC;IC	RAD, ORG, INORG, METALS
16-026(y)	2	CARBC;IC	RAD, ORG, INORG, METALS
16-026(z)	2	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: 16-027, LEAKAGE FROM PCB TRANSFORMERS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
16-027(a)	1	CARBC;IC	ORG, INORG, METALS, PCB
16-027(b)	1	CARBC;IC	ORG, INORG, METALS, PCB
16-027(c)	1	CARBC;IC	ORG, INORG, METALS, PCB
16-027(d)	1	CARBC;IC	ORG, INORG, METALS, PCB

Release Site: 16-028 ACTIVE OUTFALLS FROM COOLING TOWERS AND TANKS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
16-028(a)	9	CARBC;IC	HE, ORG, INORG, METALS, BA
16-028(b)	9	CARBC;IC	ORG, INORG, METALS, SOLV, BA
16-028(c)	9	CARBC;IC	ORG, INORG, METALS
16-028(d)	9	CARBC;IC	ORG, INORG, METALS
16-028(e)	9	CARBC;IC	ORG, INORG, METALS

Release Site: 16-029 INACTIVE HE SUMPS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
16-029(a)	1	CARBC;IC	HE, ORG, INORG, METALS, BA
16-029(a2)	1	CARBC;IC	HE, ORG, INORG, METALS, BA
16-029(b)	1	CARBC;IC	HE, ORG, INORG, METALS, BA
16-029(b2)	1	CARBC;IC	HE, ORG, INORG, METALS, BA
16-029(c)	1	CARBC;IC	HE, ORG, INORG, METALS, BA
16-029(c2)	1	CARBC;IC	HE, ORG, INORG, METALS, BA
16-029(d)	1	CARBC;IC	HE, ORG, INORG, METALS, BA
16-029(d2)	1	CARBC;IC	HE, ORG, INORG, METALS, BA
16-029(e)	1	CARBC;IC	HE, ORG, INORG, METALS, BA
16-029(e2)	1	CARBC;IC	HE, ORG, INORG, METALS, BA
16-029(f)	1	CARBC;IC	HE, ORG, INORG, METALS, BA
16-029(f2)	1	CARBC;IC	HE, ORG, INORG, METALS, BA
16-029(g)	1	CARBC;IC	HE, ORG, INORG, METALS, BA
16-029(g2)	3	CARBC;IC	HE, ORG, INORG, METALS, BA
16-029(h)	1	CARBC;IC	HE, ORG, INORG, METALS, BA
16-029(h2)	1	CARBC;IC	HE, ORG, INORG, METALS, BA
16-029(i)	1	CARBC;IC	HE, ORG, INORG, METALS, BA
16-029(j)	1	CARBC;IC	HE, ORG, INORG, METALS, BA
16-029(k)	2	CARBC;IC	HE, ORG, INORG, METALS, BA
16-029(l)	1	CARBC;IC	HE, ORG, INORG, METALS, BA
16-029(m)	2	CARBC;IC	HE, ORG, INORG, METALS, BA
16-029(n)	2	CARBC;IC	HE, ORG, INORG, METALS, BA

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
16-029(o)	2	CARBC;IC	HE, ORG, INORG, METALS, BA
16-029(p)	2	CARBC;IC	HE, ORG, INORG, METALS, BA
16-029(q)	3	CARBC;IC	HE, ORG, INORG, METALS, BA
16-029(r)	2	CARBC;IC	HE, ORG, INORG, METALS, BA
16-029(s)	1	CARBC;IC	HE, ORG, INORG, METALS, BA
16-029(t)	2	CARBC;IC	HE, ORG, INORG, METALS, BA
16-029(u)	2	CARBC;IC	HE, ORG, INORG, METALS, BA
16-029(v)	1	CARBC;IC	HE, ORG, INORG, METALS, BA
16-029(w)	1	CARBC;IC	HE, ORG, INORG, METALS, BA
16-029(x)	1	CARBC;IC	HE, ORG, INORG, METALS, BA
16-029(y)	1	CARBC;IC	HE, ORG, INORG, METALS, BA
16-029(z)	1	CARBC;IC	HE, ORG, INORG, METALS, BA

Release Site: 16-030 ACTIVE OUTFALLS FROM BUIDING DRAINS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
16-030(a)	3	CARBC;IC	HE, ORG, INORG, METALS, SOLV
16-030(b)	3	CARBC;IC	ORG, INORG, METALS
16-030(c)	6	CARBC;IC	ORG, INORG, METALS
16-030(d)	3	CARBC;IC	HE, ORG, INORG, METALS
16-030(e)	3	CARBC;IC	ORG, INORG, METALS
16-030(f)	3	CARBC;IC	ORG, INORG, METALS
16-030(g)	3	CARBC;IC	ORG, INORG, METALS
16-030(h)	3	CARBC;IC	ORG, INORG, METALS

Release Site: 16-031 INACTIVE OUTFALLS FROM COOLING TOWERS AND INDUSTRIAL LINES

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
16-031(a)	5	CARBC;IC	ORG, INORG, METALS, CR
16-031(b)	5	CARBC;IC	ORG, INORG, METALS, CR
16-031(c)		CARBC;IC	HE, ORG, INORG, METALS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
16-031(d)	5	CARBC;IC	ORG, INORG, METALS, CR
16-031(e)	5	CARBC;IC	ORG, INORG, METALS
16-031(f)	5	CARBC;IC	ORG, INORG, METALS
16-031(g)	5	CARBC;IC	ORG, INORG, METALS, CR
16-031(h)	5	CARBC;IC	ORG, INORG, METALS

Release Site: 16-032 DECOMMISSIONED HE SUMPS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
16-032(a)	1	CARBC;IC	HE, ORG, INORG, METALS, PB
16-032(b)	1	CARBC;IC	HE, ORG, INORG, METALS
16-032(c)	1	CARBC;IC	HE, ORG, INORG, METALS
16-032(d)	1	CARBC;IC	HE, ORG, INORG, METALS
16-032(e)	1	CARBC;IC	HE, ORG, INORG, METALS

Release Site: 16-033 DECOMMISSIONED FUEL TANKS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
16-033(a)	1	CARBC;IC	ORG, INORG, METALS, PET
16-033(b)	1	CARBC;IC	ORG, INORG, METALS, PET
16-033(c)	7	CARBC;IC	ORG, INORG, METALS, PET
16-033(e)	1	CARBC;IC	ORG, INORG, METALS, PET
16-033(f)	1	CARBC;IC	ORG, INORG, METALS, PET
16-033(g)	1	CARBC;IC	ORG, INORG, METALS, PET
16-033(h)	1	CARBC;IC	ORG, INORG, METALS, PET
16-033(i)	1	CARBC;IC	ORG, INORG, METALS, PET
16-033(j)	1	CARBC;IC	ORG, INORG, METALS, PET

Release Site: 16-034 SOIL CONTAMINATION FROM MISC. BUILDINGS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
16-034(a)	28	CARBC;IC	HE, ORG, INORG, METALS
16-034(b)	133	CARBC;IC	HE, ORG, INORG, METALS
16-034(c)	7	CARBC;IC	HE, ORG, INORG, METALS
16-034(d)	7	CARBC;IC	HE, ORG, INORG, METALS
16-034(e)	23	CARBC;IC	HE, ORG, INORG, METALS
16-034(f)	28	CARBC;IC	HE, ORG, INORG, METALS
16-034(g)	7	CARBC;IC	HE, ORG, INORG, METALS
16-034(h)	7	CARBC;IC	HE, ORG, INORG, METALS
16-034(i)	7	CARBC;IC	HE, ORG, INORG, METALS
16-034(j)	7	CARBC;IC	HE, ORG, INORG, METALS
16-034(k)	7	CARBC;IC	HE, ORG, INORG, METALS
16-034(l)	4	CARBC;IC	HE, ORG, INORG, METALS
16-034(m)	4	CARBC;IC	HE, ORG, INORG, METALS
16-034(n)	7	CARBC;IC	HE, ORG, INORG, METALS
16-034(o)	65	CARBC;IC	HE, ORG, INORG, METALS
16-034(p)	23	CARBC;IC	HE, ORG, INORG, METALS

Release Site: 16-035 SOIL CONTAMINATION FROM FORMER CONTROL BUNKER

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
16-035	145	CARBC;IC	ORG, INORG, METALS

Release Site: 16-036 SOIL CONTAMINATION FROM BATTLESHIP BUNKERS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
16-036	93	CARBC;IC	HE, ORG, INORG, METALS

Release Site: 16-037 INDUSTIRAL WASTE TANK

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
16-037	1	CARBC;IC	ORG, INORG, METALS

Release Site: 25-001 PIT

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
25-001	3	CARBC;IC	HE, ORG, INORG, METALS

Release Site: 37-001 SEPTIC SYSTEM

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
37-001	266	CARBC;IC	ORG, INORG, METALS

Release Site: C-11-001, TA-11-5 LAB SITE (REMOVED)

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-11-001	37	CARBC;IC	HE, ORG, INORG, METALS

Release Site: C-11-002, TA-11-12 LAB SITE (REMOVED)

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-11-002	37	CARBC;IC	HE, ORG, INORG, METALS

Release Site: C-11-003, TA-11-5

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-11-003	15	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: C-12-001 TA-12-1 TRIMMING BUILDING (REMOVED)

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-12-001	370	CARBC;IC	HE, ORG, INORG, METALS

Release Site: C-12-002 TA-12-2 CONTROL CHAMBER REMOVED

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-12-002	370	CARBC;IC	HE, ORG, INORG, METALS

Release Site: C-12-003 TA-12-3 MAGAZINE (REMOVED)

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-12-003	37	CARBC;IC	HE, ORG, INORG, METALS

Release Site: C-12-006 NEAR TA-12-8 TALL POLE

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-12-006	370	CARBC;IC	RAD, HE, ORG, INORG, METALS

Release Site: C-16-005 TA-16-53 OPTICAL EQUIPMENT STORAGE BUILDING (REMOVED)

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-16-005	370	CARBC;IC	HE, ORG, INORG, METALS

Release Site: C-16-060, TA-16-429 BUILDING (REMOVED)

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-16-060	74	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: C-16-061, CROSSOVER PLATFORM (REMOVED)

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-16-061	1	CARBC;IC	HE, ORG, INORG, METALS

Release Site: C-16-064, TA-16-183 CHEMICAL STORAGE AREA (REMOVED)

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-16-064	370	CARBC;IC	ORG, INORG, METALS

Release Site: C-16-065, CHEMICAL STORAGE AREA (ABANDONED)

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-16-065	370	CARBC;IC	ORG, INORG, METALS

Release Site: C-16-066, TA-16-186 CHEMICAL STORAGE AREA (ABANDONED)

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-16-066	37	CARBC;IC	ORG, INORG, METALS

Release Site: C-16-067, CHEMICAL STORAGE AREA (REMOVED)

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-16-067	370	CARBC;IC	ORG, INORG, METALS

Release Site: C-16-068, TA-16-522 BUILDING (REMOVED)

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-16-068	370	CARBC;IC	ORG, INORG, METALS, BE

Release Site: C-16-070 TA-16-391 UST (ABANDONED)

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-16-070	37	CARBC;IC	ORG, INORG, METALS, PET

Release Site: C-16-072 TA-16-216 FUEL TANK

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-16-072	37	CARBC;IC	ORG, INORG, METALS, PET

Release Site: C-16-073 TA-16-200

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-16-073	37	CARBC;IC	ORG, INORG, METALS, PET

Release Site: C-16-074 NEAR TA-16-516 STAINED SOIL

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-16-074	37	CARBC;IC	ORG, INORG, METALS

Release Site: C-25-001, V-3 BUILDING (REMOVED)

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-25-001	370	CARBC;IC	HE, ORG, INORG, METALS, BE

TA-14

Task #: AL-LA-54
ADS #: 1085

Release Site: 14-001 FIRING SITES

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
14-001(a) TA-14-25	1	CARBC;IC	RAD, HE, ORG, INORG, METALS, PB, BE
14-001(b) TA-14-26	1	CARBC;IC	RAD, HE, ORG, INORG, METALS, PB, BE
14-001(c) TA-14-27	1	CARBC;IC	RAD, HE, ORG, INORG, METALS, PB, BE
14-001(d) TA-14-28	1	CARBC;IC	RAD, HE, ORG, INORG, METALS, PB, BE
14-001(e) TA-14-29	1	CARBC;IC	RAD, HE, ORG, INORG, METALS, PB, BE
14-001(f) TA-14-34	2	CARBC;IC	RAD, HE, ORG, INORG, METALS, PB, BE
14-001(g) TA-14-35	3	CARBC;IC	RAD, HE, ORG, INORG, METALS, PB, BE

Release Site: 14-002 DECOMMISSIONED FIRING SITES

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
14-002(a) TA-14-2	1	CARBC;IC	RAD, HE, ORG, INORG, METALS, PB, BE
14-002(b) TA-14-17	1	CARBC;IC	RAD, HE, ORG, INORG, METALS, PB, BE
14-002(c) TA-14-5	12	CARBC;IC	RAD, HE, ORG, INORG, METALS, PB, BE
14-002(d) TA-14-14	12	CARBC;IC	RAD, HE, ORG, INORG, METALS, PB, BE
14-002(e) TA-14-15	12	CARBC;IC	RAD, HE, ORG, INORG, METALS, PB, BE
14-002(f) TA-14-12	1	CARBC;IC	RAD, HE, ORG, INORG, METALS, PB, BE

Release Site: 14-003 BURN PIT

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
14-003	36	CARBC;IC	RAD, HE, ORG, INORG, METALS

Release Site: 14-004 WASTE STORAGE AREA

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
14-004(a) TA-14-22	1	CARBC;IC	HE, ORG, INORG, METALS
14-004(b) TA-14-23	1	CARBC;IC	HE, ORG, INORG, METALS
14-004(c) TA-14-35	4	CARBC;IC	HE, ORG, INORG, METALS

Release Site: 14-005 INCINERATOR

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
14-005	1	CARBC;IC	RAD, HE, ORG, INORG, METALS

Release Site: 14-006 SUMP AND DRAIN

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
14-006	7	CARBC;IC	HE, ORG, INORG, METALS

Release Site: 14-007 SEPTIC SYSTEMS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
14-007	3	CARBC;IC	RAD, HE, ORG, INORG, METALS

Release Site: 14-008 LANDFILL/SURFACE DISPOSAL

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
14-008	1,389	CARBC;IC	RAD, HE, ORG, INORG, METALS

Release Site: 14-009 SURFACE DISPOSAL

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
14-009	74	CARBC;IC	RAD, HE, ORG, INORG, METALS

Release Site: 14-010 DECOMMISSIONED SUMP

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
14-010	7	CARBC;IC	RAD, HE, ORG, INORG, METALS

Release Site: C-14-001 TA-14-1 MAGAZINE (REMOVED)

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-14-001	37	CARBC;IC	HE, ORG, INORG, METALS

Release Site: C-14-002 TA-14-3 CONTROL ROOM (REMOVED)

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-14-002	370	CARBC;IC	RAD, HE, ORG, INORG, METALS

Release Site: C-14-003 TA-14-4 EXPLOSIVES PREPARATION BUILDING (REMOVED)

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-14-003	370	CARBC;IC	RAD, HE, ORG, INORG, METALS

Release Site: C-14-004 TA-14-7 ELECTRONIC SHOP (REMOVED)

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-14-004	370	CARBC;IC	HE, ORG, INORG, METALS

Release Site: C-14-005 TA-14-8 STORAGE BUILDING (REMOVED)

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-14-005	370	CARBC;IC	RAD, HE, ORG, INORG, METALS

Release Site: C-14-006 TA-14-9 MAGAZINE (REMOVED)

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-14-006	37	CARBC;IC	HE, ORG, INORG, METALS

Release Site: C-14-007 TA-14-10 STORAGE BUILDING (REMOVED)

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-14-007	370	CARBC;IC	RAD, HE, ORG, INORG, METALS

Release Site: C-14-008 TA-14-11 MAGAZINE (REMOVED)

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-14-008	37	CARBC;IC	HE, ORG, INORG, METALS

Release Site: C-14-009 TA-14-009 MAGAZINE (REMOVED)

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-14-009	37	CARBC;IC	HE, ORG, INORG, METALS

■ TA-15

Task #: AL-LA-23
ADS #: 1086

Release Site: 15-001 BONEYARD

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
15-001	93	CARBC;IC	RAD, HE, ORG, INORG, METALS

Release Site: 15-002 BURNING AREAS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
15-002	4	CARBC;IC	RAD, HE, ORG, INORG, METALS

Release Site: 15-003 DETONATION AREA

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
15-003	7	CARBC;IC	HE, ORG, INORG, METALS

Release Site: 15-004 DECOMMISSIONED FIRING AREAS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
15-004(a), UNNAMED	2,327	CARBC;IC	RAD, HE, ORG, INORG, METALS
15-004(b), POINT A	2,327	CARBC;IC	RAD, HE, ORG, INORG, METALS
15-004(c), POINT B	2,327	CARBC;IC	RAD, HE, ORG, INORG, METALS
15-004(d), POINT C	582	CARBC;IC	RAD, HE, ORG, INORG, METALS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
15-004(e), POINT D	582	CARBC;IC	RAD, HE, ORG, INORG, METALS
15-004(f), POINT E-F	21,685	CARBC;IC	RAD, HE, ORG, INORG, METALS
15-004(g), POINT G	5,236	CARBC;IC	RAD, HE, ORG, INORG, METALS
15-004(h), POINT H	5,236	CARBC;IC	RAD, HE, ORG, INORG, METALS
15-004(i), GULCH	5,236	CARBC;IC	RAD, HE, ORG, INORG, METALS

Release Site: 15-005 CONTAINER STORAGE AREAS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
15-005(a), TA-15-20	1	CARBC;IC	ORG, INORG, METALS
15-005(b), TA-15-242	1	CARBC;IC	HE, ORG, INORG, METALS
15-005(c), TA-15-41	1	CARBC;IC	HE, ORG, INORG, METALS
15-005(d), TA-15-30	1	CARBC;IC	ORG, INORG, METALS

Release Site: 15-006 ACTIVE FIRING AREAS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
15-006(a), PHERMEX	24,580	CARBC;IC	RAD, HE, ORG, INORG, METALS
15-006(b), ECTOR	9,308	CARBC;IC	RAD, HE, ORG, INORG, METALS
15-006(c), R-44	5,236	CARBC;IC	RAD, HE, ORG, INORG, METALS
15-006(d), R-45	5,236	CARBC;IC	RAD, HE, ORG, INORG, METALS
15-006(e), 120-MM GUN	463	CARBC;IC	RAD, HE, ORG, INORG, METALS

Release Site: 15-007 LANDFILLS/SURFACE DISPOSAL

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
15-007(a), MDA-N	2,420	IS;IC	RAD, HE, ORG, INORG, METALS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
15-007(b), MDA-Z	16,133	IS;IC	RAD, HE, ORG, INORG, METALS
15-007(c), TA-15-264	124	IS;IC	HE, ORG, INORG, METALS
15-007(d), TA-15-265	124	IS;IC	RAD, HE, ORG, INORG, METALS

Release Site: 15-008 SURFACE DISPOSAL

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
15-008(a), S of TA-15-27	2,778	CARBC;IC	RAD, HE, ORG, INORG, METALS
15-008(b), N of TA-15-44	926	CARBC;IC	RAD, HE, ORG, INORG, METALS
15-008(c), NEAR TA-15-233	463	CARBC;IC	RAD, HE, ORG, INORG, METALS
15-008(d), TA-15-22	116	CARBC;IC	ORG, INORG, METALS
15-008(e), TA-15-195	15	CARBC;IC	ORG, INORG, METALS
15-008(f), W of TA-15-29	370	CARBC;IC	ORG, INORG, METALS
15-008(g), TA-15-116, -142	370	CARBC;IC	ORG, INORG, METALS

Release Site: 15-009 ACTIVE SEPTIC SYSTEMS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
15-009(a), R-51	6	CARBC;IC	ORG, INORG, METALS
15-009(b), R-61	7	CARBC;IC	ORG, INORG, METALS
15-009(c), R-62	142	CARBC;IC	ORG, INORG, METALS
15-009(d), R-63	21	CARBC;IC	ORG, INORG, METALS
15-009(e), R-72	142	CARBC;IC	ORG, INORG, METALS
15-009(f), R-195	355	CARBC;IC	ORG, INORG, METALS
15-009(g), R-205	96	CARBC;IC	RAD, ORG, INORG, METALS, SOLV
15-009(h), R-282	117	CARBC;IC	ORG, INORG, METALS
15-009(i), R-284	145	CARBC;IC	ORG, INORG, METALS
15-009(j), R-286	145	CARBC;IC	ORG, INORG, METALS
15-009(k), R-00	141	CARBC;IC	ORG, INORG, METALS

Release Site: 15-010 INACTIVE SEPTIC SYSTEMS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
15-010(a), R-80	115	CARBC;IC	RAD, ORG, INORG, METALS
15-010(b), R-147	118	CARBC;IC	RAD, HE, ORG, INORG, METALS
15-010(c), R-92	112	CARBC;IC	ORG, INORG, METALS

Release Site: 15-011 SUMPS, DRY WELL

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
15-011(a), W of TA-15-20	142	CARBC;IC	HE, ORG, INORG, METALS
15-011(b), W of TA-15-194	23	CARBC;IC	ORG, INORG, METALS, ACIDS, SOLV
15-011(c), NEAR TA-15-50	142	CARBC;IC	ORG, INORG, METALS, ACIDS

Release Site: 15-012 OPERATIONAL RELEASE

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
15-012(a), DISPOSAL AREA	9	CARBC;IC	RAD, ORG, INORG, METALS
15-012(b), WASHING AREA	9	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: 15-013, UNDERGROUND STORAGE TANKS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
15-013(a), R-192	5	CARBC;IC	ORG, INORG, METALS, PET
15-013(b), R-266	5	CARBC;IC	ORG, INORG, METALS, PET

Release Site: 15-014 DRAINLINES AND OUTFALLS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
15-014(a), R-183	94	CARBC;IC	ORG, INORG, METALS
15-014(b), R-183	94	CARBC;IC	RAD, HE, ORG, INORG, METALS
15-014(c), R-242	94	CARBC;IC	ORG, INORG, METALS
15-014(d), R-185	94	CARBC;IC	HE, ORG, INORG, METALS
15-014(e), R-184	94	CARBC;IC	ORG, INORG, METALS
15-014(f), R-263	94	CARBC;IC	ORG, INORG, METALS
15-014(g), R-203	94	CARBC;IC	HE, ORG, INORG, METALS
15-014(h), R-40	94	CARBC;IC	HE, ORG, INORG, METALS
15-014(i), R-194	94	CARBC;IC	HE, ORG, INORG, METALS
15-014(j), R-50	94	CARBC;IC	HE, ORG, INORG, METALS, BE
15-014(k), R-20	94	CARBC;IC	ORG, INORG, METALS
15-014(l), R-202	94	CARBC;IC	HE, ORG, INORG, METALS
15-014(m), R-306	94	CARBC;IC	ORG, INORG, METALS

Release Site: C-15-001, SOIL PILE SOUTH OF TA-15-9

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-15-001, S of TA-15-9	19	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: C-15-002, SOIL PILE SOUTH OF TA-15-285

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-15-002	19	CARBC;IC	RAD, HE, METALS

Release Site: C-15-003, NORTH OF TA-15-45 BLACK GRANULAR MATERIAL

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-15-003	19	CARBC;IC	ORG, INORG, METALS

Release Site: C-15-005, FORMER LOCATION OF TA-15-1 LABORATORY AND SHOP

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-15-005, TA-15-1	370	CARBC;IC	RAD, ORG, INORG, METALS, HG

Release Site: C-15-006, TA-15-7 OFFICE AND DARK ROOM (REMOVED)

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-15-006	370	CARBC;IC	ORG, INORG, METALS, HG

Release Site: C-15-007, TA-15-194

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-15-007	4	CARBC;IC	ORG, INORG, METALS

Release Site: C-15-009, TA-15-48 FUEL UST

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-15-009	74	CARBC;IC	ORG, INORG, METALS, PET

Release Site: C-15-010, TA-15-52 FUEL UST

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-15-010	74	CARBC;IC	ORG, INORG, METALS, PET

Release Site: C-15-011, TA-15-274 GASOLINE UST

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-15-011	37	CARBC;IC	ORG, INORG, METALS, PET

■ TA's 18, 27, 65

Task #: AL-LA-18
ADS #: 1093

Release Site: 18-001 LAGOONS AND DRAINLINES

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
18-001(a), LAGOONS	533	CARBC;IC	RAD, ORG, INORG, METALS, SOLV
18-001(b), SEWER LINES	64	CARBC;IC	RAD, ORG, INORG, METALS, SOLV
18-001(c), SUMP	1	CARBC;IC	RAD, ORG, INORG, METALS, PHOCHEM

Release Site: 18-002 FIRING SITES/DROP TOWER

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
18-002(a), TA-18-2, TA-18-3	2,315	CARBC;IC	RAD, HE, ORG, INORG, METALS, CD, PB
18-002(b), TA-18-4, TA-18-5	93	CARBC;IC	RAD, HE, ORG, INORG, METALS, CD, PB
18-002(c), DROP TOWER	93	CARBC;IC	RAD, HE, ORG, INORG, METALS

Release Site: 18-003 SEPTIC SYSTEMS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
18-003(a), TA-18-105	46	CARBC;IC	RAD, ORG, INORG, METALS
18-003(b), TA-18-39	46	CARBC;IC	RAD, ORG, INORG, METALS
18-003(c), TA-18-42	54	CARBC;IC	RAD, ORG, INORG, METALS, BE
18-003(d), TA-18-120	49	CARBC;IC	RAD, ORG, INORG, METALS, ACIDS
18-003(e), TA-18-40	65	CARBC;IC	ORG, INORG, METALS, SOLV, BE
18-003(f), TA-18-41	65	CARBC;IC	ORG, INORG, METALS, SOLV, BE
18-003(g), TA-18-43	19	CARBC;IC	ORG, INORG, METALS, SOLV, BE
18-003(h), TA-18-152	19	CARBC;IC	ORG, INORG, METALS, SOLV, BE

Release Site: 18-004 TANKS/LINES

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
18-004(a), WASTELINES	1	CARBC;IC	RAD, ORG, INORG, METALS, SOLV, ACID
18-004(b), PIT	1	CARBC;IC	RAD, ORG, INORG, METALS, SOLV, ACID

Release Site: 18-005 FORMER MAGAZINE STIES

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
18-005(a), TA-18-15	23	CARBC;IC	RAD, ORG, INORG, METALS, BE
18-005(b), TA-18-11	23	CARBC;IC	HE, ORG, INORG, METALS
18-005(c), TA-18-12	23	CARBC;IC	HE, ORG, INORG, METALS

Release Site: 18-006 URANIUM SOLUTION PIPE

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
18-006	1	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: 18-007 SUSPECTED BURIAL SITE

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
18-007	174	CARBC;IC	RAD, HE, ORG, INORG, METALS

Release Site: 18-008 INACTIVE UNDERGROUND STORAGE TANK

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
18-008	1	CARBC;IC	ORG, INORG, METALS

Release Site: 18-009 LEAKAGE FROM PCB TRANSFORMERS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
18-009(a), TA-18-136	3	CARBC;IC	ORG, INORG, METALS, PCB
18-009(b), TA-18-46	1	CARBC;IC	ORG, INORG, METALS, PCB
18-009(c), TA-18-148	3	CARBC;IC	ORG, INORG, METALS, PCB
18-009(d), TA-18-142	3	CARBC;IC	ORG, INORG, METALS, PCB
18-009(e), TA-18-252	44	CARBC;IC	ORG, INORG, METALS, PCB

Release Site: 18-010 STORM SEWER OUTFALLS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
18-010(a), MAIN COMPLEX	39	CARBC;IC	RAD, ORG, INORG, METALS
18-010(b), TA-18-36	39	CARBC;IC	RAD, ORG, INORG, METALS
18-010(c), TA-18-31	39	CARBC;IC	RAD, ORG, INORG, METALS
18-010(d), TA-18-37	39	CARBC;IC	RAD, ORG, INORG, METALS,
18-010(e), TA-18-28-147	40	CARBC;IC	RAD, ORG, INORG, METALS
18-010(f), KIVA 2	39	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: 18-011 POTENTIAL SOIL CONTAMINATION BENEATH FORMER STRUCTURES

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
18-011	33	CARBC;IC	HE, ORG, INORG, METALS, HG

Release Site: 18-012 SUMPS, ACID DRAINLINES, OUTFALLS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
18-012(a)	37	CARBC;IC	RAD, ORG, INORG, METALS, ACIDS
18-012(b)	37	CARBC;IC	RAD, ORG, INORG, METALS, BE
18-012(c)	1	CARBC;IC	RAD, ORG, INORG, METALS
18-012(d)	1	CARBC;IC	ORG, INORG, METALS

Release Site: 27-001 GAMMA SITE TRENCH

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
27-001	370	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: 27-002 FIRING PITS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
27-002	11,574	CARBC;IC	RAD, HE, ORG, INORG, METALS, PB, BE

Release Site: 27-003 IMPACT ZONE

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
27-003	5,556	CARBC;IC	HE, ORG, INORG, METALS

Release Site: 27-004 SOIL CONTAMINATION UNDER FORMER BUILDING LOCATION

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
27-004	15	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: C-18-001 TA-18-1 OR TA-18-30 PHOTOPROCESSING LABORATORY (REMOVED)

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-18-001	370	CARBC;IC	ORG, INORG, METALS, PHOCHEM

Release Site: C-18-003 BEHIND TA-18-1 POSSIBLE RADIOACTIVE WASTE STORAGE AREA

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-18-003	370	CARBC;IC	RAD, ORG, INORG, METALS

■ TA's 2, 41

Task #: AL-LA-42
ADS #: 1098

Release Site: 2-001 BURN SITE

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
2-001, NO ASSOCIATED STRUCTURE	46	CARBC;IC	ORG, INORG, METALS

Release Site: 2-002 INACTIVE CONTAINER STORAGE AREA

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
2-002, NEAR TA-2-1	25	CARBC;IC	ORG, INORG, METALS, PET, PCB

Release Site: 2-003 DECOMMISSIONED REACTOR WASTE UNITS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
2-003(a), TA-2-19	8	CARBC;IC	RAD, ORG, INORG, METALS
2-003(b), TA-2-48	5	CARBC;IC	RAD, ORG, INORG, METALS
2-003(c), DELAY SYSTEM	1	CARBC;IC	RAD, ORG, INORG, METALS
2-003(d), TA-2-9	3	CARBC;IC	RAD, ORG, INORG, METALS
2-003(e), TA-2-62	2	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: 2-004 STORAGE PITS AND TANKS OF THE OMEGA WEST REACTOR

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
2-004(a), TA-2-1	3	CARBC;IC	RAD, ORG, INORG, METALS
2-004(b), TA-2-54	6	CARBC;IC	RAD, ORG, INORG, METALS
2-004(c), TA-2-55	6	CARBC;IC	RAD, ORG, INORG, METALS
2-004(d), TA-20-56	6	CARBC;IC	RAD, ORG, INORG, METALS
2-004(e), TA-2-53	21	CARBC;IC	RAD, ORG, INORG, METALS
2-004(f), TA-2-44	13	CARBC;IC	RAD, ORG, INORG, METALS
2-004(g), NEAR GUARD STATION	2	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: 2-005 COOLING TOWER DRIFT LOSS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
2-005, TA-2-49	741	CARBC;IC	ORG, INORG, METALS, CR

Release Site: 2-006 DRAINS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
2-006(a), TA-2-9	1	CARBC;IC	RAD, ORG, INORG, METALS, SOLV
2-006(b), TA-2-1	167	CARBC;IC	RAD, ORG, INORG, METALS, SOLV
2-006(c), TA-2-1	167	CARBC;IC	RAD, ORG, INORG, METALS, SOLV
2-006(d), TA-2-1	167	CARBC;IC	RAD, ORG, INORG, METALS, SOLV
2-006(e), TA-2-1	167	CARBC;IC	RAD, ORG, INORG, METALS, SOLV

Release Site: 2-007, DECOMMISSIONED SEPTIC SYSTEM

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
2-007, TA-2-43	15	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: 2-008 OUTFALLS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
2-008(a), S OF TA-2-1	19	CARBC;IC	RAD, ORG, INORG, METALS, CR
2-008(b), TA-2-4	19	CARBC;IC	ORG, INORG, METALS, PHOCHEM
2-008(c), TA-2-1	19	CARBC;IC	ORG, INORG, METALS

Release Site: 2-009 OPERATIONAL RELEASES

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
2-009(a), BEHIND TA-2-50	449	CARBC;IC	RAD, ORG, INORG, METALS
2-009(b), N OF TA-2-19	148	CARBC;IC	RAD, ORG, INORG, METALS
2-009(c), TA-2-48	208	CARBC;IC	RAD. ORG, INORG, METALS
2-009(d), TA-2-1	93	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: 2-010 CHEMICAL SHACK WASTE UNITS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
2-010, TA-2-3, -33	94	CARBC;IC	RAD, ORG, INORG, METALS, SOLV, ACID

Release Site: 2-011 STORM DRAINS AND OUTFALLS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
2-011(a), TA-2-1	228	CARBC;IC	RAD, ORG, INORG, METALS
2-011(b), TA-2-19	1	CARBC;IC	RAD, ORG, INORG, METALS
2-011(c), TA-2-44	1	CARBC;IC	RAD, ORG, INORG, METALS
2-011(d), TA-2-44	37	CARBC;IC	ORG, INORG, METALS, SOLV
2-011(e), TA-2-49	37	CARBC;IC	ORG, INORG, METALS, SOLV

Release Site: 2-012 POTENTIAL SOIL CONTAM. BENEATH FORMER UNDERGROUND STORAGE TANK

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
2-012, TA-2-29, -67	2	CARBC;IC	ORG, INORG, METALS, PET

Release Site: 2-013 ACTIVE HAZARDOUS WASTE CONTAINER STORAGE AREAS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
2-013, TA-2-1	1	CARBC;IC	ORG, INORG, METALS, SOLV

Release Site: 41-001 SEPTIC SYSTEM

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
41-001, TANK TA-41-11	2	CARBC;IC	RAD, ORG, INORG, METALS, SOLV

Release Site: 41-002 SEWAGE TREATMENT PLANT

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
41-002(a) TA-41-7	25	CARBC;IC	RAD, ORG, INORG, METALS, SOLV
41-002(b) TA-41-8	42	CARBC;IC	RAD, ORG, INORG, METALS, SOLV
41-002(c) TA-41-9	17	CARBC;IC	RAD, ORG, INORG, METALS, SOLV

Release Site: 41-003 SUMP

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
41-003, TA-41-10	1	CARBC;IC	ORG, INORG, METALS

Release Site: 41-004 CONTAINER STORAGE AREA

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
41-004, TA-41-30	1	CARBC;IC	ORG, INORG, METALS, PHOCHEM

Release Site: C-41-004 TA-41 STORM DRAINS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-41-004, TA-41	370	CARBC;IC	ORG, INORG, METALS

Release Site: C-41-005 TA-41-46

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-41-005, TA-41	10	CARBC;IC	ORG, INORG, METALS

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Task #: AL-LA-34
ADS #: 1100

Release Site: 20-001 LANDFILLS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
20-001(a) Area 1	1,778	CARBC;IC	RAD, HE, ORG, INORG, METALS
20-001(b) Area 2	5,185	CARBC;IC	RAD, HE, ORG, INORG, METALS
20-001(c) Area 3	1,333	CARBC;IC	RAD, HE, ORG, INORG, METALS

Release Site: 20-002 DETONATION PIT AND FIRING AREA

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
20-002 TA-20-6	296	CARBC;IC	RAD, HE, ORG, INORG, METALS

Release Site: 20-003 GUN FIRING SITES

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
20-003(a) TA-20-2	20	CARBC;IC	RAD, HE, ORG, INORG, METALS
20-003(b) TA-20-13	20	CARBC;IC	RAD, HE, ORG, INORG, METALS
20-003(c) TA-20-16	20	CARBC;IC	RAD, HE, ORG, INORG, METALS
20-003(d) TA-20-29	20	CARBC;IC	RAD, HE, ORG, INORG, METALS

Release Site: 20-004 SEPTIC SYSTEM

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
20-004 TA-0-276 (FORMERLY TA-20-49)	3	CARBC;IC	ORG, INORG, METALS, SOLV

Release Site: 20-005 DECOMMISSIONED SEPTIC SYSTEM

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
20-005 TA-20-27	2	CARBC;IC	ORG, INORG, METALS, SOLV

Release Site: 53-001 WASTE STORAGE AREAS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
53-001(a) TA-53-2	48	CARBC;IC	RAD, ORG, INORG, METALS, SOLV, ACID
53-001(b) TA-53-2	48	CARBC;IC	RAD, ORG, INORG, METALS, SOLV
53-001(c) TA-53-16	6	CARBC;IC	RAD, ORG, INORG, METALS
53-001(d) TA-53-14	24	CARBC;IC	RAD, ORG, INORG, METALS, PET
53-001(e) TA-53-25	1	CARBC;IC	RAD, ORG, INORG, METALS, SOLV
53-001(f) TA-53-18	1	CARBC;IC	RAD, ORG, INORG, METALS, SOLV
53-001(g) TA-53-1031	1	CARBC;IC	RAD, ORG, INORG, METALS, SOLV, PB
53-001(h) TA-53-365	1	CARBC;IC	RAD, ORG, INORG, METALS, SOLV
53-001(i) TA-53-15	1	CARBC;IC	RAD, ORG, INORG, METALS, PHOCHEM
53-001(j) TA-53-30	1	CARBC;IC	RAD, ORG, INORG, METALS, SOLV
53-001(k) TA-53-7	1	CARBC;IC	RAD, ORG, INORG, METALS, SOLV
53-001(l) TA-53-26	1	CARBC;IC	RAD, ORG, INORG, METALS, SOLV
53-001(m) TA-53-17	1	CARBC;IC	RAD, ORG, INORG, METALS, SOLV
53-001(n) TA-53-19	1	CARBC;CI	RAD, ORG, INORG, METALS, SOLV
53-001(o) TA-53-622	1	CARBC;IC	RAD, ORG, INORG, METALS, PHOCHEM

Release Site: 53-002 LAGOON SYSTEM

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
53-002(a) TA-53-166	14,974	CARBC;IC	RAD, ORG, INORG, METALS
53-002(b) TA-53-166	9,733	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: 53-003 HOLDING TANK

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
53-003 TA-53-1016	2	CARBC;IC	ORG, INORG, METALS

Release Site: 53-004 BEAD BLASTER

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
53-004 TA-53-56	23	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: 53-005 DISPOSAL PIT

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
53-005 TA-53-2	5	CARBC;IC	ORG, INORG, METALS, PCB

Release Site: 53-006 UNDERGROUND STORAGE TANKS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
53-006(a) TA-53-59	8	CARBC;IC	RAD, ORG, INORG, METALS
53-006(b) TA-53-68	13	CARBC;IC	RAD, ROG, INORG, METALS, SOLV
53-006(c) TA-53-69	13	CARBC;IC	RAD, ORG, INORG, METALS, SOLV
53-006(d) TA-53-144	20	CARBC;IC	RAD, ORG, INORG, METALS, SOLV
53-006(e) TA-53-145	20	CARBC;IC	RAD, ORG, INORG, METALS, SOLV
53-006(f) TA-53-1	20	CARBC;IC	RAD, ORG, INORG, METALS, ACIDS

Release Site: 53-007 ABOVEGROUND STORAGE TANKS AND SUMPS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
53-007(a) TA-53-1	14	CARBC;IC	RAD, ORG, INORG, METALS, SOLV
53-007(b) TA-53-3	4	CARBC;IC	RAD, ORG, INORG, METALS, SOLV

Release Site: 53-008 BONEYARD

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
53-008 NO ASSOC. STRUCTURES	120	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: 53-009 BERMS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
53-009 TA-53-166	3	CARBC;IC	ORG, INORG, METALS

Release Site: 53-010 SOIL CONTAMINATION

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
53-010 TA-53-384	35	CARBC;IC	ORG, INORG, METALS

Release Site: 53-011 LEAKING PCB TRANSFORMERS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
53-011(a) TA-53-67	1	CARBC;IC	ORG, INORG, METALS, PCB, PET
53-011(b) TA-53-196	1	CARBC;IC	ORG, INORG, METALS, PCB, PET
53-011(c) TA-53-184	1	CARBC;IC	ORG, INORG, METALS, PCB, PET
53-011(d) TA-53-71	1	CARBC;IC	ORG, INORG, METALS, PCB, PET

Release Site: 53-012 DRAINS AND OUTFALLS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
53-012(a) TA-53-60	39	CARBC;IC	RAD, ORG, INORG, METALS
53-012(b) TA-53-62	26	CARBC;IC	RAD, ORG, INORG, METALS
53-012(c) TA-53-64	52	CARBC;IC	RAD, ORG, INORG, METALS,
53-012(d) TA-53-7	156	CARBC;IC	RAD, ORG, INORG, METALS
53-012(e) TA-53-2	156	CARBC;IC	RAD, ORG, INORG, METALS
53-012(f) TA-53-293	156	CARBC;IC	RAD, ORG, INORG, METALS
53-012(g) TA-53-274	104	CARBC;IC	RAD, ORG, INORG, METALS
53-012(h) TA-53-19	65	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: 72-001, ACTIVE FIRING RANGE

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
72-001, TA-72-11	405	CARBC;IC	ORG, INORG, METALS, PCB

Release Site: 72-002, OPEN DETONATION AREA

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
72-002	2,017	CARBC;IC	HE, ORG, INORG, METALS

Release Site: 72-003, SEPTIC SYSTEM

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
72-003(a), TA-72-18	936	CARBC;IC	ORG, INORG, METALS, SOLV
72-003(b), TA-0-276	3	CARBC;IC	ORG, INORG, METALS, SOLV

Release Site: C-20-001 TA-20-11 STORAGE BUILDING (REMOVED)

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
72-003(b), TA-0-276	3	CARBC;IC	
C-20-001 TA-20-11	370	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: C-20-002 TA-20-12 STORAGE BUILDING (REMOVED)

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-20-002 TA-20-12	370	CARBC;IC	HE, ORG, INORG, METALS

Release Site: C-20-003 TA-20-14 MAGAZINE (REMOVED)

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-20-003 TA-20-14	37	CARBC;IC	HE, ORG, INORG, METALS

Release Site: C-53-017 TA-53-70 CAPACITOR PCB SPILL

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-53-017 TA-53-70	4	CARBC;IC	ORG, INORG, METALS, PCB

Release Site: C-53-019 TA-53 SECTOR A TRANSFORMER OIL SPILL

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-53-019 SECTOR A, NORTH	1	CARBC;IC	ORG, INORG, METALS, PCB

TA-21

Task #: AL-LA-9
ADS #: 1106

Release Site: 21-001, RADIOACTIVE WASTE CONTAINER STORAGE AREA

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
21-001, TA-21-257	234	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: 21-002, CONTAINER STORAGE AREA

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
21-002(a), TA-21		CARBC;IC	ORG, INORG, METALS
21-002(b), TA-21-31	80,700	CARBC;IC	ORG, INORG, METALS, ACIDS

Release Site: 21-003, PCB STORAGE AREA

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
21-003, TA-21-61	347	CARBC;IC	ORG, INORG, METALS, PCB, PET

Release Site: 21-004, ABOVEGROUND TANKS AND DRAINLINES

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
21-004(a), TA-23-335	1	CARBC;IC	RAD, ORG, INORG, METALS
21-004(b), NORTH OF TA-21-223	25	CARBC;IC	RAD, ORG, INORG, METALS
21-004(c), NORTH OF TA-21-223	25	CARBC;IC	RAD, ORG, INORG, METALS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
21-004(d), OUTFALL	72	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: 21-005, ACID PIT

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
21-005, TA-21-70	21	CARBC;IC	ORG, INORG, METALS, ACIDS

Release Site: 21-006, UNDERGROUND SEEPAGE PITS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
21-006(a), TA-21-3	242	CARBC;IC	RAD, ORG, INORG, METALS
21-006(b), TA-21-118	270	CARBC;IC	RAD, ORG, INORG, METALS
21-006(c), TA-21-3	242	CARBC;IC	RAD, ORG, INORG, METALS, ACIDS
21-006(d), TA-21-272	242	CARBC;IC	RAD, ORG, INORG, METALS
21-006(e), TA-21-4	242	CARBC;IC	RAD, ORG, INORG, METALS
21-006(f), TA-21-4	242	CARBC;IC	RAD, ORG, INORG, METALS, F

Release Site: 21-007, SALAMANDERS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
21-007, NEAR TA-21-35	540	CARBC;IC	RAD, ORG, INORG, METALS, PET

Release Site: 21-008, INCINERATOR

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
21-008, TA-21-2	271	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: 21-009, WASTE TREATMENT LABORATORY

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
21-009, TA-21-33	341	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: 21-010, INDUSTRIAL LIQUID WASTE TREATMENT FACILITY

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
21-010(a), TA-21-35	5,603	CARBC;IC	RAD, ORG, INORG, METALS, SOLV
21-010(b), TA-21-93	7	CARBC;IC	RAD, ORG, INORG, METALS, SOLV
21-010(c), TA-21-145	2	CARBC;IC	ORG, INORG, METALS, ACIDS
21-010(d), TA-21-147	2	CARBC;IC	ORG, INORG, METALS, ACIDS
21-010(e), TA-21-185	2	CARBC;IC	ORG, INORG, METALS
21-010(f), TA-21-192	6	CARBC;IC	RAD, ORG, INORG, METALS, SOLV
21-010(g), TA-21-255	12	CARBC;IC	RAD, ORG, INORG, METALS, SOLV
21-010(h), TA-21-271	3	CARBC;IC	ORG, INORG, METALS, ACIDS

Release Site: 21-011, NEW INDUSTRIAL WASTE TREATMENT PLANT

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
21-011(a), TA-21-257	21,511	CARBC;IC	RAD, ORG, INORG, METALS, SOLV

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
21-011(b), TA-21-223	34	CARBC;IC	RAD, ORG, INORG, METALS, SOLV
21-011(c), TA-21-120	20	CARBC;IC	RAD, ORG, INORG, METALS, SOLV
21-011(d), TA-21-110	75	CARBC;IC	RAD, ORG, INORG, METALS, SOLV
21-011(e), TA-21-111	75	CARBC;IC	RAD, ORG, INORG, METALS, SOLV
21-011(f), TA-21-112	75	CARBC;IC	RAD, ORG, INORG, METALS, SOLV
21-011(g), TA-21-113	75	CARBC;IC	RAD, ORG, INORG, METALS, SOLV
21-011(h), TA-21-256	11	CARBC;IC	RAD, ORG, INORG, METALS, SOLV
21-011(i), TA-21-288	5	CARBC;IC	RAD, ORG, INORG, METALS, SOLV
21-011(j), TA-21-289	4	CARBC;IC	RAD, ORG, INORG, METALS, SOLV

Release Site: 21-012, DRY WELLS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
21-012(a), TA-21-357	405	CARBC;IC	ORG, INORG, METALS
21-012(b), TA-21-9	405	CARBC;IC	ORG, INORG, METALS

Release Site: 21-013, SURFACE DISPOSAL

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
21-013(a), TA -21-230	4	CARBC;IC	RAD, ORG, INORG, METALS
21-013(b), NEAR MDA-V	74	CARBC;IC	RAD, ORG, INORG, METALS
21-013(c), NE OF TA-21-209	1,152	CARBC;IC	RAD, ORG, INORG, METALS
21-013(d), N OF TA-21-20	102	CARBC;IC	RAD, ORG, INORG, METALS
21-013(e), NW of TA-21-20	17,130	CARBC;IC	RAD, ORG, INORG, METALS
21-013(f), TA-21-62	1,111	CARBC;IC	RAD, ORG, INORG, METALS
21-013(g), S OF MDA-V	1	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: 21-014, MATERIAL DISPOSAL AREA A

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
21-014, TA-21-107, -108	7,007	IS;IC	RAD, ORG, INORG, METALS, SOLV

Release Site: 21-015, MATERIAL DISPOSAL AREA B

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
21-015, MDA-B	210,473	IS;IC	RAD, ORG, INORG, METALS, SOLV

Release Site: 21-016, MATERIAL DISPOSAL AREA T

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
21-016(a), TA-21-121, -122, -131	69,395	IS;IC	RAD, ORG, INORG, METALS, ACIDS
21-016(b), TA-21-186	1	IS;IC	RAD, ORG, INORG, METALS, ACIDS
21-016(c), MDA-T	2,566	IS;IC	RAD, ORG, INORG, METALS, ACIDS

Release Site: 21-017, MATERIAL DISPOSAL AREA U

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
21-017(a), TA-21-162	20,186	IS;IC	RAD, ORG, INORG, METALS, PCB
21-017(b), TA-21-163	20,186	IS;IC	RAD, ORG, INORG, METALS, PCB
21-017(c), TA-21-164	20,186	IS;IC	RAD, ORG, INORG, METALS, PCB

Release Site: 21-018, MATERIAL DISPOSAL AREA V

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
21-018(a), MDA-V	241,939	IS;IC	RAD, ORG, INORG, METALS, SOLV
21-018(b), TA-21-20	3,573	CARBC;IC	RAD, ORG, INORG, METALS, SOLV

Release Site: 21-019, FILTER HOUSES/EXHAUST STACKS SOIL CONTAMINATION

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
21-019(a), TA-21-3	40	CARBC;IC	RAD, ORG, INORG, METALS
21-019(b), TA-21-4	40	CARBC;IC	RAD, ORG, INORG, METALS
21-019(c), TA-21-146	40	CARBC;IC	RAD, ORG, INORG, METALS
21-019(d), TA-21-150	40	CARBC;IC	RAD, ORG, INORG, METALS
21-019(e), TA-21-155	40	CARBC;IC	RAD, ORG, INORG, METALS
21-019(f), TA-21-209	40	CARBC;IC	RAD, ORG, INORG, METALS
21-019(g), TA-21-257	40	CARBC;IC	RAD, ORG, INORG, METALS
21-019(h), TA-21-313	40	CARBC;IC	RAD, ORG, INORG, METALS
21-019(i), TA-21-314	40	CARBC;IC	RAD, ORG, INORG, METALS
21-019(j), TA-21-315	40	CARBC;IC	RAD, ORG, INORG, METALS
21-019(k), TA-21-322	40	CARBC;IC	RAD, ORG, INORG, METALS
21-019(l), TA-21-323	40	CARBC;IC	RAD, ORG, INORG, METALS
21-019(m), TA-21-324	40	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: 21-020, DECOMMISSIONED FILTER HOUSES

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
21-020(a), TA-21-12	7,222	CARBC;IC	RAD, ORG, INORG, METALS, ACIDS
21-020(b), TA-21-153	3,889	CARBC;IC	RAD, ORG, INORG, METALS, ACIDS

Release Site: 21-021, STACK EMISSIONS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
21-021, TA-21	59,796	CARBC;IC	RAD, ORG, INORG, METALS, ACIDS

Release Site: 21-022, ACID WASTE LINES AND SUMPS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
21-022(a), TA-21-74	3	CARBC;IC	RAD, ORG, INORG, METALS, ACIDS
21-022(b), TA-21-81	188	CARBC;IC	RAD, ORG, INORG, METALS, ACIDS
21-022(c), TA-21-84	217	CARBC;IC	RAD, ORG, INORG, METALS, ACIDS
21-022(d), TA-21-87	173	CARBC;IC	RAD, ORG, INORG, METALS, ACIDS
21-022(e), TA-21-89	193	CARBC;IC	RAD, ORG, INORG, METALS, ACIDS
21-022(f), TA-21-173	5	CARBC;IC	RAD, ORG, INORG, METALS, ACIDS
21-022(g), TA-21-139	21	CARBC;IC	RAD, ORG, INORG, METALS, ACIDS
21-022(h), TA-21-202	7	CARBC;IC	RAD, ROG, INORG, METALS, ACIDS
21-022(i), TA-21-2	9	CARBC;IC	RAD, ORG, INORG, METALS, ACIDS
21-022(j), TA-21-3	9	CARBC;IC	RAD, ROG, INORG, METALS, ACIDS

Release Site: 21-023, DECOMMISSIONED SPETIC SYSTEMS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
21-023(a), TA-21-225	11	CARBC;IC	RAD, ORG, INORG, METALS
21-023(b), TA-21-142	4	CARBC;IC	RAD, ORG, INORG, METALS
21-023(c), TA-21-62	14	CARBC;IC	RAD, ORG, INORG, METALS
21-023(d), TA-21-187	4	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: 21-024, SEPTIC SYSTEMS/OUTFALLS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
21-024(a), TA-21-53	38	CARBC;IC	RAD, ORG, INORG, METALS
21-024(b), TA-21-55	9	CARBC;IC	RAD, ORG, INORG, METALS
21-024(c), TA-21-56	8	CARBC;IC	RAD, ORG, INORG, METALS
21-024(d), TA-21-106	33	CARBC;IC	RAD, ORG, INORG, METALS
21-024(e), TA-21-123	14	CARBC;IC	RAD, ORG, INORG, METALS
21-024(f), TA-21-124	6	CARBC;IC	RAD, ORG, INORG, METALS
21-024(g), TA-21-125	33	CARBC;IC	RAD, ORG, INORG, METALS
21-024(h), TA-21-163	17	CARBC;IC	RAD, ORG, INORG, METALS
21-024(i), TA-21-181	16	CARBC;IC	RAD, ORG, INORG, METALS
21-024(j), TA-21-194	5	CARBC;IC	RAD, ORG, INORG, METALS
21-024(k), TA-21-219	18	CARBC;IC	RAD, ORG, INORG, METALS
21-024(l), NEAR TA-21-21	1	CARBC;IC	RAD, ORG, INORG, METALS
21-024(m), FROM TA-21-209	1	CARBC;IC	RAD, ORG, INORG, METALS
21-024(n), FROM TA-21-155	1	CARBC;IC	RAD, ORG, INORG, METALS
21-024(o), FROM TA-21-46	1	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: 21-025, OFF-GAS SYSTEM

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
21-025(a), TA-21-155	9	CARBC;IC	RAD, ORG, INORG, METALS
21-025(b), TA-21-209	9	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: 21-026, OUTFALL/TREATMENT PLANT

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
21-026(a), TA-21-227	636	CARBC;IC	RAD, ORG, INORG, METALS
21-026(b), TA-21-230,	295	CARBC;IC	RAD, ORG, INORG, METALS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
21-026(c), TA-21-348	2	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: 21-027, SURFACE DISCHARGE

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
21-027, TA-21-3,-4,-5,-6,-47,-143,-152	106	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: 21-028, ACTIVE CONTAINER STORAGE AREAS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
21-028(a), TA-21-121	1	CARBC;IC	ORG, INORG, METALS, SOLV
21-028(b), TA-21-150	1	CARBC;IC	ORG, INORG, METALS, SOLV
21-028(c), TA-21-3	1	CARBC;IC	ORG, INORG, METALS, SOLV
21-028(d); TA-21-209	1	CARBC;IC	RAD, ORG, INORG, METALS
21-028(e), TA-21-210	1	CARBC;IC	ORG, INORG, METALS, SOLV

Release Site: 21-029, DP TANK FARM

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
21-029, DP ROAD	7,502	CARBC;IC	ORG, INORG, METALS, SOLV, PET

Release Site: C-21-002 TA-21-35 WASTE TANK LEAK (REMOVED)

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-21-002, TA-21-35	37	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: C-21-003 TA-21-2,-3 PAVED AREA LEAKS (CLEANED UP)

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-21-003, TA-21-2	37	CARBC;IC	RAD, ORG, INORG, METALS, ACIDS

Release Site: C-21-004 TA-21-2 ASPHALT DRIVEWAYS (CLEANED UP)

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-21-004, TA-21-2	37	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: C-21-006 TA-21-2 TRAILER LEAK (CLEANED UP)

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-21-006, TA-21-2	37	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: C-21-008 TA-21-4 EXHAUST LINE SPILL (CLEANED UP)

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-21-008, TA-21-4	37	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: C-21-010 TA-21-35 LEAKING DRUMS (CLEANED UP)

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-21-010, TA-21-35	37	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: C-21-011 TA-21-155 PLUGGED SCRUBBER (CLEANED UP)

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-21-011, TA-21-155	37	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: C-21-013 TA-21-331 WASTE STORAGE PIT (POSSIBLY NEVER BUILT)

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-21-013, TA-21-331	370	CARBC;IC	ORG, INORG, METALS

Release Site: C-21-022 TA-21-34 LABORATORY BUILDING (REMOVED)

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-21-022, TA-21-34	370	CARBC;IC	ORG, INORG, METALS

Release Site: C-21-023 TA-21-54 LABORATORY BUILDING (REMOVED)

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-21-023, TA-21-54	370	CARBC;IC	ORG, INORG, METALS

Release Site: C-21-024 TA-21-22 WAREHOUSE (REMOVED)

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-21-024, TA-21-22	370	CARBC;IC	ORG, INORG, METALS

Release Site: C-21-025 TA-21-19 CORRIDOR (REMOVED)

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-21-025, TA-21-19	370	CARBC;IC	ORG, INORG, METALS

Release Site: C-21-028 TA-21-47 TANK (REMOVED)

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-21-028, TA-21-47	74	CARBC;IC	ORG, INORG, METALS, SOLV, PET

Release Site: C-21-029, TA-21-60

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-21-029, TA-21-60	74	CARBC;IC	ORG, INORG, METALS, SOLV, PET

TA's 6, 7, 22, 40, 64

Task #: AL-LA-30
ADS #: 1111

Release Site: 22-001 HE WASTE STORAGE AREA

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
22-001, TA-22-24	2	CARBC;IC	HE, ORG, INORG, METALS

Release Site: 22-003 SATELLITE WASTE STORAGE AREAS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
22-003(a) TA-22-5	1	CARBC;IC	ORG, INORG, METALS, SOLV, ACIDS
22-003(b) TA-22-96	1	CARBC;IC	HE, ORG, INORG, METALS, SOLV
22-003(c) TA-22-34	1	CARBC;IC	HE,ORG,INORG,METALS,SOLV,PHOCHEM
22-003(d) TA-22-91	1	CARBC;IC	ORG,INORG,METALS,SOLV,ACIDS,CAUST
22-003(e) TA-22-95	1	CARBC;IC	ORG,INORG,METALS,SOLV,ACIDS,CAUST
22-003(f) TA-22-93	1	CARBC;IC	HE, ORG, INORG, METALS
22-003(g) TA-22-52	1	CARBC;IC	ORG, INORG, METALS, SOLV

Release Site: 22-010, ACTIVE SEPTIC SYSTEMS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
22-010(a) TA-22-50	7	CARBC;IC	RAD, ORG, INORG, METALS, SOLV
22-010(b) TA-22-51	43	CARBC;IC	RAD, HE, ORG, INORG, METALS, SOLVE

Release Site: 22-011 DISPOSAL PIT

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
22-011, NO ASSOCIATED STRUCTURE	89	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: 22-012 WASH PAD

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
22-012, TA-22-77	2	CARBC;IC	HE, ORG, INORG, METALS

Release Site: 22-013 LIQUID WASTE TREATMENT

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
22-013, TA-22-91	10	CARBC;IC	ORG, INORG, METALS, ACIDS

Release Site: 22-014 ACTIVE SUMPS, DRY WELLS, AND OUTFALLS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
22-014(a), TA-22-93	16	CARBC;IC	HE, ORG, INORG, METALS
22-014(b), TA-22-34	2	CARBC;IC	HE,ORG,INORG,METALS,SOLV,PHOCHEM

Release Site: 22-015 INACTIVE SUMPS, DRY WELLS, AND OUTFALLS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
22-015(a) TA-22-91	52	CARBC;IC	ORG, INORG, METALS, ACIDS
22-015(b) TA-22-25	2	CARBC;IC	HE, ORG, INORG, METALS, SOLV
22-015(c) TA-22-52	1	CARBC;IC	ORG, INORG, METALS, ACIDS
22-015(d) TA-22-1	2	CARBC;IC	HE, ORG, INORG, METALS, SOLV
22-015(e) NEAR TA-22-1		CARBC;IC	HE, ORG, INORG, METALS, SOLV

Release Site: 22-016 INACTIVE SEPTIC SYSTEM

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
22-016 TA-22-42	17	CARBC;IC	RAD, ORG, INORG, METALS, SOLV

Release Site: 40-001, SEPTIC SYSTEMS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
40-001(a), TA-40-22	5	CARBC;IC	ORG, INORG, METALS, SOLV
40-001(b), TA-40-24	6	CARBC;IC	ORG, INORG, METALS, SOLV
40-001(c), TA-40-25	3	CARBC;IC	ORG, INORG, METALS, SOLV

Release Site: 40-002, CONTAINER STORAGE AREAS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
40-002(a), TA-40-23	1	CARBC;IC	ORG, INORG, METALS, SOLV
40-002(b), TA-40-15	1	CARBC;IC	HE, ORG, INORG, METALS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
40-002(c), TA-40-5	1	CARBC;IC	ORG, INORG, METALS, PHOCHEM

Release Site: 40-003, BURNING AREA OPEN DETONATION

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
40-003(a), TA-40-15	1,613	CARBC;IC	HE, ORG, INORG, METALS, HERBICIDE
40-003(b), TA-40-15	807	CARBC;IC	HE, ORG, INORG, METALS, HERBICIDE

Release Site: 40-004, DECOMMISSIONED CONTAINER STORAGE AREA

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
40-004, TA-40-9	4	CARBC;IC	ORG, INORG, METALS, SOLV

Release Site: 40-005, SUMP

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
40-005, TA-40-41	5	CARBC;IC	RAD, HE, ORG, INORG, METALS, BA

Release Site: 40-006, FIRING PADS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
40-006(a), TA-40-15	3	CARBC;IC	RAD, HE, ORG, INORG, METALS
-006(b), TA-40-8	1	CARBC;IC	RAD, HE, ORG, INORG, METALS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
40-006(c), TA-40-5	1	CARBC;IC	RAD, HE, ORG, INORG, METALS

Release Site: 40-007, HE STORAGE AREAS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
40-007(a), TA-40-3	26	CARBC;IC	HE, ORG, INORG, METALS
40-007(b), TA-40-6	1	CARBC;IC	HE, ORG, INORG, METALS
40-007(c), TA-40-11	17	CARBC;IC	HE, ORG, INORG, METALS
40-007(d), TA-40-14	15	CARBC;IC	HE, ORG, INORG, METALS
40-007(e), TA-22-41	50	CARBC;IC	HE, ORG, INORG, METALS

Release Site: 40-008, DECOMMISSIONED HE STORAGE

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
40-008, TA-40-2	16	CARBC;IC	HE, ORG, INORG, METALS

Release Site: 40-009, LANDFILL

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
40-009, NO ASSOCIATED STRUCTURE	12,800	CARBC;IC	RAD, HE, ORG, INORG, METALS

Release Site: 6-001, SEPTIC SYSTEMS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
6-001(a), TA-6-40, -1, -3	6	CARBC;IC	HE, ORG, INORG, METALS, SOLV
6-001(b), TA-6-43, -6	5	CARBC;IC	HE, ORG, INORG, METALS, SOLV

Release Site: 6-002, DECOMMISSIONED SEPTIC SYSTEMS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
6-002, TA-6-41, -10	6	CARBC;IC	HE, ORG, INORG, METALS

Release Site: 6-003, FIRING SITE

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
6-003(a), TA-6-37	2,327	CARBC;IC	RAD, HE, ORG, INORG, METALS
6-003(b), NO ASSOCIATED STRUCTURE	11	CARBC;IC	RAD, HE, ORG, INORG, METALS
6-003(c), NO ASSOCIATED STRUCTURE	7	CARBC;IC	RAD, HE, ORG, INORG, METALS
6-003(d), TA-6-7	101	CARBC;IC	HE, ORG, INORG, METALS
6-003(e), TA-6-9	93	CARBC;IC	HE, ORG, INORG, METALS

Release Site: 6-004, SUMP

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
6-004, TA-6-10	11	CARBC;IC	HE, ORG, INORG, METALS

Release Site: 6-005, PIT

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
6-005, TA-6-42	96	CARBC;IC	RAD, HE, ORG, INORG, METALS

Release Site: 6-006, STORAGE AREAS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
6-006, TA-6-6, -5	222	CARBC;IC	ORG, INORG, METALS, PCB, PET

Release Site: 6-007, MDA-F AND OTHER LANDFILLS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
6-007(a), MDA-F	1,222	IS;IC	RAD, HE, ORG, INORG, METALS
6-007(b), NO ASSOCIATED STRUCTURES	622	CARBC;IC	RAD, HE, ORG, INORG, METALS
6-007(c), NO ASSOCIATED STRUCTURES	8	CARBC;IC	RAD, HE, ORG, INORG, METALS
6-007(d), NO ASSOCIATED STRUCTURES	1	CARBC;IC	RAD, HE, ORG, INORG, METALS
6-007(e), NO ASSOCIATED STRUCTURES	44	CARBC;IC	RAD, HE, ORG, INORG, METALS

Release Site: 6-008, DECOMMISSIONED UNDERGROUND STORAGE TANK

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
6-008, TA-6-47, -37	10	CARBC;IC	HE, ORG, INORG, METALS

Release Site: 64-001, WASTE CONTAINER STORAGE AREA

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
64-001	5	CARBC;IC	ORG, INORG, METALS, SOLV

Release Site: 7-001, FIRING PITS AND DETONATOR DISPOSAL

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
7-001(a), NO ASSOCIATED STRUCTURE	105	CARBC;IC	RAD, HE, ORG, INORG, METALS
7-001(b), NO ASSOCIATED STRUCTURE	105	CARBC;IC	RAD, HE, ORG, INORG, METALS

Release Site: C-40-001 TA-40-3, -6, -11, -14 HERBICIDE USE

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-40-001, TA-40-3, -6, -11, -14	4,444	CARBC;IC	ORG, INORG, METALS, HERBICIDE

Release Site: C-6-001, POTENTIAL SOIL CONTAMINATION AT FORMER MAGAZINE SITE

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-6-001, TA-6-4	37	CARBC;IC	HE, ORG, INORG, METALS

Release Site: C-6-002, POTENTIAL SOIL CONTAMINATION AT FORMER BUILDING SITE

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-6-002, TA-6-10	370	CARBC;IC	HE, ORG, INORG, METALS

Release Site: C-6-003, POTENTIAL SOIL CONTAMINATION AT FORMER BUILDING SITE

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-6-003, TA-6-11	370	CARBC;IC	HE, ORG, INORG, METALS

Release Site: C-6-004, POTENTIAL SOIL CONTAMINATION AT FORMER BUILDING SITE

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-6-004, TA-6-12	370	CARBC;IC	HE, ORG, INORG, METALS

Release Site: C-6-005, POTENTIAL SOIL CONTAMINATION AT FORMER BUILDING SITE

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-6-005, TA-6-13	370	CARBC;IC	HE, ORG, INORG, METALS

Release Site: C-6-006, POTENTIAL SOIL CONTAMINATION AT FORMER BUILDING SITE

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-6-006, TA-6-14	370	CARBC;IC	HE, ORG, INORG, METALS

Release Site: C-6-007, POTENTIAL SOIL CONTAMINATION AT FORMER BUILDING SITE

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-6-007, TA-6-15	370	CARBC;IC	ORG, INORG, METALS

Release Site: C-6-008, POTENTIAL SOIL CONTAMINATION AT FORMER BUILDING SITE

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-6-008, TA-6-16	37	CARBC;IC	HE, ORG, INORG, METALS

Release Site: C-6-009, POTENTIAL SOIL CONTAMINATION AT FORMER BUILDING SITE

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-6-009, TA -6-17	37	CARBC;IC	HE, ORG, INORG, METALS

Release Site: C-6-010, POTENTIAL SOIL CONTAMINATION AT FORMER BUILDING SITE

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-6-010, TA-6-21	37	CARBC;IC	HE, ORG, INORG, METALS

Release Site: C-6-011, POTENTIAL SOIL CONTAMINATION AT FORMER BUILDING SITE

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-6-011, C-6-22	37	CARBC;IC	HE, ORG, INORG, METALS

Release Site: C-6-012, POTENTIAL SOIL CONTAMINATION AT FORMER BUILDING SITE

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-6-012, TA-6-23	37	CARBC;IC	HE, ORG, INORG, METALS

Release Site: C-6-013, POTENTIAL SOIL CONTAMINATION AT FORMER BUILDING SITE

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-6-013, TA-6-24	37	CARBC;IC	HE, ORG, INORG, METALS

Release Site: C-6-014, POTENTIAL SOIL CONTAMINATION AT FORMER BUILDING SITE

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-6-014, TA-6-25	37	CARBC;IC	HE, ORG, INORG, METALS

Release Site: C-6-015, POTENTIAL SOIL CONTAMINATION AT FORMER BUILDING SITE

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-6-015, TA-6-27	37	CARBC;IC	HE, ORG, INORG, METALS

Release Site: C-6-016, POTENTIAL SOIL CONTAMINATION AT FORMER BUILDING SITE

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-6-016, TA-6-28	37	CARBC;IC	HE, ORG, INORG, METALS

Release Site: C-6-017, POTENTIAL SOIL CONTAMINATION AT FORMER BUILDING SITE

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-6-017, TA-6-29	37	CARBC;IC	HE, ORG, INORG, METALS

Release Site: C-6-018, POTENTIAL SOIL CONTAMINATION AT FORMER BUILDING SITE

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-6-018, TA-6-30	37	CARBC;IC	HE, ORG, INORG, METALS

Release Site: C-6-019, POTENTIAL SOIL CONTAMINATION AT FORMER BUILDING SITE

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-6-019, TA-6-38	37	CARBC;IC	HE, ORG, INORG, METALS

Release Site: C-6-020, POTENTIAL SOIL CONTAMINATION AT FORMER BUILDING SITE

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-6-020, TA-6-49	370	CARBC;IC	ORG, INORG, METALS

Release Site: C-6-021, TA-6-26

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-6-021, TA-6-26	37	CARBC;IC	HE, ORG, INORG, METALS

TA's 3, 30, 59, 60, 61, 64

Task #: AL-LA-20
ADS #: 1114

Release Site: 3-001, ACTIVE CONTAINER STORAGE AREAS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
3-001(a)	6	CARBC;IC	ORG, INORG, METALS, SOLV, BE, ACIDS
3-001(b)	5	CARBC;IC	ORG, INORG, METALS, SOLV, PHOCHEM
3-001(c)	3	CARBC;IC	RAD, ORG, INORG, METALS, PET
3-001(d)	1	CARBC;IC	RAD, ORG, INORG, METALS, PET
3-001(e)	3	CARBC;IC	RAD, ORG, INORG, METALS, SOLV, PET
3-001(f)	2	CARBC;IC	ORG, INORG, METALS, SOLV
3-001(g)	1	CARBC;IC	ORG, INORG, METALS, SOLV
3-001(h)	1	CARBC;IC	ORG, INORG, METALS, SOLV
3-001(i)	1	CARBC;IC	ORG, INORG, METALS, PET
3-001(j)	1	CARBC;IC	ORG, INORG, METALS
3-001(k)	1	CARBC;IC	RAD, ORG, INORG, METALS, SOLV, PET
3-001(l)	3	CARBC;IC	ORG, INORG, METALS
3-001(m)	1	CARBC;IC	ORG, INORG, METALS
3-001(n)	1	CARBC;IC	ORG, INORG, METALS, SOLV, PET
3-001(o)	1	CARBC;IC	ORG, INORG, METALS, SOLV, ACIDS
3-001(p)	1	CARBC;IC	ORG, INORG, METALS, SOLV
3-001(q)	1	CARBC;IC	ORG, INORG, METALS, SOLV
3-001(r)	1	CARBC;IC	ORG, INORG, METALS, SOLV
3-001(s)	1	CARBC;IC	ORG, INORG, METALS, SOLV
3-001(t)	1	CARBC;IC	ORG, INORG, METALS, SOLV
3-001(u)	1	CARBC;IC	ORG, INORG, METALS, SOLV
3-001(v)	1	CARBC;IC	ORG, INORG, METALS, SOLV
3-001(w)	1	CARBC;IC	ORG, INORG, METALS, PESTICIDES
3-001(x)	1	CARBC;IC	ORG, INORG, METALS, SOLV

Release Site: 3-002 INACTIVE CHEMICAL STORAGE AREA

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
3-002(a)	2	CARBC;IC	ORG, INORG, METALS, ACIDS
3-002(b)	1	CARBC;IC	ORG, INORG, METALS, SOLV, PET
3-002(c)	71	CARBC;IC	ORG, INORG, METALS, PESTICIDES
3-002(d)	1	CARBC;IC	ORG, INORG, METALS, PET

Release Site: 3-003 SOIL CONTAMINATION FROM ELECTRICAL STORAGE AREAS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
3-003(a)	1	CARBC;IC	ORG, INORG, METALS
3-003(b)	1	CARBC;IC	ORG, INORG, METALS
3-003(c)	2	CARBC;IC	ORG, INORG, METALS
3-003(d)	1	CARBC;IC	ORG, INORG, METALS
3-003(e)	1	CARBC;IC	ORG, INORG, METALS
3-003(f)	1	CARBC;IC	ORG, INORG, METALS, PCB
3-003(g)	1	CARBC;IC	ORG, INORG, METALS, PCB
3-003(h)	1	CARBC;IC	ORG, INORG, METALS, PCB
3-003(i)	1	CARBC;IC	ORG, INORG, METALS, PCB
3-003(j)	2	CARBC;IC	ORG, INORG, METALS, PCB
3-003(k)	1	CARBC;IC	ORG, INORG, METALS, PCB
3-003(l)	1	CARBC;IC	ORG, INORG, METALS, PCB
3-003(m)	3	CARBC;IC	ORG, INORG, METALS, PCB
3-003(n)	1	CARBC;IC	ORG, INORG, METALS, PCB
3-003(o)	1	CARBC;IC	ORG, INORG, METALS, PCB
3-003(p)	1	CARBC;IC	ORG, INORG, METALS, PCB

Release Site: 3-004 RADIOACTIVE WASTE STORAGE AREAS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
3-004(a)	5	CARBC;IC	ORG, INORG, METALS
3-004(b)	4	CARBC;IC	RAD, ORG, INORG, METALS
3-004(c)	20	CARBC;IC	RAD, ORG, INORG, METALS
3-004(d)	10	CARBC;IC	ORG, INORG, METALS, ACIDS
3-004(e)	1	CARBC;IC	ORG, INORG, METALS
3-004(f)	1	CARBC;IC	ORG, INORG, METALS

Release Site: 3-007 FIRING CHAMBER

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
3-007	12	CARBC;IC	HE, ORG, INORG, METALS

Release Site: 3-008 DECOMMISSIONED FIRING SITES

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
3-008(a)	627	CARBC;IC	ORG, INORG, METALS
3-008(b)	46	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: 3-009 LANDFILL/SURFACE DISPOSAL

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
3-009(a)	667	CARBC;IC	ORG, INORG, METALS, ASBESTOS
3-009(b)	1,613	CARBC;IC	ORG, INORG, METALS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
3-009(c)	1,481	CARBC;IC	ORG, INORG, METALS
3-009(d)	17,778	CARBC;IC	ORG, INORG, METALS
3-009(e)	185	CARBC;IC	ORG, INORG, METALS
3-009(f)	2,222	CARBC;IC	ORG, INORG, METALS
3-009(g)	4,444	CARBC;IC	ORG, INORG, METALS

Release Site: 3-010 VACUUM PUMP OIL/SURFACE DISPOSAL

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
3-010(a)	2	CARBC;IC	HE, ORG, INORG, METALS
3-010(b)	1	CARBC;IC	HE, ORG, INORG, METALS, PET
3-010(c)	1	CARBC;IC	ORG, INORG, METALS, PET
3-010(d)	1	CARBC;IC	ORG, INORG, METALS, BE, PET

Release Site: 3-011 WASHING PLATFORM OPERATIONAL RELEASE

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
3-011	2	CARBC;IC	ORG, INORG, METALS

Release Site: 3-012

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
3-012(a)	23	CARBC;IC	ORG, INORG, METALS, SOLV
3-012(b)	160,000	CARBC;IC	ORG, INORG, METALS, CR

Release Site: 3-013 OPERATIONAL RELEASES

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
3-013(a)	33	CARBC;IC	ORG, INORG, METALS, SOLV, ACIDS
3-013(b)	53	CARBC;IC	ORG, INORG, METALS, SOLV
3-013(c)	17	CARBC;IC	ORG, INORG, METALS, ASPHALT
3-013(d)	1	CARBC;IC	ORG, INORG, METALS, PET
3-013(e)	93	CARBC;IC	ORG, INORG, METALS
3-013(f)	1	CARBC;IC	ORG, INORG, METALS, PET
3-013(g)	1	CARBC;IC	ORG, INORG, METALS, PET

Release Site: 3-014 WASTEWATER TREATMENT PLANT

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
3-014(a)	46	CARBC;IC	ORG, INORG, METALS
3-014(a2)	1	CARBC;IC	ORG, INORG, METALS
3-014(b)	1	CARBC;IC	ORG, INORG, METALS
3-014(c)	20	CARBC;IC	ORG, INORG, METALS
3-014(d)	36	CARBC;IC	ORG, INORG, METALS
3-014(e)	20	CARBC;IC	ORG, INORG, METALS
3-014(f)	1	CARBC;IC	ORG, INORG, METALS
3-014(g)	111	CARBC;IC	ORG, INORG, METALS
3-014(h)	36	CARBC;IC	ORG, INORG, METALS
3-014(i)	1	CARBC;IC	ORG, INORG, METALS
3-014(j)	93	CARBC;IC	ORG, INORG, METALS
3-014(k)	6	CARBC;IC	ORG, INORG, METALS
3-014(l)	15	CARBC;IC	ORG, INORG, METALS
3-014(m)	15	CARBC;IC	ORG, INORG, METALS
3-014(n)	15	CARBC;IC	ORG, INORG, METALS
3-014(o)	400	CARBC;IC	ORG, INORG, METALS
3-014(p)	19	CARBC;IC	ORG, INORG, METALS
3-014(q)	92	CARBC;IC	ORG, INORG, METALS
3-014(r)	1	CARBC;IC	ORG, INORG, METALS
3-014(s)	8	CARBC;IC	ORG, INORG, METALS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
3-014(t)	8	CARBC;IC	ORG, INORG, METALS
3-014(u)	17	CARBC;IC	ORG, INORG, METALS, PHOCHEM
3-014(v)	1	CARBC;IC	ORG, INORG, METALS, PHOCHEM
3-014(w)	1	CARBC;IC	ORG, INORG, METALS
3-014(x)	1	CARBC;IC	ORG, INORG, METALS
3-014(y)	1	CARBC;IC	ORG, INORG, METALS
3-014(z)	1	CARBC;IC	ORG, INORG, METALS

Release Site: 3-015 ROLLING MILL OUTFALL REGION

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
3-015	1,852	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: 3-016 ACTIVE SEPTIC TANKS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
3-016(a)	5	CARBC;IC	ORG, INORG, METALS
3-016(b)	5	CARBC;IC	ORG, INORG, METALS
3-016(c)	2	CARBC;IC	ORG, INORG, METALS
3-016(d)	7	CARBC;IC	ORG, INORG, METALS
3-016(e)	7	CARBC;IC	ORG, INORG, METALS

Release Site: 3-018 CESS POOL

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
3-018	4	CARBC;IC	ORG, INORG, METALS

Release Site: 3-019 DECOMMISSIONED SEPTIC SYSTEM

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
3-019	7	CARBC;IC	RAD, ORG, INORG, METALS, SOLV

Release Site: 3-020 PITS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
3-020(a)	1	CARBC;IC	ORG, INORG, METALS, SOLV, PET
3-020(b)	1	CARBC;IC	ORG, INORG, METALS, SOLV, PET

Release Site: 3-021 CAUSTIC WASTE SUMP

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
3-021	139	CARBC;IC	ORG, INORG, METALS

Release Site: 3-022 MARX GENERATOR SUMP

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
3-022	198	CARBC;IC	ORG, INORG, METALS, PET

Release Site: 3-023, INACTIVE OIL SUMP

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
3-023	2	CARBC;IC	ORG, INORG, METALS, PET

Release Site: 3-024, PROCESS WATER PUMP PIT

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
3-024	118	CARBC;IC	ORG, INORG, METALS

Release Site: 3-025, SUMPS AND OIL TRAPS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
3-025(a)	10	CARBC;IC	ORG, INORG, METALS, PET
3-025(b)	7	CARBC;IC	RAD, ORG INORG, METALS, PET
3-025(c)	10	CARBC;IC	ORG, INORG, METALS, PET

Release Site: 3-026, SUMPS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
3-026(a)	22	CARBC;IC	ORG, INORG, METALS
3-026(b)	8	CARBC;IC	ORG, INORG, METALS
3-026(c)	12	CARBC;IC	ORG, INORG, METALS
3-026(d)	1	CARBC;IC	ORG, INORG, METALS

Release Site: 3-027, VEHICLE MAINTENANCE SUMPS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
3-027	2	CARBC;IC	ORG, INORG, METALS, PET

Release Site: 3-028, ACTIVE SURFACE IMPOUNDMENT

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
3-028	4	CARBC;IC	ORG, INORG, METALS

Release Site: 3-029, INACTIVE LANDFILL

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
3-029	11,850	CARBC;IC	ORG, INORG, METALS, PET

Release Site: 3-030, INACTIVE SURFACE IMPOUNDMENTS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
3-030	990	CARBC;IC	ORG, INORG, METALS, FLOURIDE

Release Site: 3-031, BUILDING 29 DISPOSAL COMPLEX

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
3-031	104	CARBC;IC	RAD, HE, ORG, INORG, METALS

Release Site: 3-032, SCRUBBER TRANK

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
3-032	1	CARBC;IC	ORG, INORG, METALS, SOLV

Release Site: 3-033, PRINTED CIRCUIT SHOP TANKS AND SUMPS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
3-033	1	CARBC;IC	ORG, INORG, METALS, ACIDS

Release Site: 3-034, RADIOACTIVE WASTE STORAGE TANKS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
3-034(a)	1	CARBC;IC	RAD, ORG, INORG, METALS
3-034(b)	1	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: 3-035, LEAKING UNDERGROUND FUEL TANKS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
3-035(a)	50	CARBC;IC	ORG, INORG, METALS, PET
3-035(b)	15	CARBC;IC	ORG, INORG, METALS, PET
3-035(c)	20	CARBC;IC	ORG, INORG, METALS, PET

Release Site: 3-036, PRODUCT TANK CONTAINMENT AREAS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
3-036(a)	21	CARBC; IC	ORG, INORG, METALS
3-036(b)		CARBC;IC	ORG, INORG, METALS, PET
3-036(c)		CARBC;IC	ORG, INORG, METALS
3-036(d)		CARBC;IC	ORG, INORG, METALS
3-036(e)	25	CARBC;IC	ORG, INORG, METALS
3-036(f)	1	CARBC;IC	ORG, INORG, METALS, PET
3-036(g)	3	CARBC;IC	ORG, INORG, METALS, PET
3-036(h)	20	CARBC;IC	ORG, INORG, METALS, ACIDS
3-036(i)	40	CARBC;IC	ORG, INORG, METALS
3-036(j)	1	CARBC;IC	ORG, INORG, METALS, PET
3-036(k)	1,486	CARBC;IC	ORG, INORG, METALS, PET

Release Site: 3-037, UNDERGROUND STORAGE TANKS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
3-037(a)	25	CARBC;IC	ORG, INORG, METALS, ACIDS
3-037(b)	25	CARBC;IC	ORG, INORG, METALS, PET
3-037(c)	1	CARBC;IC	ORG, INORG, METALS, PET
3-037(d)	1	CARBC;IC	ORG, INORG, METALS, PET
3-037(e)	1	CARBC;IC	ORG, INORG, METALS, PET

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
3-037(f)	11	CARBC;IC	ORG, INORG, METALS, PET
3-037(g)	33	CARBC;IC	ORG, INORG, METALS, PET
3-037(h)	11	CARBC;IC	ORG, INORG, METALS, PET

Release Site: 3-038, INACTIVE AND DECOMMISSIONED INDUSTRIAL WASTE LINES

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
3-038(a)	23	CARBC;IC	ORG, INORG, METALS, ACIDS
3-038(b)	82	CARBC;IC	ORG, INORG, METALS, ACIDS
3-038(c)	1	CARBC;IC	ORG, INORG, METALS, ACIDS
3-038(d)	12	CARBC;IC	ORG, INORG, METALS
3-038(e)	12	CARBC;IC	ORG, INORG, METALS
3-038(f)	20	CARBC;IC	ORG, INORG, METALS

Release Site: 3-039, SILVER RECOVERY

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
3-039	1	CARBC;IC	ORG, INORG, METALS, PHOCHEM

Release Site: 3-040, PHOTOGRAPHIC FILM STORAGE/TREATMENT

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
3-040(a)	1	CARBC;IC	ORG, INORG, METALS, PHOCHEM
3-040(b)	1	CARBC;IC	ORG, INORG, METALS, PHOCHEM

Release Site: 3-041, SIGMA COMPLEX TANKS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
3-041	6	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: 3-042, DECOMMISSIONED SUMPS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
3-042	1	CARBC;IC	ORG, INORG, METALS, PET

Release Site: 3-043, DECOMMISSIONED TANKS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
3-043(a)	99	CARBC;IC	ORG, INORG, METALS
3-043(b)	50	CARBC;IC	ORG, INORG, METALS
3-043(c)	99	CARBC;IC	ORG, INORG, METALS
3-043(d)	99	CARBC;IC	ORG, INORG, METALS
3-043(e)	99	CARBC;IC	ORG, INORG, METALS, PET
3-043(f)	50	CARBC;IC	ORG, INORG, METALS, PET
3-043(g)	149	CARBC;IC	ORG, INORG, METALS
3-043(h)	50	CARBC;IC	ORG, INORG, METALS, PET
3-043(i)	99	CARBC;IC	ORG, INORG, METALS
3-043(j)	99	CARBC;IC	ORG, INORG, METALS, PET

Release Site: 3-044, DECOMMISSIONED CONTAINER STORAGE AREA

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
3-044	5	CARBC;IC	ORG, INORG, METALS

Release Site: 3-045, SOIL CONTAMINATION FROM OUTFALLS IN SANDIA CANYON

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
3-043(a)	1,833	CARBC;IC	ORG, INORG, METALS
3-045(b)	1,833	CARBC;IC	ORG, INORG, METALS
3-045(c)	5,236	CARBC;IC	ORG, INORG, METALS
3-045(d)	5,341	CARBC;IC	ORG, INORG, METALS
3-045(e)	5,367	CARBC;IC	ORG, INORG, METALS
3-045(f)	5,341	CARBC;IC	ORG, INORG, METALS
3-045(g)	1,257	CARBC;IC	ORG, INORG, METALS
3-045(h)	52	CARBC;IC	ORG, INORG, METALS
3-045(i)	314	CARBC;IC	ORG, INORG, METALS
3-045(j)	236	CARBC;IC	ORG, INORG, METALS
3-045(k)	209	CARBC;IC	ORG, INORG, METALS

Rel se Site: 3-046, WASTE TREATMENT TANK

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
3-046	99	CARBC;IC	ORG, INORG, METALS

Release Site: 3-047, SOIL CONTAMINATION FROM PRODUCT STORAGE AREAS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
3-047(a)	12	CARBC;IC	ORG, INORG, METALS, PCB
3-047(b)	82	CARBC;IC	ORG, INORG, METALS, SOLV, PET
3-047(c)	12	CARBC;IC	ORG, INORG, METALS
3-047(d)	6	CARBC;IC	ORG, INORG, METALS, PET
3-047(e)	6	CARBC;IC	ORG, INORG, METALS, SOLV, PET
3-047(f)	6	CARBC;IC	RAD, ORG, INORG, METALS, PHOCHEM
3-047(g)	23	CARBC;IC	RAD, ORG, INORG, METALS
3-047(h)	3	CARBC;IC	ORG, INORG, METALS, PET
3-047(i)	3	CARBC;IC	ORG, INORG, METAL, SOLV, PET
3-047(j)	6	CARBC;IC	ORG, INORG, METALS, SOLV, PET
3-047(k)	3	CARBC;IC	ORG, INORG, METALS
3-047(l)	3	CARBC;IC	ORG, INORG, METALS
3-047(m)	35	CARBC;IC	ORG, INORG, METALS, PET

Release Site: 3-048, UNPLANNED LIQUID EFFLUENT RELEASE

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
3-048	79	CARBC;IC	ORG, INORG, METALS, PET

Release Site: 3-049, HOT CELL

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
3-049	1	CARBC;IC	ORG, INORG, METALS

Release Site: 3-050, SOIL CONTAMINATION FROM OUTFALLS IN MORTANDAD CANYON

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
3-050(a)	52	CARBC;IC	ORG, INORG, METALS
3-050(b)	105	CARBC;IC	ORG, INORG, METALS, PET
3-050(c)	28	CARBC;IC	ORG, INORG, METALS, ACIDS
3-050(d)	26	CARBC;IC	ORG, INORG, METALS, ACIDS
3-050(e)	26	CARBC;IC	ORG, INORG, METALS, ACIDS

Release Site: 3-051, SOIL CONTAMINATION BY STACK EMMISSIONS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
3-051(a)		CARBC;IC	RAD, ORG, INORG, METALS
3-051(b)		CARBC;IC	ORG, INORG, METALS, TRITIUM
3-051(c)		CARBC;IC	RAD, ORG, INORG, METALS
3-051(d)		CARBC;IC	ORG, INORG, METALS, LI
3-051(e)		CARBC;IC	ORG, INORG, METALS, BE
3-051(f)		CARBC;IC	ORG, INORG, METALS, BE
3-051(g)		CARBC;IC	ORG, INORG, METALS, BE

Release Site: 3-052, SOIL CONTAMINATION FROM LEAKING COMPRESSORS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
3-052(a)	1	CARBC;IC	ORG, INORG, METALS, PET
3-052(b)	1	CARBC;IC	ORG, INORG, METALS, PET
3-052(c)	1	CARBC;IC	ORG, INORG, METALS, PET
3-052(d)	1	CARBC;IC	ORG, INORG, METALS, PET

Release Site: 3-053, STORM DRAINAGE SYSTEM

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
3-053(a)	26	CARBC;IC	ORG, INORG, METALS, SOLV, PET
3-053(b)	47	CARBC;IC	ORG, INORG, METALS, SOLV, PET
3-053(c)	20	CARBC;IC	ORG, INORG, METALS, PET
3-053(d)	23	CARBC;IC	ORG, INORG, METALS
3-053(e)	23	CARBC;IC	ORG, INORG, METALS
3-053(f)	20	CARBC;IC	ORG, INORG, METALS, SOLV, PET

Release Site: 3-054, ROLLING MILL BUILDING & SOIL

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
3-054	14	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: 3-055, COOLING TOWERS AND ASSOCIATED OUTFALLS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
3-055(a)	105	CARBC;IC	ORG, INORG, METALS
3-055(b)	111	CARBC;IC	ORG, INORG, METALS
3-055(c)	41	CARBC;IC	ORG, INORG, METALS
3-055(d)	13	CARBC;IC	ORG, INORG, METALS, SOLV, PET
3-055(e)	2,592	CARBC;IC	ORG, INORG, METALS

Release Site: 3-056, OUTFALLS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
3-056(a)	26	CARBC;IC	RAD, ORG, INORG, METALS, ACIDS
3-056(b)	157	CARBC;IC	ORG, INORG, METALS, ACIDS
3-056(c)	52	CARBC;IC	ORG, INORG, METALS

Release Site: 3-057, WASTE STORAGE FACILITIES

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
3-057(a)	23	CARBC;IC	ORG, INORG, METALS
3-057(b)	12	CARBC;IC	ORG, INORG, METALS, PET
3-057(c)	3	CARBC;IC	ORG, INORG, METALS, PCB, PET
3-057(d)	36	CARBC;IC	ORG, INORG, METALS, PET
3-057(e)	23	CARBC;IC	ORG, INORG, METALS, PET
3-057(f)	3	CARBC;IC	ORG, INORG, METALS, PET
3-057(g)	6	CARBC;IC	ORG, INORG, METALS, PET
3-057(h)	92	CARBC;IC	ORG, INORG, METALS, PET
3-057(i)	46	CARBC;IC	ORG, INORG, METALS, PET
3-057(j)	12	CARBC;IC	ORG, INORG, METALS, PET
3-057(k)	3	CARBC;IC	RAD, ORG, INORG, METALS, SOLV, PET
3-057(l)	3	CARBC;IC	ORG, INORG, METALS, BE
3-057(m)	23	CARBC;IC	ORG, INORG, METALS, SOLV, PET
3-057(n)	12	CARBC;IC	ORG, INORG, METALS

Release Site: 3-058, CAFETERIA GREASE TRAPS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
3-058	7	CARBC;IC	ORG, INORG, METALS

Release Site: 3-059, SOIL CONTAMINATION AT SALVAGE YARD

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
3-059	889	CARBC;IC	ORG, INORG, METALS, ACIDS, PET

Release Site: 30-001 SURFACE DISPOSAL

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
30-001	1,111	CARBC;IC	ORG, INORG, METALS

Release Site: 59-001 SEPTIC SYSTEM

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
59-001	94	CARBC;IC	ORG, INORG, METALS, PHOCHEM

Release Site: 59-002 DRUM STORAGE

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
59-002	6	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: 59-003 SUMPS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
59-003	1	CARBC;IC	RAD, ORG, INORG, METALS, SOLV

Release Site: 59-004 OUTFALL

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
59-004	37	CARBC;IC	ORG, INORG, METALS

Release Site: 60-001, ACTIVE CONTAINER STORAGE AREA

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
60-001(a)	4	CARBC;IC	ORG, INORG, METALS, SOLV, PET
60-001(b)	1	CARBC;IC	ORG, INORG, METALS
60-001(c)	1	CARBC;IC	ORG, INORG, METALS
60-001(d)	1	CARBC;IC	ORG, INORG, METALS, PESTICIDES

Release Site: 60-002, LANDFILL/SURFACE DISPOSAL

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
60-002	807	CARBC;IC	ORG, INORG, METALS

Release Site: 60-003, VEHICLE MAINTENANCE OIL AND WATER SEPARATORS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
60-003	8	CARBC;IC	ORG, INORG, METALS, PET

Release Site: 60-004, SIGMA MESA STORAGE FACILITIES

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
60-004(a), MID MESA STORAGE	134	CARBC;IC	ORG, INORG, METALS, PET
60-004(b), DRUMS	20	CARBC;IC	ORG, INORG, METALS, SOLV, PET
60-004(c), EXPERIMENTAL POND	3	CARBC;IC	ORG, INORG, METALS
60-004(d), TANKS	4	CARBC;IC	ORG, INORG, METALS, PET
60-004(e), STORAGE AREA	46	CARBC;IC	ORG, INORG, METALS, PET, PCB

Release Site: 60-005, INACTIVE SURFACE INPOUNDMENTS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
60-005(a)	124	CARBC;IC	RAD, ORG, INORG, METALS
60-005(b)	267	CARBC;IC	ORG, INORG, METALS

Release Site: 60-006, SEPTIC SYSTEMS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
60-006(a), TA-60-17	5	CARBC;IC	ORG, INORG, METALS, SOLV
60-006(b), END OF MESA	3	CARBC;IC	ORG, INORG, METALS, SOLV
60-006(c), TEST TRACT	4	CARBC;IC	ORG, INORG, METALS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants

Release Site: 60-007, OPERATIONAL RELEASES

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
60-007(a), GEOTHERMAL WELL	1	CARBC;IC	ORG, INORG, METALS, SOLV, PET
60-007(b), TA-60-1	6	CARBC;IC	ORG, INORG, METALS, SOLV, PET

Release Site: 61-001, ACTIVE CONTAINER STORAGE AREA

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
61-001	269	CARBC;IC	ORG, INORG, METALS, PCB

Release Site: 61-002, PCB STORAGE AREA

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
61-002	494	CARBC;IC	ORG, INORG, METALS, PET, PCB

Release Site: 61-003, BURN SITE

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
61-003	377	CARBC;IC	RAD, HE, ORG, INORG, METALS

Release Site: 61-004, INACTIVE SEPTIC SYSTEMS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
61-004(a)	11	CARBC;IC	RAD, ORG, INORG, METALS
61-004(b)	11	CARBC;IC	ORG, INORG, METALS

Release Site: 61-005, ACTIVE LANDFILL

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
61-005, LANDFILL	313,630	IS;IC	RAD, ORG, INORG, METALS, SOLV

Release Site: 61-006, USED OIL CONTAINER STORAGE AREA

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
61-006, SOUTH MESA	40	CARBC;IC	ORG, INORG, METALS, PET

Release Site: 61-007, SOIL CONTAMINATION/OPERATION RELEASE

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
61-007	600	CARBC;IC	ORG, INORG, METALS, PCB

Release Site: 64-001, ACTIVE WASTE CONTAINER STORAGE AREA

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
64-001	5	CARBC;IC	ORG, INORG, METALS, SOLV

Release Site: C-3-003, TA-3-39 ASPHALT STAIN

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-3-003	1	CARBC;IC	ORG, INORG, METALS

Release Site: C-3-004, TA-3-66 SOIL AND DEBRIS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-3-004	4	CARBC;IC	ORG, INORG, METALS, PET

Release Site: C-3-005, TA-3-73 OIL EMULSION SPILL

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-3-005	556	CARBC;IC	ORG, INORG, METALS, PET

Release Site: C-3-006, SOUTH OF TA-3-29 SPILL

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-3-006	111	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: C-3-010, TA-3-19 COOLING TOWER (REMOVED)

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-3-010	370	CARBC;IC	ORG, INORG, METALS

Release Site: C-3-011, NEAR TA-3-73 GASOLINE TANK (DECOMMISSIONED)

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-3-011	7	CARBC;IC	ORG, INORG, METALS, PET

Release Site: C-3-014, TA-3-35 STORAGE AREA

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-3-014	93	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: C-3-016, NEAR TA-3-73 CLEAN OUT TANK

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-3-016	5	CARBC;IC	ORG, INORG, METALS, SOLV, PET

Release Site: C-3-019, TA-3-16 UST (UNLOCATED)

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-3-019	37	CARBC;IC	ORG, INORG, METALS, SOLV, PET

Release Site: C-3-020, TA-3-107, -108, -109 THREE USTS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-3-020	185	CARBC;IC	ORG, INORG, METALS, SOLV, PET

Release Site: C-60-001, TA-3-382-2 UST (REMOVED)

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-60-001	74	CARBC;IC	ORG, INORG, METALS

Release Site: C-60-002, TA-3-318 UST (REMOVED)

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-60-002	67	CARBC;IC	ORG, INORG, METALS, SOLV, PET

Release Site: C-60-004, NEAR TA-60-1 UST

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-60-004	74	CARBC;IC	ORG, INORG, METALS, SOLV, PET

Release Site: C-61-001, TA-61-23 SOIL BENEATH TRANSFORMER

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-61-001	7	CARBC;IC	ORG, INORG, METALS, PCB

TA-33

Task #: AL-LA-3
ADS #: 1122

Release Site: 33-001, MATERIAL DISPOSAL AREA E

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
33-001(a), PIT 1	292	IS;IC	RAD, HE, ORG, INORG, METALS
33-001(b), PIT 2	175	IS;IC	RAD, HE, ORG, INORG, METALS
33-001(c), PIT 3	4	IS;IC	RAD, HE, ORG, INORG, METALS
33-001(d), PIT 4	389	IS;IC	RAD, HE, ORG, INORG, METALS
33-001(e), TEST CHAMBER	148	IS;IC	RAD, HE, ORG, INORG, METALS

Release Site: 33-002, MATERIAL DISPOSAL AREA K

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
33-002(a), TA-33-9302(a)	157	IS;IC	RAD, ORG, INORG, METALS, SOLV
33-002(b), TA-33-134	203	IS;IC	RAD, ORG, INORG, METALS, SOLV
33-002(c), TA-33-133	203	IS;IC	RAD, ORG, INORG, METALS, SOLV
33-002(d), TA-33-86	1	IS;IC	RAD, ORG, INORG, METALS
33-002(e), TA-33-86	1	IS;IC	RAD, ORG, INORG, METALS

Release Site: 33-003, MATERIAL DISPOSAL AREA D

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
33-003(a), TA-33-4	144	IS;IC	RAD, METALS
33-003(b), TA-33-6	144	IS;IC	RAD, METALS

Release Site: 33-004, SEPTIC SYSTEMS/OUTFALLS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
33-004(a), TA-33-31	102	CARBC;IC	RAD, ORG, INORG, METALS
33-004(b), TA-33-33	6	CARBC;IC	RAD, ORG, INORG, METALS
33-004(c), TA-33-96	12	CARBC;IC	RAD, ORG, INORG, METALS
33-004(d), TA-33-121	24	CARBC;IC	RAD, ORG, INORG, METALS
33-004(e), TA-33-161	9	CARBC;IC	RAD, ORG, INORG, METALS
33-004(f), TA-33-23	4	CARBC;IC	RAD, ORG, INORG, METALS
33-004(g), TA-33-16	17	CARBC;IC	RAD, HE, ORG, INORG, METALS
33-004(h), TA-33-20	34	CARBC;IC	RAD, ORG, INORG, METALS
33-004(i), TA-33-39	25	CARBC;IC	RAD, ORG,INORG, METALS
33-004(j), TA-33-26	21	CARBC;IC	RAD, ORG, INORG, METALS
33-004(k), TA-33-87	16	CARBC;IC	RAD, ORG, INORG, METALS
33-004(l), TA-33-89	29	CARBC;IC	RAD, ORG, INORG, METALS
33-004(m), TA-33-179	5	CARBC;IC	RAD, ORG, INORG, METALS
33-004(n), TA-33-200	5	CARBC; IC	RAD, ORG, INORG, METALS

Release Site: 33-005, DECOMMISSIONED BUILDING 21 DRAIN SYSTEM

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
33-005(a), TA-33-32	31	CARBC;IC	RAD, ORG, INORG, METALS
33-005(b), TA-33-21	21	CARBC;IC	RAD, ORG, INORG, METALS
33-005(c),	550	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: 33-006, SHOT FACILITIES

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
33-006(a), TA-33-26, -146	1,667	CARBC;IC	RAD, HE, ORG, INORG, METALS
33-006(b), TA-33-97, -98	2,708	CARBC;IC	RAD, HE, ORG, INORG, METALS

Release Site: 33-007, GUN FIRING AREAS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
33-007(a), EAST MESA	2,685	CARBC;IC	RAD, HE, ORG, INORG, METALS, PET
33-007(b), TOWER AREA	1,917	CARBC;IC	RAD, HE, ORG, INORG, METALS, PET
33-007(c), AREA 6	611	CARBC;IC	RAD, HE, ORG, INORG, METALS, PET

Release Site: 33-008, FIRING AREA LANDFILLS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
33-008(a), TA-33-43	1,389	CARBC;IC	HE, ORG, INORG, METALS
33-008(b), TA-33-151	1,389	CARBC;IC	HE, ORG, INORG, METALS

Release Site: 33-009, AREA 6 LANDFILL

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
33-009, AREA 6	1,925	CARBC;IC	RAD, HE, ORG, INORG, METALS, PCB

Release Site: 33-010, CANYON-SIDE DISPOSAL SITES

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
33-010(a), S OF TA-33-118	810	CARBC;IC	RAD, HE, ORG, INORG, METALS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
33-010(b), SW OF TA-33-89	1,667	CARBC;IC	RAD, HE, ORG, INORG, METALS
33-010(c), S OF TA-33-26	2,333	CARBC;IC	RAD, HE, ORG, INORG, METALS
33-010(d), NW OF TA-33-6	3,500	CARBC;IC	RAD, HE, ORG, INORG, METALS
33-010(e), SE OF TA-33-2	1,167	CARBC;IC	RAD, HE, ORG, INORG, METALS
33-010(f), E OF TA-33-86	1,750	CARBC;IC	RAD, HE, ORG, INORG, METALS
33-010(g), S OF MDA-E	7,963	CARBC;IC	RAD, HE, ORG, INORG, METALS
33-010(h), NEAR TA-33-43	7,750	CARBC;IC	RAD, HE, ORG, INORG, METALS

Release Site: 33-011, INACTIVE STORAGE AREAS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
33-011(a), NEAR TA-33-21	102	CARBC;IC	ORG, INORG, PET, PCB
33-011(b), NEAR TA-33-3	3,333	CARBC;IC	RAD, HE, ORG, INORG, METALS
33-011(c), NEAR TA-33-63	79	CARBC;IC	RAD, ORG, INORG, METALS
33-011(d), NEAR TA-33-20	292	CARBC;IC	RAD, ORG, INORG, METALS
33-011(e), NW TA-33-22	185	CARBC;IC	RAD, HE, ORG, INORG, METALS

Release Site: 33-012, ACTIVE CONTAINER STORAGE AREAS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
33-012(a), STORAGE FOR TA-33-39	1	CARBC;IC	ORG, INORG, METALS, SOLV, PCB
33-012(b), STORAGE FOR TA-33-114	1	CARBC;IC	ORG, INORG, METALS, PHOCHEM
33-012(c), STORAGE FOR TA-33-114	1	CARBC;IC	ORG, INORG, METALS
33-012(d), TA-33-19	1	CARBC;IC	ORG, INORG, METALS, SOLV

Release Site: 33-013, TRITIUM-CONTAMINATED LIQUID WASTE STORAGE

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
33-013, TA-33-86	1	CARBC;IC	RAD, ORG, INORG, METALS, SOLV

Release Site: 33-014, BURN SITE

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
33-014, BURN SITE	4,033	CARBC;IC	RAD, HE, ORG, INORG, METALS

Release Site: 33-015, INCINERATOR

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
33-015, TA-33-110	1	CARBC;IC	ORG, INORG

Release Site: 33-016, HE SUMP

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
33-016, TA-33-23	17	CARBC;IC	HE, ORG, INORG, METALS, PET

Release Site: 33-017, TA-33 OPERATIONAL RELEASES

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
33-017, TA-33-21, -40, -86	1,062	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: C-33-001 TA-33-124 TRANSFORMER

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-33-001, TA-33-124, TRANSFORMER	1	CARBC;IC	ORG, INORG, METALS, PCB

TA's 4, 5, 35, 42, 48, 52, 55, 63, 66

Task #: AL-LA-6
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Release Site: 35-001, MATERIAL DISPOSAL AREA W

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
35-001, MDA-W	112	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: 35-002, MATERIAL DISPOSAL AREA X

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
35-002, MDA-X	16,133	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: 35-003, WASTE TREATMENT PLANT AND RECEIVING CANYON

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
35-003(a), TA-35-4	65,488	CARBC;IC	RAD, ORG, INORG, METALS
35-003(b), TA-35-5	65,488	CARBC;IC	RAD, ORG, INORG, METALS
35-003(c), TA-35-6	65,488	CARBC;IC	RAD, ORG, INORG, METALS
35-003(d), TA-35-10	65,488	CARBC;IC	RAD, ORG, INORG, METALS
35-003(e), TA-35-36	65,488	CARBC;IC	RAD, ORG, INORG, METALS
35-003(f), TA-35-37	65,488	CARBC;IC	RAD, ORG, INORG, METALS
35-003(g), TA-35-38	65,488	CARBC;IC	RAD, ORG, INORG, METALS
35-003(h), TA-35-31	65,488	CARBC;IC	RAD, ORG, INORG, METALS
35-003(i), TA-35-78	65,488	CARBC;IC	RAD, ORG, INORG, METALS
35-003(j), TA-35-96	65,488	CARBC;IC	RAD, ORG, INORG, METALS
35-003(k), TA-35-97	65,488	CARBC;IC	RAD, ORG, INORG, METALS
35-003(l), TA-35-8	65,488	CARBC;IC	RAD, ORG, INORG, METALS
35-003(m), TA-35-22	65,488	CARBC;IC	RAD, ORG, INORG, METALS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
35-003(n), TA-35-3	65,488	CARBC;IC	RAD, ORG, INORG, METALS
35-003(o), TA-35-12	65,488	CARBC;IC	RAD, ORG, INORG, METALS
35-003(p), TA-35-7	65,488	CARBC;IC	RAD, ORG, INORG, METALS
35-003(q), TA-35-9	65,488	CARBC;IC	RAD, ORG, INORG, METALS
35-003(r), OUTFALL	3,986	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: 35-004, ACTIVE/INACTIVE CONTAINER STORAGE AREAS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
35-004(a), TA-35-25	1	CARBC;IC	ORG, INORG, METALS
35-004(b), TA-35-85	1	CARBC;IC	ORG, INORG, METALS, SOLV
35-004(c), TA-35-125, SOUTH SIDE	1	CARBC;IC	ORG, INORG, METALS, SOLV, PET
35-004(d), TA-35-125 BASEMENT	1	CARBC;IC	ORG, INORG, METALS, SOLV, PET
35-004(e), TA-35-2	1	CARBC;IC	ORG, INORG, METALS, SOLV, PCB
35-004(f), TA-35-207	1	CARBC;IC	ORG, INORG, METALS, SOLV, PET
35-004(g), TA-35-67	1	CARBC;IC	ORG, INORG, METALS, SOLV, PET
35-004(h), TA-35-11	1	CARBC;IC	ORG, INORG, METALS, SOLV, PET
35-004(i), TA-35-58	1	CARBC;IC	ORG, INORG, METALS, SOLV, PET
35-004(j), TA-35-128	1	CARBC;IC	ORG, INORG, METALS, PET
35-004(k), TA-35-2	1	CARBC;IC	ORG, INORG, METALS, SOLV, PCB
35-004(l), TA-35-27	1	CARBC;IC	ORG, INORG, METALS, SOLV
35-004(m), TA-35-86	1	CARBC;IC	ORG, INORG, METALS, SOLV, PET
35-004(n), TA-35-87	1	CARBC;IC	ORG, INORG, METALS, SOLV, PHOCHEM
35-004(o), TA-35-213	1	CARBC;IC	ORG, INORG, METALS, SOLV

Release Site: 35-005, INACTIVE SURFACE IMPOUNDMENTS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
35-005(a), TA-35-85	343	CARBC;IC	ORG, INORG, METALS, SOLV, PET
35-005(b), TA-35-125	330	CARBC;IC	ORG, INORG, METALS, SOLV, PET

Release Site: 35-006, DECOMMISSIONED SURFACE IMPOUNDMENT

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
35-006	343	CARBC;IC	ORG, INORG, METALS, SOLV, PET

Release Site: 35-007, WASTE OIL TREATMENT

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
35-007, NEAR TA-35-125	111	CARBC;IC	ORG, INORG, METALS, SOLV, PET

Release Site: 35-008, SURFACE DISPOSAL/LANDFILL

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
35-008, TA-35-85	1,389	CARBC;IC	ORG, INORG, METALS

Release Site: 35-009, SEPTIC SYSTEMS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
35-009(a), TA-35-14, -15, -16	120	CARBC;IC	ORG, INORG, METALS
35-009(b), TA-35-77, -76	633	CARBC;IC	ORG, INORG, METALS
35-009(c), TA-35-44, -45	278	CARBC;IC	ORG, INORG, METALS
35-009(d), TA-35-65	254	CARBC;IC	ORG, INORG, METALS
35-009(e), TA-35-25	47	CARBC;IC	ORG, INORG, METALS

Release Site: 35-010, SANITARY LAGOON AND SAND FILTER

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
35-010(a), TA-35-144	10,489	CARBC;IC	RAD, ORG, INORG, METALS, SOLV
35-010(b), TA-35-145	8,519	CARBC;IC	RAD, ORG, INORG, METALS, SOLV
35-010(c), TA-35-146	8,944	CARBC;IC	RAD, ORG, INORG, METALS, SOLV
35-010(d), TA-35-215	3,333	CARBC;IC	RAD, ORG, INORG, METALS, SOLV

Release Site: 35-011, ACTIVE UNDERGROUND TANKS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
35-011(a), TA-35-2	74	CARBC;IC	RAD, ORG, INORG, METALS
35-011(b), TA-35-159	333	CARBC;IC	RAD, ORG, INORG, METALS, SOLV
35-011(c), TA-35-197	222	CARBC;IC	RAD, ORG, INORG, METALS
35-011(d), TA-35-188	444	CARBC;IC	RAD, ORG, INORG, METALS, SOLV

Release Site: 35-012, UNDERGROUND STORAGE TANKS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
35-012(a), TA-35-158	37	CARBC;IC	ORG, INORG, METALS, SOLV, PET
35-012(b), TA-35-278, -279	593	CARBC;IC	ORG, INORG, METALS, SOLV, PET

Release Site: 35-013, SUMPS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
35-013(a), TA-35-213	28	CARBC;IC	RAD, ORG, INORG, METALS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
35-013(b), TA-35-2	6	CARBC;IC	RAD, ORG, INORG, METALS, SOLV
35-013(c), TA-35-27	3	CARBC;IC	RAD, ORG, INORG, METALS, SOLV
35-013(d), TA-35-85	11	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: 35-014, OPERATIONAL RELEASES

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
35-014(a), EASTEND TA-35	208	CARBC;IC	RAD, ORG, INORG, METALS
35-014(b), TA-35-2	1	CARBC;IC	RAD, ORG, INORG, METALS, PCB, PET
35-014(c), TA-35-29	7	CARBC;IC	RAD, ORG, INORG, METALS, PET
35-014(d), TA-35-29	1	CARBC;IC	RAD, ORG, INORG, METALS, PET
35-014(e), TA-35-85	2	CARBC;IC	RAD, ORG, INORG, METALS, PET
35-014(f), TA-35-188	1	CARBC;IC	RAD, ORG, INORG, METALS, PET
35-014(g), TA-35-86	56	CARBC;IC	RAD, ORG, INORG, METALS, PET

Release Site: 35-015, DECOMMISSIONED WASTE OIL TREATMENT

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
35-015(a), TANK FARM	2,667	CARBC;IC	ORG, INORG, METALS, PET
35-015(b), GEMINI	556	CARBC;IC	ORG, INORG, METALS, PET

Release Site: 35-016, DRAINS AND OUTFALLS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
35-016(a), TA-35-34	47	CARBC;IC	ORG, INORG, METALS
35-016(b), TA-35-87	47	CARBC;IC	ORG, INORG, METALS
35-016(c), TA-35-67	47	CARBC;IC	ORG, INORG, METALS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
35-016(d), TA-35-46	47	CARBC;IC	ORG, INORG, METALS
35-016(e), TA-35-85	93	CARBC;IC	ORG, INORG, METALS
35-016(f), TA-35-85	94	CARBC;IC	ORG, INORG, METALS
35-016(g), TA-35-213	93	CARBC;IC	ORG, INORG, METALS
35-016(h), TA-35-213	101	CARBC;IC	ORG, INORG, METALS
35-016(i), TA-35-249	94	CARBC;IC	ORG, INORG, METALS
35-016(j), TA-35-125	48	CARBC;IC	ORG, INORG, METALS
35-016(k), TA-35-29	46	CARBC;IC	ORG, INORG, METALS
35-016(l), TA-35-29	48	CARBC;IC	RAD, ORG, INORG, METALS
35-016(m), TA-35-33	93	CARBC;IC	ORG, INORG, METALS
35-016(n), TA-35-86	48	CARBC;IC	ORG, INORG, METALS
35-016(o), TA-35-2	96	CARBC;IC	ORG, INORG, METALS
35-016(p), TA-35-27	93	CARBC;IC	ORG, INORG, METALS
35-016(q), TA-35-34	315	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: 35-017, SOIL CONTAMINATION FROM REACTOR OPERATIONS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
35-017, TA-35-2	1,157	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: 35-018, LEAKING PCB TRANSFORMER

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
35-018(a), 35-32	56	CARBC;IC	ORG, INORG, METALS, PCB
35-018(b), 35-2	56	CARBC;IC	ORG, INORG, METALS, PCB

Release Site: 4-001, FIRING SITE

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
4-001, TA-4-18	741	CARBC;IC	RAD, HE, ORG, INORG, METALS

Release Site: 4-002, SURFACE DISPOSAL SITE

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
4-002, MORTANDAD CANYON	35	CARBC;IC	RAD, HE, ORG, INORG, METALS

Release Site: 4-003, DRAINS AND OUTFALLS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
4-003(a), TA-4-7	116	CARBC;IC	RAD, ORG, INORG, METALS, PHOCHEM
4-003(b), TA-4-3	116	CARBC;IC	ORG, INORG, METALS

Release Site: 4-004, SOIL CONTAMINATION BENEATH FORMER BUILDING

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
4-004, TA-4-7	17	CARBC;IC	RAD, ORG, INORG, METALS, PHOCHEM

Release Site: 42-001, INCINERATOR COMPLEX

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
42-001(a), TA-42-1	3,161	CARBC;IC	RAD, ORG, INORG, METALS
42-001(b), TA-42-2	14	CARBC;IC	RAD, ORG, INORG, METALS
42-001(c), TA-42-3	14	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: 42-002, DECONTAMINATION FACILITY

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
42-002(a)	3,161	CARBC;IC	RAD, ORG, INORG, METALS, SOLV, ACID
42-002(b)	14	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: 42-003, SEPTIC SYSTEM

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
42-003, TA-42-4	1,573	CARBC;IC	RAD, ORG, INORG, METALS, SOLV, ACID

Release Site: 42-004, CANYON DISPOSAL

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
42-004	556	CARBC;IC	ORG, INORG, METALS

Release Site: 48-001, AIR EXHAUST SYSTEM

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
48-001	10,895	CARBC;IC	RAD, ORG, INORG, METALS, ACIDS

Release Site: 48-002, CONTAINER STORAGE AREAS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
48-002(a), MERCURY STORAGE	4	CARBC;IC	ORG, INORG, METALS
48-002(b), STORAGE (b)	3	CARBC;IC	ORG, INORG, METALS
48-002(c), STORAGE(c)	7	CARBC;IC	ORG, INORG, METALS
48-002(d), STORAGE(d)	1	CARBC;IC	RAD, ORG, INORG, METALS
48-002(e), STORAGE(e)	1	CARBC;IC	ORG, INORG, METALS, SOLV

Release Site: 48-003, INACTIVE SEPTIC SYSTEM

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
48-003, TA-48-5, TA-48-6	532	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: 48-004, SUMPS AND TANKS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
48-004(a), TA-48-1	8	CARBC;IC	RAD, ORG, INORG, METALS
48-004(b), TA-48-1	38	CARBC;IC	RAD, ORG, INORG, METALS
48-004(c), TA-48-1	21	CARBC;IC	RAD, ORG, INORG, METALS
48-004(d), TA-48-1	10	CARBC;IC	RAD, ORG, INORG, METALS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants

Release Site: 48-005, WASTE LINES

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
48-005, NW OF TA-48-1	1	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: 48-006, ACTIVE SEPTIC SYSTEM

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
48-006, TA-48-32	29	CARBC;IC	ORG, INORG, METALS

Release Site: 48-007, DRAINS AND OUTFALLS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
48-007(a), EAST OF TA-48-1	116	CARBC;IC	ORG, INORG, METALS
48-007(b), NORTH OF TA-48-1	116	CARBC;IC	ORG, INORG, METALS
48-007(c), NE of TA-48-1	116	CARBC;IC	ORG, INORG, METALS
48-007(d), EAST OF TA-48	93	CARBC;IC	ORG, INORG, METALS
48-007(e), NW OF TA-48-8	116	CARBC;IC	ORG, INORG, METALS
48-007(f), NE OF TA-48-46	116	CARBC;IC	ORG, INORG, METALS

Release Site: 48-008, LEAKAGE FROM PCB TRANSFORMERS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
48-008, TA-48-1	3	CARBC;IC	ORG, INORG, PCB

Release Site: 48-009, SOIL CONTAMINATION FROM AIR COMPRESSOR OPERATIONS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
48-009	8	CARBC;IC	ORG, INORG, PET

Release Site: 48-010, SURFACE IMPOUNDMENT

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
48-010, EAST OF TA-48-1	417	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: 5-001, FIRING SITES

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
5-001(a) NEAR TA-5-7	748	CARBC;IC	RAD, HE, ORG, INORG, METALS
5-001(b) NEAR TA-5-15	748	CARBC;IC	RAD, HE, ORG, INORG, METALS
5-001(c) EAST OF TA-5-4	748	CARBC;IC	HE, ORG, INORG, METALS

Release Site: 5-002, CANYONSIDE DISPOSAL

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
5-002	726	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: 5-003, CALIBRATION CHAMBER

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
5-003	48	CARBC;IC	RAD, ORG, INORG, METALS, PB

Release Site: 5-004, SEPTIC SYSTEM

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
5-004, TA-5-13	9	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: 5-005, DRAINS AND OUTFALLS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
5-005(a), FRENCH DRAIN NEAR TA-5-4	111	CARBC;IC	RAD, ORG, INORG, METALS
5-005(b), OUTFALL NEAR TA-5-5	111	CARBC;IC	ORG, INORG, METALS, PHOCHEM

Release Site: 5-006, SOIL CONTAMINATION BENEATH FORMER BUILDINGS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
5-006(a), TA-5-1	3	CARBC;IC	HE, ORG, INORG, METALS
5-006(b), TA-5-4	3	CARBC;IC	RAD, ORG, INORG, METALS
5-006(c), TA-5-5	3	CARBC;IC	HE, ORG, INORG, METALS, PHOCHEM
5-006(d), TA-5-6	2	CARBC;IC	HE, ORG, INORG, METALS
5-006(e), TA-5-19	2	CARBC;IC	RAD, ORG, INORG, METALS
5-006(f), TA-5-2	1	CARBC;IC	HE, ORG, INORG, METALS
5-006(g), TA-5-3	1	CARBC;IC	HE, ORG, INORG, METALS
5-006(h), TA-5-9	1	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: 52-001, UHTREX WASTE TREATMENT

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
52-001(a), TA-52-14	1	CARBC;IC	RAD, ORG, INORG, METALS
52-001(b), TA-52-15	1	CARBC;IC	RAD, ORG, INORG, METALS
52-001(c), TA-52-16	1	CARBC;IC	RAD, ORG, INORG, METALS
52-001(d), TA-52-1	35	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: 52-002, ACTIVE SEPTIC SYSTEMS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
52-002(a), TA-52-3, -4	14	CARBC;IC	ORG, INORG, METALS, SOLV
52-002(b), TA-52-34, -97, -98	5	CARBC;IC	ORG, INORG, METALS
52-002(c), TA-52-46	3	CARBC;IC	ORG, INORG, METALS
52-002(d), TA-52-47	3	CARBC;IC	ORG, INORG, METALS
52-002(e), TA-52-49, -50	6	CARBC;IC	ORG, INORG, METTALS
52-002(f), TA-52-99	8	CARBC;IC	ORG, INORG, METALS
52-002(g), TA-52-95	4	CARBC;IC	ORG, INORG, METALS

Release Site: 52-003, TREATMENT FACILITY

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
52-003, TA-52-2	58	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: 52-004, OUTFALL FROM HAMMER MILL BUILDING

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
52-004, TA-52-11	19	CARBC;IC	ORG, INORG, METALS

Release Site: 55-001, CEMENT PLANT

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
55-001	15,483	CARBC;IC	RAD, ORG, INORG, METALS, ACIDS

Release Site: 55-002, RADIOACTIVE WASTE CONTAINER STORAGE AREAS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
55-002(a), TA-55-4	17	CARBC;IC	RAD, ORG, INORG, METALS, PET
55-002(b), TA-55-8, -18	12	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: 55-003, CONTAINMENT AREA

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
55-003	9	CARBC;IC	ORG, INORG, METALS, ACIDS

Release Site: 55-004, EVAPORATOR

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
55-004, TA-55-4	15,483	CARBC;IC	RAD, ORG, INORG, METALS, ACIDS

Release Site: 55-005, FILTRATION UNIT

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
55-005, TA-55-4	15,483	CARBC;IC	RAD, ORG, INORG, METALS, ACIDS

Release Site: 55-006, GLASS BREAKER

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
55-006, TA-55-4	15,483	CARBC;IC	RAD, ORG, INORG, METALS, ACIDS

Release Site: 55-007, INCINERATOR

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
55-007, TA-55-4	5	CARBC;IC	RAD, ORG, INORG, METALS, ACIDS

Release Site: 55-008, SUMPS AND TANKS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
55-008, TA-55-4	7	CARBC;IC	RAD, ORG, INORG, METALS, ACIDS

Release Site: 55-009, SUMP

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
55-009, TA-55-71	54	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: 55-010, SOLVENT SPILLS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
55-010, TA-55-4	23	CARBC;IC	ORG, INORG, METALS

Release Site: C-35-001, TA-35-18 UST (REMOVED)

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-35-001, TA-35-18	36	CARBC;IC	ORG, INORG, METALS, PET

Release Site: C-35-002, TA-35-19 UST (REMOVED)

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-35-002, TA-35-19	67	CARBC;IC	ORG, INORG, METALS, PET

Release Site: C-35-003, TA-35-20 UST (REMOVED)

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-35-003, TA-35-20	67	CARBC;IC	ORG, INORG, METALS, PET

Release Site: C-35-004, SOUTH OF TA-35-125 OIL SPILL (CLEANED UP)

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-35-004	37	CARBC;IC	ORG, INORG, METALS, PET

Release Site: C-35-005, NEAR TA-35-125 OIL SPILL (CLEANED UP)

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-35-005, NEAR TA-35-125	37	CARBC;IC	ORG, INORG, METALS, PET

Release Site: C-35-006, TA-35-213 ORGANIC WASTE SPILL (CLEANED UP)

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-35-006, TA-35-213	4	CARBC;IC	ORG, INORG, METALS

Release Site: C-35-007, EAST OF TA-35 DIRT ROAD SPILL

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-35-007, EAST OF TA-35 LAGOONS	111	CARBC;IC	ORG, INORG, METALS

Release Site: C-4-001, TA-4-3, -4,-5,-6.-1,-8,-13 BUILDINGS (REMOVED)

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-4-001, TA-4-3, -4, -5, -6, -1, -13	37,037	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: 55-011, DRAINS AND OUTFALLS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
55-011(a), TA-55-79	20	CARBC;IC	RAD, ORG, INORG, METALS
55-011(b), TA-55-82	11	CARBC;IC	RAD, ORG, INORG, METALS
55-011(c), TA-55-83	9	CARBC;IC	RAD, ORG, INORG, METALS
55-011(d), TA-55-78	13	CARBC;IC	RAD, ORG, INORG, METALS
55-011(e), TA-55-81	8	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: 55-012, INACTIVE HAZARDOUS WASTE CONTAINER STORAGE AREA

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
55-012	1	CARBC;IC	ORG, INORG, METALS

Release Site: 55-013, ACTIVE HAZARDOUS WASTE CONTAINER STORAGE AREA

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
55-013(a), TA-55-3	1	CARBC;IC	ORG, INORG, METALS
55-013(b), TA-55-4	1	CARBC;IC	ORG, INORG, METALS

Release Site: 63-001 SEPTIC SYSTEMS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
63-001(a) TA-63-12	11	CARBC;IC	ORG, INORG, METALS
63-001(b) TA-63-14	11	CARBC;IC	ORG, INORG, METALS, SOLV

Release Site: C-5-001, TA-5-8, -21 BUILDINGS (REMOVED)

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-5-001, TA-5-8, -21	3,704	CARBC;IC	ORG, INORG, METALS

Release Site: C-52-001, TA-52-9 TRANSFORMER PAD

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-52-001, TA-52-9	1	CARBC;IC	ORG, INORG, METALS, PCB

Release Site: C-52-002, TA-52-9 TRANSFORMER PAD

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-52-002, TA-52-9	1	CARBC;IC	ORG, INORG, METALS, PCB

TA-36

Task #: AL-LA-39
ADS #: 1130

Release Site: 36-001, MATERIAL DISPOSAL AREA AA AND LANDFILLS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
36-001, MDA-AA	13,777	CARBC;IC	RAD, HE, ORG, INORG, METALS

Release Site: 36-002, SUMP

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
36-002, TA-36-49	1	CARBC;IC	HE, ORG, INORG, METALS

Release Site: 36-003, SEPTIC SYSTEMS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
36-003(a), TA-36-17	133	CARBC;IC	RAD,ORG,INORG,METALS,SOLV,PHOCHEM
36-003(b), TA-36-61	2	CARBC;IC	ORG, INORG, METALS
36-003(c), TA-36-70	3	CARBC;IC	ORG, INORG, METALS
36-003(d), TA-36-100	90	CARBC;IC	ORG, INORG, METALS

Release Site: 36-004, FIRING SITES AND TEST FACILITIES

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
36-004(a), EENIE	2,327	CARBC;IC	RAD, HE, ORG, INORG, METALS, ACIDS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
36-004(b), MEENIE	2,327	CARBC;IC	RAD, HE, ORG, INORG, METALS
36-004(c), MINIE	20,943	CARBC;IC	RAD, HE, ORG, INORG, METALS
36-004(d), LOWER SLOBBOVIA	9,493	CARBC;IC	RAD, HE, ORG, INORG, METALS
36-004(e), I-J	2,327	CARBC;IC	RAD, HE, ORG, INORG, METALS
36-004(f), MOE	20,943	CARBC;IC	RAD, HE, ORG, INORG, METALS

Release Site: 36-005, BONEYARD

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
36-005	833	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: 36-006, SURFACE DISPOSAL AREAS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
36-006, N of EENIE	139	CARBC;IC	ORG, INORG, METALS

Release Site: 36-007, WASTE HIGH EXPLOSIVES CONTAINER STORAGE AREAS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
36-007(a), TA-36-4	1	CARBC;IC	HE, ORG, INORG, METALS
36-007(b), TA-36-5	1	CARBC;IC	HE, ORG, INORG, METALS
36-007(c), TA-36-7	1	CARBC;IC	HE, ORG, INORG, METALS
36-007(d), TA-36-11	1	CARBC;IC	HE, ORG, INORG, METALS
36-007(e), TA-36-8	8	CARBC;IC	HE, ORG, INORG, METALS
36-007(f), MINIE	8	CARBC;IC	HE, ORG, INORG, METALS

Release Site: 36-009, MORTAR IMPACT AREA

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
36-009, PAJARITO CANYON	1,008	CARBC;IC	HE, ORG, INORG, METALS

Release Site: C-36-003, STORM DRAINS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-36-003, TA-36-1, -3, -4, -5, -6, -7, -8, -11, -12	33	CARBC;IC	RAD, ORG, INORG, METALS, PHOCHEM

TA-39

Task #: AL-LA-48
ADS #: 1132

Release Site: 39-001 MATERIAL DISPOSAL AREA Y AND OTHER LANDFILLS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
39-001(a) NEAR TA-39-69	44,445	CARBC;IC	RAD, ORG, INORG, METALS, PCB
39-001(b) MDA-Y	133,333	CARBC;IC	RAD, ORG, INORG, METALS, PCB

Release Site: 39-002 ACTIVE WASTE STORAGE AREAS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
39-002(a) TA-39-2	2	CARBC;IC	ORG, INORG, METALS, SOLV
39-002(b) TA-39-6	1	CARBC;IC	ORG, INORG, METALS
39-002(c) TA-39-56	1	CARBC;IC	ORG, INORG, METALS, SOLV
39-002(d) TA-39-57	1	CARBC;IC	ORG, INORG, METALS
39-002(e) TA-39-69	1	CARBC;IC	INORG, METALS
39-002(f) TA-39-88	1	CARBC;IC	ORG, INORG, METALS, SOLV, PET
39-002(g) TA-39-98	1	CARBC;IC	ORG, INORG, METALS, SOLV

Release Site: 39-003 INCINERATOR

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
39-003	101	CARBC;IC	RAD, HE, ORG, INORG, METALS

Release Site: 39-004 FIRING SITES

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
39-004(a) TA-39-7	58,182	CARBC;IC	RAD, HE, ORG, INORG, METALS, PCB
39-004(b) TA-39-8	58,182	CARBC;IC	RAD, HE, ORG, INORG, METALS, PCB
39-004(c) TA-39-6	58,182	CARBC;IC	RAD, HE, ORG, INORG, METALS, PCB
39-004(d) TA-39-57	58,182	CARBC;IC	RAD, HE, ORG, INORG, METALS, PCB
39-004(e) TA-39-88	58,182	CARBC;IC	RAD, HE ORG, INORG, METALS, PCB

Release Site: 39-005 SUMP AND DRAINFIELD

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
39-005	1,140	CARBC;IC	HE, ORG, INORG, METALS, SOLV

Release Site: 39-006 SEPTIC SYSTEMS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
39-006(a) TA-39-104	448	CARBC;IC	ORG, INORG, METALS, PHOCHEM
39-006(b) TA-39-132	417	CARBC;IC	ORG, INORG, METALS, PHOCHEM

Release Site: 39-007 INACTIVE WASTE STORAGE AREAS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
39-007(a) TA-39-63	1	CARBC;IC	ORG, INORG, METALS, SOLV
39-007(b) TA-39-4	1	CARBC;IC	HE, ORG, INORG, METALS
39-007(c) TA-39-103	2	CARBC;IC	ORG, INORG, METALS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
39-007(d) TA-39-24	2	CARBC;IC	ORG, INORG, METALS
39-007(e) NEAR MDA-Y	2	CARBC;IC	ORG, INORG, METALS, SOLV

Release Site: 39-008 SOIL CONTAMINATION AT GUN FIRING SITE

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
39-008	278	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: 39-009 DRAINLINE AND OUTFALL

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
39-009	57	CARBC;IC	ORG, INORG, METALS

TA-43

Task #: AL-LA-50
ADS #: 1136

Release Site: 43-001 SANITARY AND INDUSTRIAL WASTE LINES

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
43-001(a), INDUSTRIAL DRAINLINES	2	CARBC;IC	RAD, ORG, INORG, METALS
43-001(b), TA-43-24	1	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: 43-002 INCINERATOR

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
43-002, TA-43-1	4	CARBC;IC	ORG, INORG, METALS

Release Site: 43-003 WASTE CONTAINER STORAGE AREAS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
43-003,TA-43-1	1	CARBC;IC	ORG, INORG, METALS, PHOCHEM

Release Site: 43-004 CARCASS STORAGE

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
43-004,TA-43-1	6	CARBC;IC	ORG, INORG, METALS

Release Site: 43-005 RADIOACTIVE LIQUID WASTE STORAGE

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
43-005, TA-43-1	2	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: C-43-001, TA-43-1 HEALTH RESEARCH LABORATORY STORM DRAIN

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-43-001, TA-43-1	370	CARBC;IC	ORG, INORG, METALS

TA-46
Task #: AL-LA-33
ADS #: 1140

Release Site: 46-001 SIX ACID STORGAGE TANKS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
46-001 TA-46-88	41	CARBC;IC	ORG, INORG, METALS, ACIDS

Release Site: 46-002 SANITARY LAGOON AND SAND FILTER

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
46-002 TA-46-149	378	CARBC;IC	RAD,ORG,INORG,METALS,ACIDS,SOLV

Release Site: 46-003 SEPTIC SYSTEMS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
46-003(a) TA-46-8	7	CARBC;IC	RAD, ORG, INORG, METALS, ACIDS
46-003(b) TA-46-22	7	CARBC;IC	RAD, ORG, INORG, METALS, ACIDS
46-003(c) TA-46-49	7	CARBC;IC	RAD, ORG, INORG, METALS, ACIDS
46-003(d) TA-46-53	7	CARBC;IC	RAD, ORG, INORG, METALS, ACIDS
46-003(e) TA-46-66	7	CARBC;IC	RAD, ORG, INORG, METALS, ACIDS
46-003(f) TA-46-94	7	CARBC;IC	RAD, ORG, INORG, METALS, ACIDS
46-003(g) TA-46-230	7	CARBC;IC	RAD, ORG, INORG, METALS
46-003(h) TA-46-77	5	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: 46-004 SUMPS, DRAINS, AND OUTFALLS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
46-004(a) TA-46-31	5	CARBC;IC	ORG, INORG, METALS
46-004(b) TA-46-81	1	CARBC;IC	ORG, INORG, METALS
46-004(c) TA-46-61	117	CARBC;IC	RAD, ORG, INORG, METALS
46-004(d) TA-46-69	58	CARBC;IC	RAD,ORG,INORG,METALS,SOLV,ACIDS
46-004(e) TA-46-70	58	CARBC;IC	RAD,ORG,INORG,METALS,SOLV,ACIDS
46-004(f) TA-46-24	59	CARBC;IC	ORG,INORG, METALS, ACIDS
46-004(g) TA-46-1	1	CARBC;IC	RAD, ORG, INORG, METALS,
46-004(h) TA-46-16	1	CARBC;IC	RAD, ORG, INORG, METALS
46-004(i) TA-46-86,-87	59	CARBC;IC	ORG, INORG, METALS, ACIDS
46-004(j) TA-46-1	59	CARBC;IC	ORG, INORG, METALS, ACIDS
46-004(k) TA-46-169	5	CARBC;IC	ORG, INORG, METALS, ACIDS
46-004(l) TA-46-39	5	CARBC;IC	ORG, INORG, METALS, ACIDS
46-004(m) TA-46-30	5	CARBC;IC	ORG, INORG, METALS, ACIDS
46-004(n) TA-46-41	5	CARBC;IC	ORG, INORG, METALS, ACIDS
46-004(o) TA-46-200	5	CARBC;IC	ORG, INORG, METALS, ACIDS

Release Site: 46-005 SANITARY LAGOONS (FORMER SOLAR PONDS)

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
46-005, TA-46-170, -171	222	CARBC;IC	ORG, INORG, METALS

Release Site: 46-006 OPERATIONAL RELEASES

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
46-006(a) TA-46-71	11	CARBC;IC	RAD, ORG, INORG, METALS, PESTICIDE
46-006(b) TA-46-197	11	CARBC;IC	ORG, INORG, METALS, PET
46-006(c) TA-46-158	11	CARBC;IC	ORG, INORG, METALS, PET

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
46-006(d) TA-46-31	11	CARBC;IC	ORG, INORG, METALS, PET
46-006(e) TA-46-1	59	CARBC;IC	ORG, INORG, METALS, PET

Release Site: 46-007 CESIUM TREATMENT DITCH

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
46-007 SOUTH OF TA-46-1	13	CARBC;IC	RAD, METALS

Release Site: 46-008 INACTIVE DRUM STORAGE AREAS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
46-008(a) TA-46-88	3	CARBC;IC	ORG, INORG, METALS
46-008(b) TA-46-79	6	CARBC;IC	ORG, INORG, METALS
46-008(c) FENCED AREA	6	CARBC;IC	ORG, INORG, METALS
46-008(d) TA-46-262	3	CARBC;IC	ORG, INORG, METALS
46-008(e) TA-46-255	5	CARBC;IC	ORG, INORG, METALS
46-008(f) TA-46-31	5	CARBC;IC	ORG, INORG, METALS
46-008(g) TA-46-76	26	CARBC;IC	ORG, INORG, METALS

Release Site: 46-009 CANYONSIDE DISPOSAL

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
46-009(a) NO ASSOC. STRUCTURE	69	CARBC;IC	ORG, INORG, METALS
46-009(b) TA-46-149	426	CARBC;IC	RAD, ORG, INORG, METALS, SOLV, ACID

Release Site: 46-010 ACTIVE WASTE STORAGE AREAS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
46-010(a) TA-46-1	1	CARBC;IC	ORG, INORG, METALS, ACIDS, PET
46-010(b) TA-46-24	1	CARBC;IC	ORG, INORG, METALS, PHOCHEM, PET
46-010(c) TA-46-31	1	CARBC;IC	ORG, INORG, METALS
46-010(d) TA-46-41	1	CARBC;IC	ORG, INORG, METALS
46-010(e) TA-46-154	1	CARBC;IC	ORG, INORG, METALS
46-010(f) TA-46-158	1	CARBC;IC	ORG, INORG, METALS

Release Site: C-46-001 NEAR TA-46-75 MERCURY SPILL

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-46-001 TA-46-75	4	CARBC;IC	ORG, INORG, METALS

Release Site: C-46-002 TA-46-31 STACK RELEASE

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-46-002 TA-46-131	3,704	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: C-46-003 TA-46-158 UF6 RELEASE

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-46-003 TA-46-158	3,704	CARBC;IC	RAD, ORG, INORG, METALS

ENVIRONMENTAL RESTORATION PROGRAM
POTENTIAL RELEASE SITE REPORT

R030010

TA-49

Task #: AL-LA-51
ADS #: 1144

Release Site: 49-001 MATERIAL DISPOSAL AREA AB

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
49-001(a) Area 1	3,307	IS;IC	RAD, HE, ORG, INORG, METALS
49-001(b) Area 2	6,732	IS;IC	RAD, HE, ORG, INORG, METALS
49-001(c) Area 2A	1,686	IS;IC	RAD, HE, ORG, INORG, METALS
49-001(d) Area 2B	2,257	IS;IC	RAD, HE, ORG, INORG, METALS
49-001(e) Area 3	5,557	IS;IC	RAD, HE, ORG, INORG, METALS
49-001(f) Area 4	5,580	IS;IC	RAD, HE, ORG, INORG, METALS
49-001(g) DRAINAGE AREA	2,581	IS;IC	RAD, HE, ORG, INORG, METALS

Release Site: 49-002 UNDERGROUND EXPERIMENTAL CHAMBER

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
49-002	404	IS;IC	RAD, METALS

Release Site: 49-003 RADIOCHEMISTRY LAB LEACH FIELD

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
49-003	807	CARBC;IC	RAD, ORG, INORG, METALS, ACIDS

Release Site: 49-004 TRASH BURNING AREA AND LANDFILL

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
49-004	5,000	CARBC;IC	ORG, INORG, METALS

Release Site: 49-005 LANDFILL

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
49-005(a) EAST OF AREA 10	4,444	CARBC;IC	ORG, INORG, METALS
49-005(b) IN AREA 5	5	CARBC;IC	ORG, INORG, METALS

Release Site: 49-006 SUMPS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
49-006	19	CARBC;IC	ORG, INORG, METALS, PHOCHEM

Release Site: 49-007 SEPTIC TANKS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
49-007(a) TA-49-118	5	CARBC;IC	ORG, INORG, METALS
49-007(b) TA-49-119	7	CARBC;IC	ORG, INORG, METALS

Release Site: 49-008 SUBSURFACE CONTAMINATION AT AREA 12

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
49-008(a) Area 5	33	IS;IC	RAD, ORG, INORG, METALS
49-008(b) Area 6	39	IS;IC	RAD, ORG, INORG, METALS
49-008(c) Area 11	6	CARBC;IC	RAD, ORG, INORG, METALS, ACIDS
49-008(d) Area 12	18	CARBC;IC	RAD, HE, ORG, INORG, METALS, ACIDS

Release Site: 49-009 DECOMMISSIONED UNDERGROUND STORAGE TANK

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
49-009	37	CARBC;IC	ORG, INORG, METALS, PET

TA-50

Task #: AL-LA-5
ADS #: 1147

Release Site: 50-001, RADIOACTIVE WASTE TREATMENT FACILITY

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
50-001(a), TA-50-1, -90	10,962	CARBC;IC	RAD, ORG, INORG, METALS, ACIDS
50-001(b), TA-50-1(b)	77	CARBC;IC	RAD, ORG, INORG, METALS, ACIDS

Release Site: 50-002, TANKS AND DRAINLINES

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
50-002(a), TA-50-2	954	CARBC;IC	RAD, ORG, INORG, METALS
50-002(b), TA-50-67	15	CARBC;IC	RAD, ORG, INORG, METALS, ACIDS
50-002(c), TA-50-68	15	CARBC;IC	RAD, ORG, INORG, METALS, ACIDS
50-002(d), TA-50-5, -12	34	CARBC;IC	ORG, INORG, METALS, ACIDS
50-002(e), TANK	2	CARBC;IC	PET

Release Site: 50-003, WASTE STORAGE AREAS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
50-003(a), TA-50-1)	163	CARBC;IC	RAD, ORG, INORG, METALS
50-003(b), TA-50-1)	1	CARBC;IC	RAD, ORG, INORG, METALS, ACIDS
50-003(c), TA-50-2	11	CARBC;IC	RAD, ORG, INORG, METALS, ACIDS
50-003(d), TA-50-1	9	CARBC;IC	ORG, INORG, METALS, ACIDS
50-003(e), TA-50-125	1	CARBC;IC	ORG, INORG, METALS

Release Site: 50-004, DECOMMISSIONED TANKS AND WASTELINES

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
50-004(a), WASTELINE	4	CARBC;IC	RAD, ORG, INORG, METALS
50-004(b), TANK FARM	37	CARBC;IC	RAD, ORG, INORG, METALS
50-004(c), WASTELINES	26	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: 50-005, NONRADIOACTIVE WASTE TREATMENT PLANT

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
50-005, TA-50-1	119	CARBC;IC	ORG, INORG, METALS

Release Site: 50-006, OPERATIONAL RELEASES/OUTFALLS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
50-006(a), TEN SITE CANYON	86	CARBC;IC	RAD, ORG, INORG, METALS
50-006(b), TA-50-37	1	CARBC;IC	ORG, INORG, METALS
50-006(c), AIR EMMISSION	963	CARBC;IC	RAD, ORG, INORG, METALS
50-006(d), TA-50 TREATMENT OUTFALLS	20,575	CARBC;IC	RAD, ORG, INORG, METALS
50-006(e) TANK	40	CARBC;IC	ORG, INORG, METALS, PET

Release Site: 50-007, INCINERATOR COMPLEX

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
50-007, TA-50-37	8,324	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: 50-008, SIZE REDUCTION FACILITY

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
50-008, IN TA-50-69	756	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: 50-009, MATERIAL DISPOSAL AREA C

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
50-009, MDA-C	135,185	IS;IC	RAD, ORG, ACID, INORG, METALS

Release Site: 50-010, RADIOACTIVE DECONTAMINATION FACILITY

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
50-010, TA-50-1	367	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: 50-011, SEPTIC SYSTEMS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
50-011(a), TA-50-9, -11	22	CARBC;IC	RAD, ORG, INORG, METALS, ACIDS
50-011(b) SANITARY PIPELINES	5	CARBC;IC	RAD, ORG, INORG, METALS, ACIDS

Release Site: C-50-001, TRANSFORMER PAD

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-50-001, TA-50-4	1	CARBC;IC	ORG, INORG, METALS, PCB

TA's 51, 54

Task #: AL-LA-55
ADS #: 1148

Release Site: 54-001, HAZARDOUS WASTE CONTAINER STORAGE AREAS IN AREAS G AND L

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
54-001(a), STORAGE AREA ABOVE PIT A	15	CARBC;IC	ORG, INORG, METALS
54-001(b), TA-54-31 AREA L	8	CARBC;IC	ORG, INORG, METALS
54-001(c), AREA L STORAGE PAD	15	CARBC;IC	ORG, INORG, METALS, SOLV, PET
54-001(d), TA-54-39 AREA L	59	CARBC;IC	ORG, INORG, METALS, SOLV, PET, PCB
54-001(e), TA-54-32 AREA L	111	CARBC;IC	ORG, INORG, METALS
54-001(f), EAST OF TRU PADS AREA G	15	CARBC;IC	ORG, INORG, METALS

Release Site: 54-002, COMPRESSED GAS STORAGE IN AREA L

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
54-002, AREA L	7	CARBC;IC	ORG, INORG, METALS

Release Site: 54-004, MATERIAL DISPOSAL AREA H

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
54-004, SHAFTS 1-9	432	IS;IC	RAD, HE, ORG, INORG, METALS

Release Site: 54-005, MATERIAL DISPOSAL AREA J

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
54-005, PITS 1-4, SHAFTS 1&2	14,154	IS;IC	RAD,HE,ORG,INORG,METALS,ASBESTOS

Release Site: 54-006, MATERIAL DISPOSAL AREA L

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
54-006, SHAFTS 1-34, PIT A, & S.I. B,C,D	20,067	IS;IC	RAD,HE,ORG,INORG,METALS,ASBESTOS

Release Site: 54-007, SEPTIC SYSTEMS IN AREA L AND TA-54 WEST

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
54-007(a), TA-54-16	40	CARBC;IC	RAD, ORG, INORG, METALS
54-007(b), TA-54-28	5	CARBC;IC	RAD, ORG, INORG, METALS
54-007(c), TA-54 WEST	36	CARBC;IC	RAD, ORG, INORG, METALS
54-007(d), TA-54-4	14	CARBC;IC	RAD, ORG, INORG, METALS
54-007(e), TA-54-9	22	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: 54-008, SEWAGE TANK IN AREA L

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
54-008, 54-43	1	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: 54-009, TREATMENT TANKS IN AREA L

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
54-009, 54-35	6	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: 54-010, UNDERGROUND TANK IN AREA G

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
54-010, TA-54-17	1	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: 54-012, COMPACTORS IN AREAS G AND L

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
54-012(a), AREA G, TA-54-2	1	CARBC;IC	RAD, ORG, INORG, METALS
54-012(b), AREA L	4	CARBC;IC	ORG, INORG, METALS

Release Site: 54-013, TRUCK WASHING PITS AND OPERATIONAL RELEASES IN AREA G AND TA-54 WEST

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
54-013(a)	56	CARBC;IC	RAD, ORG, INORG, METALS, PET
54-013(b)	56	CARBC;IC	RAD, ORG, INORG, METALS, PET

Release Site: 54-014, RADIOACTIVELY CONTAMINATED WASTE STORAGE SHAFTS & PITS IN AREAS G AND L

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
54-014(a) SHAFTS, AREA L	438	IS;IC	RAD, ORG, INORG, METALS, PB
54-014(b) PIT 9, AREA G	28,000	IS;IC	RAD, ORG, INORG, METALS
54-014(c) SHAFTS 200-233, AREA G	227	IS;IC	RAD, ORG, INORG, METALS
54-014(d) TRENCH A-D, AREA G	8,316	IS;IC	RAD, ORG, INORG, METALS

Release Site: 54-015, SURFACE STORAGE OF RADIOACTIVELY CONTAMINATED WASTE IN AREAS G,L,TA-54 W

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
54-015(a) , TA-54-8	22	CARBC;IC	RAD, ORG, INORG, METALS
54-015(b), NEAR TA-54-11	5	CARBC;IC	RAD, ORG, INORG, METALS
54-015(c), PAD 1	4,016	CARBC;IC	ORG, INORG, METALS
54-015(d), PAD 2	1,931	CARBC;IC	ORG, INORG, METALS
54-015(e), PAD 3	4,016	CARBC;IC	ORG, INORG, METALS
54-015(f), PAD 4	2,273	CARBC;IC	ORG, INORG, METALS
54-015(g), NEAR SHAFT 4	44	CARBC;IC	RAD, ORG, INORG, METALS
54-015(h), TA-54-38	59	CARBC;IC	ORG, INORG, METALS
54-015(i), SW CORNER AREA L	1	CARBC;IC	RAD, ORG, INORG, METALS
54-015(j), TA-54-49	267	CARBC;IC	RAD, ORG, INORG, METALS, SOLV
54-015(k), ABOVE PIT 29	574	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: 54-016, SUMPS IN AREA G AND TA-54 WEST

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
54-016(a), TA-54-38	13	CARBC;IC	RAD, ORG, INORG, METALS
54-016(b), TA-54-33	1	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: 54-017, MDA-G DISPOSAL PITS ACTIVE PRIOR TO 11-19-80

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
54-017, MDA-G	107,713	IS;IC	RAD, ORG, INORG, METALS, ASBESTOS

Release Site: 54-018, MDA-G DISPOSAL PITS ACTIVE AFTER 11-19-80

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
54-018, MDA-G	104,987	IS, IC	RAD, ORG, INORG, METALS, PCB

Release Site: 54-019, MDA-G DISPOSAL SHAFTS ACTIVE PRIOR TO 11-19-80

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
54-019, MDA-G	318	IS;IC	RAD, ORG, INORG, METALS, PET

Release Site: 54-020, MDA-G DISPOSAL SHAFTS ACTIVE AFTER 11-19-80

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
54-020, MDA-G	1,435	IS;IC	RAD, ORG, INORG, METALS, PCB, PET

Release Site: 54-021, WASTE OIL STORAGE TANKS IN AREA G

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
54-021, AREA G	3	CARBC;IC	ORG, INORG, METALS, PET

Release Site: 54-022, LEAKAGE FROM PCB TRANSFORMER

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
54-022, TA-54-75	3	CARBC;IC	ORG, INORG, METALS, PCB

Release Site: C-51-002, SOIL CONTAMINATION ASSOCIATED WITH FORMER STRUCTURES

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-51-002	370	CARBC;IC	RAD, HE, ORG, INORG, METALS

TA-57

Task #: AL-LA-56
ADS #: 1154

Release Site: 57-001 DECOMMISSIONED DRILLING MUD PITS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
57-001(a), BARLEY CANYON	89	CARBC;IC	ORG, INORG, METALS
57-001(b), GT-2	2,500	CARBC;IC	ORG, INORG, METALS
57-001(c), TA-57-26	89	CARBC;IC	ORG, INORG, METALS

Release Site: 57-002 DISPOSAL AREAS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
57-002, WEST OF TA-57	6,667	CARBC;IC	ORG, INORG, METALS

Release Site: 57-003 SATELLITE STORAGE AREA

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
57-003, TA-57-56	1	CARBC;IC	ORG, INORG, METALS, SOLV, PET

Release Site: 57-004 DRILLING MUD PITS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
57-004(a), CIRCULATION PIT	2,500	CARBC;IC	ORG, INORG, METALS
57-004(b), TA-57-1	356	CARBC;IC	ORG, INORG, METALS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants

Release Site: 57-005 WATER FILTER

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
57-005, EE-1 POND	1	CARBC;IC	ORG, INORG, METALS

TA's 8, 9, 23, 69, 73

Task #: AL-LA-36
ADS #: 1157

Release Site: 69-001, TWO-MILE MESA INCINERATOR

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
69-001, TA-69-3	1,852	CARBC;IC	ORG, INORG, METALS

Release Site: 69-002, SEPTIC SYSTEMS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
69-002(a), TA-69-9	43	CARBC;IC	ORG, INORG, METALS, SOLV
69-002(b), TA-69-10	6	CARBC;IC	ORG, INORG, METALS, SOLV

Release Site: 8-001, OFF GAS FACILITIES

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
8-001(a), TA-8-1	19	CARBC;IC	HE, ORG, INORG, METALS, SOLV
8-001(b), TA-8-2	4	CARBC;IC	HE, ORG, INORG, METALS, SOLV

Release Site: 8-002, FIRING SITE

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
8-002, TA-8-1,-23	185	CARBC;IC	RAD, HE, ORG, INORG, METALS

Release Site: 8-003, INACTIVE SEPTIC TANKS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
8-003(a), TA-8-59, -1	13	CARBC;IC	HE, ORG, INORG, METALS, PHOCHEM
8-003(b), TA-8-64, -11	2	CARBC;IC	ORG, INORG, METALS
8-003(c), TA-8-67, -9	2	CARBC;IC	HE, ORG, INORG, METALS, PHOCHEM

Release Site: 8-004, DRAINS AND SUMPS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
8-004(a), TA-8-1	1	CARBC;IC	RAD, HE, ORG, INORG, METALS, SOLV
8-004(b), TA-8-2	1	CARBC;IC	RAD, HE, ORG, INORG, METALS, SOLV
8-004(c), TA-8-3	16	CARBC;IC	RAD, HE, ORG, INORG, METALS, SOLV
8-004(d), TA-8-24	1	CARBC;IC	RAD, HE, ORG, INORG, METALS, SOLV

Release Site: 8-005, WASTE STORAGE VESSEL

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
8-005, WEST OF TA-8-2	3	CARBC;IC	ORG, INORG, METALS

Release Site: 8-006, MATERIAL DISPOSAL AREA Q

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
8-006(a), TA-8-1, -23	356	CARBC;IC	RAD, HE, ORG, INORG, METALS
8-006(b), TA-8-21	74	CARBC;IC	RAD, HE, ORG, INORG, METALS

Release Site: 8-007, SILVER RECOVERY RESIN BED

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
8-007, TA-8-22	1	CARBC;IC	ORG, INORG, METALS, PHOCHEM

Release Site: 8-008, TRANSFORMER STORAGE AREA

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
8-008(a), SW of TA-8-22	1	CARBC;IC	ORG, INORG, METALS, PCB, PET
8-008(b), W of TA-8-21	1	CARBC;IC	ORG, INORG, METALS, PCB, PET
8-008(c), E of TA-8-24	1	CARBC;IC	ORG, INORG, METALS, PCB, PET
8-008(d), SE of TA-8-21	1	CARBC;IC	ORG, INORG, METALS, PCB, PET

Release Site: 8-009, DRAINS AND OUTFALLS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
8-009(a), TA-8-1, -2	20	CARBC;IC	ORG, INORG, METALS
8-009(b), TA-8-70	1	CARBC;IC	ORG, INORG, METALS
8-009(c), TA-8-23	13	CARBC;IC	ORG, INORG, METALS, PHOCHEM
8-009(d), TA-8-22	1	CARBC;IC	ORG, INORG, METALS, SOLV
8-009(e), TA-8-21	1	CARBC;IC	ORG, INORG, METALS, PHOCHEM

Release Site: 8-010, WASTE CONTAINER STORAGE AREA

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
8-010(a), TA-8-70	224	CARBC;IC	RAD, ORG, INORG, METALS, SOLV

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
8-010(b), TA-8-21	144	CARBC;IC	RAD, ORG, INORG, METALS, SOLV
8-010(c), TA-8-30	17	CARBC;IC	RAD, ORG, INORG, METALS, SOLV

Release Site: 8-011, DECOMMISSIONED UNDERGOUND STORAGE TANKS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
8-011(a), TA-8-60	11	CARBC;IC	ORG, INORG, METALS, PET
8-011(b), TA-8-61	11	CARBC;IC	ORG, INORG, METALS, PET

Release Site: 9-001, OLD ANCHOR EAST FIRING SITES (DECOMMISSIONED AREAS)

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
9-001(a), TA-9-4	24	CARBC;IC	RAD, HE, ORG, INORG, METALS
9-001(b), TA-9-5	36	CARBC;IC	RAD, HE, ORG, INORG, METALS
9-001(c), TA-9-15	43	CARBC;IC	RAD, HE, ORG, INORG, METALS
9-001(d), TA-9-1	37	CARBC;IC	RAD, HE, ORG, INORG, METALS

Release Site: 9-002, OLD ANCHOR EAST BURN PIT (DECOMMISSIONED AREA)

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
9-002, NO ASSOCIATED STRUCTURE	89	CARBC;IC	RAD, HE, ORG, INORG, METALS

Release Site: 9-003, OLD ANCHOR EAST DECOMMISSIONED SUMPS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
9-003(a), TA-9-14, -83	2	CARBC;IC	RAD, HE, ORG, INORG, METALS
9-003(b), TA-9-12, -84	2	CARBC;IC	RAD, HE, ORG, INORG, METALS
9-003(c), TA-9-14, -85	2	CARBC;IC	RAD, HE, ORG, INORG, METALS
9-003(d), TA-9-1, -88	7	CARBC;IC	RAD, HE, ORG, INORG, METALS
9-003(e), TA-9-14, -62	3	CARBC;IC	RAD, HE, ORG, INORG, METALS
9-003(f), TA-9-51, -199	2	CARBC;IC	RAD, HE, ORG, INORG, METALS
9-003(g), TA-9-2	2	CARBC;IC	RAD, HE, ORG, INORG, METALS
9-003(h), TA-9-3	2	CARBC;IC	RAD, HE, ORG, INORG, METALS
9-003(i), TA-9-13	2	CARBC;IC	RAD, HE, ORG, INORG, METALS

Release Site: 9-004, ACTIVE HE SUMPS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
9-004(a), TA-9-184	7	CARBC;IC	HE, ORG, INORG, METALS, SOLV
9-004(b), TA-9-185	7	CARBC;IC	HE, ORG, INORG, METALS, SOLV
9-004(c), TA-9-186	7	CARBC;IC	HE, ORG, INORG, METALS, SOLV
9-004(d), TA-9-187	7	CARBC;IC	HE, ORG, INORG, METALS, SOLV
9-004(e), TA-9-188	7	CARBC;IC	HE, ORG, INORG, METALS, SOLV
9-004(f), TA-9-189	7	CARBC;IC	HE, ORG, INORG, METALS, SOLV
9-004(g), TA-9-190	7	CARBC;IC	HE, ORG, INORG, METALS, SOLV
9-004(h), TA-9-191	7	CARBC;IC	HE, ORG, INORG, METALS, SOLV
9-004(i), TA-9-192	7	CARBC;IC	HE, ORG, INORG, METALS, SOLV
9-004(j), TA-9-193	7	CARBC;IC	HE, ORG, INORG, METALS, SOLV
9-004(k), TA-9-194	7	CARBC;IC	HE, ORG, INORG, METALS, SOLV
9-004(l), TA-9-195	7	CARBC;IC	HE, ORG, INORG, METALS, SOLV
9-004(m), TA-9-196	7	CARBC;IC	HE, ORG, INORG, METALS, SOLV
9-004(n), TA-9-197	7	CARBC;IC	HE, ORG, INORG, METALS, SOLV
9-004(o), TA-9-198	7	CARBC;IC	HE, ORG, INORG, METALS, SOLV

Release Site: 9-005, SEPTIC SYSTEMS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
9-005(a), TA-9-81	8	CARBC;IC	RAD,HE,ORG,INORG,METALS,PHOCHEM
9-005(b), TA-9-105	10	CARBC;IC	RAD, HE, ORG, INORG, METALS, SOLV
9-005(c), TA-9-106	8	CARBC;IC	RAD, HE, ORG, INORG, METALS, SOLV
9-005(d), TA-9-211	20	CARBC;IC	RAD, HE, ORG, INORG, METALS, SOLV
9-005(e), TA-9-107	6	CARBC;IC	RAD, HE, ORG, INORG, METALS, SOLV
9-005(f), TA-9-108	8	CARBC;IC	RAD, HE, ORG, INORG, METALS, SOLV
9-005(g), TA-9-109	4	CARBC;IC	RAD, HE, ORG, INORG, METALS, SOLV
9-005(h), TA-9-110	2	CARBC;IC	RAD, HE, ORG, INORG, METALS, SOLV

Release Site: 9-006, DECOMMISSIONED SEPTIC SYSTEM

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
9-006, TA-9-203, -3	5	CARBC;IC	RAD,HE,ORG,INORG,METAL,SOLV,PHOCHEM

Release Site: 9-007, INACTIVE SUMP

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
9-007, TA-9-202, -51	4	CARBC;IC	HE, ORG, INORG, METALS

Release Site: 9-008, OXIDATION POND

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
9-008(a) OLD LAGOON	1,944	CARBC;IC	ORG, INORG, METALS, SOLV

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
9-008(b), TA-9-212	217	CARBC;IC	ORG, INORG, METALS

Release Site: 9-009, LAGOON AND SAND FILTER

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
9-009, TA-9-218	627	CARBC;IC	ORG, INORG, METALS, SOLV, PHOCHEM

Release Site: 9-010, WASTE CAN SHELTERS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
9-010(a), TA-9-48	7	CARBC;IC	HE, ORG, INORG, METALS
9-010(b), TA-9-206	13	CARBC;IC	HE, ORG, INORG, METALS
9-010(c), TA-9-207	13	CARBC;IC	HE, ORG, INORG, METALS

Release Site: 9-011, ACTIVE CONTAINER STORAGE AREAS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
9-011(a), TA-9-21	1	CARBC;IC	RAD, HE, ORG, INORG, METALS
9-011(b), TA-9-39	1	CARBC;IC	RAD, HE, ORG, INORG, METALS
9-011(c), TA-9-38	1	CARBC;IC	RAD, HE, ORG, INORG, METALS, SOLV

Release Site: 9-012, POSSIBLE WASTE PIT

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
9-012, NO ASSOCIATED STRUCTURE	1,111	CARBC/IC	RAD, HE, ORG, INORG, METALS

Release Site: 9-013, MATERIAL DISPOSAL AREA M

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
9-013, MDA-M	576	IS;IC	RAD,HE,ORG,INORG,METALS,ASBESTOS

Release Site: 9-014, FIRING SITE

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
9-014, TA-9-176	70	CARBC;IC	HE, ORG, INORG, METALS

Release Site: 9-015, INDUSTRIAL WASTE MANHOLE

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
9-015, TA-9-178	1,881	CARBC;IC	RAD, HE, ORG, INORG, METALS

Release Site: 9-016, DECOMMISSIONED UNDERGROUND STORAGE TANK

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
9-016, TA-9-182	74	CARBC;IC	ORG, INORG, METALS

Release Site: C-8-001, POTENTIAL SOIL CONTAMINATION AT FORMER FIELD TEST BUILDING

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-8-001, TA-8-4	370	CARBC;IC	HE, ORG, INORG, METALS

Release Site: C-8-002, POTENTIAL SOIL CONTAMINATION AT FORMER FIELD TEST BUILDING

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-8-002, TA-8-5	370	CARBC;IC	HE, ORG, INORG, METALS

Release Site: C-8-020, POTENTIAL SOIL CONTAMINATION NORTH OF OLD ANCHOR WEST

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-8-020, TA-8-76	370	CARBC;IC	RAD, ORG, INORG, METALS

Release Site: C-9-001, STAINED SOIL NEAR OUTFALL

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-9-001, TA-9-31	370	CARBC;IC	ORG, INORG, METALS

Release Site: C-9-002, POTENTIAL SOIL CONTAMINATION AT FORMER BUILDING SITE

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-9-002, TA-9-9	370	CARBC;IC	HE, ORG, INORG, METALS

Release Site: C-9-003, POTENTIAL SOIL CONTAMINATION AT FORMER PUMP BUILDING

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-9-003, TA-9-16	370	CARBC;IC	HE, ORG, INORG, METALS

Release Site: C-9-005, POTENTIAL SOIL CONTAMINATION AT X-RAY CHAMBER

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-9-005, TA-9-58	370	CARBC;IC	RAD, HE, ORG, INORG, METALS

Release Site: C-9-006, POTENTIAL SOIL CONTAMINATION AT FORMER MAGAZINES AT FAR POINT SITE

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-9-006, TA-9-6, -11, -12, -16 (AE-6, -11, -18)	1,852	CARBC;IC	HE, ORG, INORG, METALS

Release Site: C-9-007, POTENTIAL SOIL CONTAMINATION AT FORMER STORAGE BUILDINGS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-9-007, TA-9-7, -8	1,111	CARBC;IC	RAD, HE, ORG, INORG, METALS

Release Site: C-9-008, POTENTIAL SOIL CONTAMINATION AT SITE OF FORMER UST

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-9-008, TA-9-182	74	CARBC;IC	ORG, INORG, METALS, PET

Release Site: C-9-009, OIL STAINS

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-9-009, TA-9-28	4	CARBC;IC	ORG, INORG, METALS, PET

Release Site: C-9-010, SMALL BURNING PIT (UNLOCATED)

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-9-010, TA-9-2b	37	CARBC;IC	RAD, HE, ORG, INORG, METALS

Release Site: C-9-011 TA-9-2C BURN AREA (UNLOCATED)

Site Type	Waste Amt. Cubic Yards	Potential Corrective Action	Potential Contaminants
C-9-011, TA-9-2C	37	CARBC;IC	RAD, HE, ORG, INORG, METALS

APPENDIX H

Sequential Sampling

SEQUENTIAL SAMPLING APPROACH FOR SITE CHARACTERIZATION

1.0 Introduction

1.1 Sampling and Site Characterization Definitions and Objectives

Populations, Samples, and Specimens

The sampling problem is defined in terms of a target population that is to be characterized. The target population is a collection of population units that are at least in principle available for observation. Examples of population units that arise in environmental work are

- core sections that could be obtained by drilling to depths up to 30 ft below the surface of the site,
- 1-L volumes of mixed soil, rock, and litter from the top 12 in. of the site, and
- filtered air samples collected at 3-month intervals within 500 m of the site perimeter.

The first problem, then, is to define the population of interest, specifying carefully the units of which it is composed.

Sometimes there may be units that belong to the population to be characterized but that in practice are excluded, *a priori,* from the collection of units available for observation. This might occur because we "know" that these units are not "representative," because they are inaccessible, because specimens suitable for our measuring devices cannot be prepared from them, or because of any number of other factors. Careful thought must be given to the differences between the nominal target population and the set of units that is truly available for observation. However, such considerations are beyond the scope of the ensuing discussion, which presupposes that these populations are identical.

Sampling is the process of selecting the units to be observed. This is a statistical concern because only a tiny fraction of the available units will ever be selected and assertions about the whole population based on these observations are only the result of inference. The process used to select the units to be observed affects the validity of the inference process. although it is by no means the only important influence, even from a statistical point of view. This section of this document outlines statistical considerations in sampling, with emphasis on the use of sequential sampling plans to expedite the characterization of large and possibly inhomogeneous populations.

In this section, the words "sample" and "sampling" are used in the traditional statistical sense. In particular, a population unit that is included in the sample is not called a "sample," but rather a "sampled (population) unit."

The sampled population units are often subsampled to prepare specimens, perhaps more than one per sampled unit, according to the specifications of the proposed analytical techniques. This subsampling process is very important and should be considered when

defining the target population. For example, specimens for a given analytical instrument may be preferentially prepared from the soil fraction of a sampled population unit, whereas the target population unit is defined as a volume of mixed soil, rock, and litter. As a result, laboratory measurements may not accurately represent the sampled unit even if the field sample is "representative" of the population.

"Compositing" is another postsampling procedure in which several sampled population units are combined, homogenized, and then subsampled. For some types of measurements (such as measurements of organic volatiles), this cannot be done. Where compositing can be used, however, it can make significant contributions to reducing the number of samples needed to adequately characterize a heterogeneous site.

Sequential Sampling

Sequential sampling involves selecting two or more samples and using the results of measurements on the first sample to guide the selection of the second sample. Unbiased estimates of population parameters can be based on single samples, but efficient data collection uses a first-stage or "pilot" sample to answer specific questions:

- How large a sample will be required to estimate a given population parameter with a given accuracy?
- What is the optimal allocation of resources remaining for sampling and analysis to characterize this site?

Questions such as these, particularly questions about the tradeoff between sample size and accuracy, cannot be answered without some prior site-specific information. However, the selection of the first-stage sample can often be guided by prior information of a more qualitative nature, including knowledge about the processes that have controlled the source and distribution of the contaminants, remote sensing information, and field measurements of relatively low precision.

Outcome Variables and Auxiliary Variables

Associated with each population unit is one or more outcome variables that will be measured for (specimens prepared from) the sampled units. Inference about these outcome variables for the whole population is the general goal of site characterization, although important specific properties of their distribution in the whole population need much more careful consideration before a sampling plan is selected.

In addition to known measured variables, up to measurement error (which here includes not only analytical error but also variability and bias introduced by subsampling and preparation of analytical specimens from sampled units) only for sampled units, in environmental work some auxiliary variables are always known, at least approximately, for all population units. At a minimum, the auxiliary variables include spatial location (a set of coordinates with respect to some reference coordinate system), possibly time (as in the case of air sampling), and unit volume (in the case of air sampling, the volume of air passing

through the filter in a given time period is probably estimated only roughly). Other auxiliary variables might be provided by remote sensing or by extrapolation from field screening measurements.

Goals of Site Characterization

As stated above, the general goal of site characterization is to answer one or more questions about the distributions of the outcome variables in the target population on the basis of statistical inference from the measurements made on the sampled units. Possible questions include

- What is the total amount of a measured variable in the population (i.e., what is the sum over all population units)?
- What is the largest value of a measured variable in a single population unit? More realistically from a statistical point of view, what is its pth percentile, $p < 100$, in the population?
- Are there any subpopulations of the target population (usually defined as volumes of a given size and shape) in which the variable uniformly exceeds a specified minimum (i.e., are there any hot spots)?
- How is the outcome variable distributed as a function of the auxiliary variables?

Often, in fact, the ultimate criterion for choosing among possible remedial actions is (or should be) a very indirect function of the answers to these or other questions that can be resolved by measuring outcome variables describing contaminant levels at a site, but also extensive modeling of transport to the surrounding environment, effects on human and other biological populations, and scenarios for future development. Uncertainties in these downstream models and scenarios may well dominate any uncertainty caused by sampling at the site characterization stage. Thus the anticipated use of site characterization data should, ideally, dictate the questions that should be answered and the level of accuracy required. These in turn direct the selection of a sampling plan. Unfortunately, this goal-oriented approach is not often followed; it is easier to use a regulatory or arbitrary bound on the measured variables themselves.

Whether or not risk-based criteria are used, however, once a model for the distribution of the outcome variables as a function of the auxiliary variables has been constructed, prediction-based answers to most other questions become available. For large, possibly complex sites, modeling can significantly reduce the total sample size needed for adequate site characterization, especially if sampling is done sequentially with attention to the different requirements of each stage. Section 1.2 compares this model-based approach with more traditional randomized sampling, and Section 1.3 contains some general remarks about sequential sampling. The remainder of this discussion goes into some detail concerning the practical application of these general ideas, largely by example. These examples demonstrate, however, that every site is an individual case, and detailed prescriptions cannot be laid out in advance.

1.2 Approaches to Spatial Sampling and Inference

Statistics is concerned with the modeling of variability and uncertainty according to probability theory and with the use of such models to guide inference-based observations generated by stochastic processes. Sampling, on the other hand, is concerned with the study of nonstochastic populations, and its formulation as a statistical problem can lead to some deep philosophical questions. Two rather divergent schools of thought are found in the literature.

1.2.1 Design-Based Sampling

Traditional survey sampling approaches a problem by designing an appropriate sampling distribution, a probability distribution P_S on the space S of possible samples, that is, on a set of subsets (usually those of a fixed size n only) of the population. Then one sample is selected at random according to P_S. Inference about population parameters based on this sample is conditioned only on the probability, under P_S, that the selected units actually have been included in the sample.

The starting point for the design of P_S is simple random sampling (SRS), in which each subset of size n is assigned probability $\binom{N}{n}^{-1}$, assuming that a sample of size n is to be selected from a population of size N. Under simple random sampling,

$$E_{P_S}[\bar{Y}_S]=\bar{Y} \ ;$$

that is, the mean outcome of the sampled units is an unbiased (with respect to P_S) estimator of the population mean. More elaborate sampling distributions—stratified sampling, cluster sampling, multistage sampling, and so forth—are designed to address additional objectives, such as reducing the variance

$$E_{P_S}[\bar{Y}_S-\bar{Y}]^2 \ ,$$

increasing the efficiency of allocation of field work resources, or eliminating samples that are considered unacceptable. (For some of these sampling distributions, the sample mean $\bar{Y}_S$ must be replaced by a weighted mean, in which the weights depend on P_S but not on the actual values of auxiliary or outcome variables.)

The distinguishing features of design-based sampling are that probabilistic considerations apply only to the process of selecting a sample, and inference (about parameters characterizing the entire population) is conditioned only on the probability that a unit is included in the sample. Proponents of these methods stress the objectivity provided by the randomized selection of the sample. Auxiliary information may be used to design or restrict the sampling distribution. For site characterization, for example, samples concentrated on one quadrant of the site may be considered unacceptable, and spatial distribution requirements may be enforced by stratifying on spatial coordinates or by limiting consideration to systematic sampling plans (with random starting points). However, once P_S is selected, the auxiliary information has no further effect on the actual selection of a sample, nor does it reappear, once the sample has been selected, in the estimation of the

population parameters (except indirectly as it affected the probability of a given unit's inclusion in the sample).

1.2.2 Model-Based Sampling

By contrast, the second approach to sampling views the problem as one of constructing and estimating a model for the outcome variables, based explicitly on the auxiliary variables (which, by definition, are known for all population units in advance of sampling) and the observed outcome variables, available only for sampled units. Model-based estimators for population parameters, such as the population mean, are constructed as functionals of the estimated model. In addition, individual predictions are available for the outcome variables associated with unobserved units.

In general, the models used are statistical mixed-effects models. The fixed effects are represented by a functional relationship between the auxiliary variables and the outcome variables, whereas deviations from this trend component are treated as random effects and are modeled using a correlation structure (which may also depend on the auxiliary variables). Thus, the probabilistic structure that relates the observed outcomes to the population is here introduced as a superpopulation model rather than as a model for the sampling process.

From this perspective, the sampling problem becomes one of carefully selecting population units to efficiently estimate model parameters or prespecified functionals. Optimization of some criterion (such as minimization of the average prediction error over all unobserved units) could be used to determine a best sample. In general, however, such criteria functions are very flat in the neighborhood of the optimum, and the range of near-optimum samples is quite large. The ideas of model-based sampling are, therefore, usually implemented as restrictions on random sampling, and many of the desirable restrictions turn out to be similar to those in design-based sampling, such as stratification with respect to auxiliary variables.

The choice of a method for sample selection should be based primarily on the questions to be answered. If the problem is to estimate a small number of overall population parameters (for example, the population mean or perhaps an upper-tail quantile), then the detailed information that might be extracted from a more formal, model-based estimator can be ignored in favor of the objectivity provided by randomized sample selection and the accompanying simple estimators (usually straightforward sample analogs of the corresponding population parameters).This approach is suitable for many monitoring situations, including the confirmatory, postcleanup surveying of remediated sites.

However, for characterization of unknown sites where partial remediation may be required, detailed information (for example, the spatial distribution of predicted mean outcomes in blocks of some minimum remediation size that is probably much larger than the sampling unit but much smaller than the whole site) is important. Under these conditions, sampling should be conducted with model identification and estimation in mind, which by no means excludes the possibility of randomized sample selection. It does restrict, more than is

customary in traditional sampling, the range of subsets given positive probability under the sampling distribution P_S. The most significant difference, however, turns out to be in the use of the resulting observations, especially the way they can be used to design a purposive second-stage sample in a sequential sampling plan.

1.3 Sequential Sampling

Sequential sampling is appropriate whenever the target population is too large and potentially too complex to be adequately characterized by a small number of samples (30 or fewer). Under these circumstances, a pilot study is used to provide estimates of the variability and predictability of the observations. With data from a pilot study in hand, the investigator can determine how the accuracy of estimates of population parameters will increase with sample size, perform tradeoff analyses comparing the costs of further sampling and analysis with the potential benefits, and decide how to allocate resources remaining for sampling and analysis.

1.3.1 Design-Based Sampling

In design-based sampling, the most important variable to be estimated from pilot data is population variability. Given this parameter (and perhaps some estimate of spatial correlation), the total sample size required to attain a given level of accuracy in estimation of a given population parameter can be computed. [Gilbert (1987) is an excellent general reference on environmental sampling from the design-based point of view.]

1.3.2 Model-Based Sampling

The model-based approach carries a particularly strong bias towards sequential sampling, although model-based inference can be applied to a single sample as well. The first stage is oriented towards model construction and the second stage towards model checking and refinement. Prior knowledge and prior data ("hard" data or relatively "soft" remotely sensed data or extrapolations from field screening measurements) can provide some assistance at the first stage, but estimates of spatial correlation, essential for estimating accuracy, are seldom available.

The goals of the first stage of a sequential plan, when using the model-based approach to sampling and inference, are

- the construction of a model relating the observed outcome variables to the outcomes for unobserved units,
- preliminary prediction of unobserved units from the model and the data, and
- estimation of prediction error for these units.

In general, the model consists of a trend component (a simple functional relationship between the auxiliary variables and the outcome variable) and a correlation component (an estimate of the covariance among deviations from this trend, also a function of the auxiliary variables). The usual method for using this model for prediction is called best linear

unbiased prediction (BLUP), but in much of the geostatistical literature this method goes by the name of "kriging."

If preliminary predictions and/or/prediction uncertainties are deemed inadequate for the completed site characterization (where ideally, adequacy is defined relative to the ultimate decision criteria rather than to some arbitrary but more immediate proxy), additional observations are required. Depending on the status at the end of the first-stage model estimation, various goals are possible for second (and subsequent) sampling stages.

- If it is already apparent that some areas of the site will require remediation, the second stage can be devoted to confirming low predictions so that unnecessary remediation can be avoided with confidence. [It has been observed that "...a decision to require remediation can be based on only one sample. The decision not to remediate, however, requires much more evidence" (Splitstone 1987).]
- If the bulk of the site appears to be in satisfactory condition, the second stage may be devoted largely to more detailed characterization of apparent hot spots to determine precisely the extent of remediation required.
- If the estimate of the spatial correlation among observations suggests that the prediction errors can be significantly reduced by modest additional expenditure, then perhaps a second, systematic, infill sample is called for. [This is the case to which most of the existing literature is devoted.]

The results of the first-stage analysis allow a determination of how much more sampling will be required to achieve the selected goal and thus to evaluate the costs of this effort against the possibilities of missing areas that should be remediated or of performing unnecessary remediation.

2.0 Spatial Sampling with No Prior Information

Although there may be very few sites about which there is really no prior information, such cases are conceptually simple, and other cases represent appropriate modifications.

2.1 The First Stage: Requirements

2.1.1 Stratification for Detecting Trends

One component of the model at the end of the first-stage analysis is a trend component. This trend component may turn out to be a constant, reflecting the absence of any apparent large-scale trends across the site; however, in the absence of prior information, it is desirable to distribute the sample around the site fairly evenly, for example, by stratification or systematic sampling. Such a distribution increases the probability of detecting trends with the small sample.

2.1.2 Data for Covariance Model

Stratified or systematic sampling is entirely consistent with the design-based approach to spatial sampling. However, model-based sampling imposes additional requirements associated with the need to estimate the parameters of the stochastic superpopulation model.

Of these parameters, the most important is the spatial correlation. The observations obtained from a stratified or gridded sample are adequate to estimate spatial correlation (if any) only at relatively large separations between points. However, an estimate of the spatial correlation at shorter distances is vital in assessing the predictability of unobserved units; therefore, a few additional points must be included in a stratified or gridded sample.

Quantitative estimates of prediction accuracy also require some information about the nonsampling component of variability, that is, measurement error, which may need to be determined using duplicate analyses and/or splits (two or more specimens prepared from the same sampled unit).

2.1.3 Identification of Hot Spots

Occasionally the dimensions of the first-stage grid are chosen to minimize the probability of missing a hot spot of a given size and shape, that is, to guarantee with high probability that any such area will be sampled. Gilbert (1987) presents the details of this design-based approach. If this turns out to be too expensive, emphasis on hot-spot characterization at the second stage of a prediction-based approach may be more reasonable.

2.3 The Second Stage: Alternative Strategies

By the end of the first stage, which includes not only sampling but also data analysis and model building, a rough picture of the site and some idea of the predictability (the spatial correlation) among outcome variables are available. One of the first things to be examined is the sample quantiles for the gridded part of the sample to see whether there is any indication of a problem. If all the observations are far below any level that could be considered a problem, it is appropriate to proceed with estimates of population variance and to evaluate the possibility that no problem exists at the site.

If the results are more ambiguous, it is necessary to look at the spatial distribution in more detail. The first-stage predictions should allow a preliminary classification of site locations into three classes (1) the site probably requires remediation, (2) the site probably does not require remediation, and (3) the site may or may not require remediation. Where second-stage sampling should be concentrated depends on the relative sizes of these regions and also on the apparent spatial correlation. If the correlation between nearby observations is high, then it may already be possible to place high confidence in the predictions. If the second sample is concentrated on borderline areas of the site, it should be possible to obtain a fairly complete picture of exactly how much remediation will be required at a modest additional expenditure.

On the other hand, if the predictability of outcomes is poor (that is, if there appears to be little spatial correlation), site-wide characterization with good precision will be out of the question. One possibility is to write off the probably require remediation area, and maybe some fraction of the borderline area as well, and plan to remediate those areas without further investigation. Second-stage sampling can then concentrate on establishing that the remainder of the site is acceptable. Alternatively, it may be more reasonable to accept, tentatively, the probably-does-not-require-remediation classification and dedicate the second stage to improved characterization of the parts of the site that may well require action, although a small fraction of the second-stage sample might be allocated to looking for surprises in the apparently clean areas.

3.0 Using Prior Information

Prior information can take several forms. Models of radial dispersal of contaminants from a firing point or longitudinal dispersal along stream beds in canyons (away from entry points at outfalls) suggest logical sampling patterns. Plans, as-built maps, and other historical information may be spatially more complex than prior models for dispersion, but this information can be treated in a similar fashion. Finally, hard data may exist for a given site, although such data are seldom sufficient to supply all of the the first-stage requirements discussed in Section 2.

The modifications needed to incorporate prior information into the approach outlined above are found both in sample design and in data analysis as applied to the first stage. Samples should be stratified with respect to variables about which prior information exists, as well as with respect to spatial coordinates. Data analysis must incorporate the possibility of trends at all stages, and prior information is valuable in suggesting the most probable form for such trends.

4.0 Conclusions

The most important aspect of sampling, sequential or otherwise, is to have clearly in mind the goals that must be accomplished and the routes along which postsampling data analysis and synthesis will proceed. Different approaches to sampling have been designed to answer different questions, and failure to recognize these differences seems to be the source of much of the argument between different schools of sampling. The approach of this discussion is based on the premise that the site characterization problem is an inverse problem for which the goal is to approximate the true spatial distribution of contaminants over the site under investigation and not merely to estimate the total amount of contamination. It is up to an investigator to decide, however, if this really describes the objectives and, therefore, whether these techniques are appropriate.

Sequential sampling has a place in almost all types of sampling; however, it is impossible to determine sample sizes even for answering relatively simple questions, such as, "What is the total amount of contamination at the site?" without having some idea of the variability within the target population. As a rule, the only way to acquire this information is to conduct a pilot study, which is the first stage of a sequential plan. The main point of the

preceding discussion is to suggest that a pilot study can and should be designed to characterize population variability in more detail than by a single number, the variance. This additional information, available at no extra expense if only the first sample is subjected to a few additional restrictions suggested by the model-based approach, will usually provide valuable information (if of a rather negative kind) about the potential improvement in site characterization that can be expected for a given amount of work.

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APPENDIX I

Decision Analysis

DECISION ANALYSIS METHODOLOGY

1.0 Development Process

A decision analysis methodology constitutes a technical structure that can be used to coordinate many individual activities. These activities include the Environmental Restoration (ER) Program investigations that must be performed to identify the appropriate corrective measures needed to make identified waste disposal sites and adjacent areas safe for both human health and the environment. The methodology described here directs the activities to implement the Resource Conservation and Recovery Act (RCRA) corrective action process. Within the site characterization effort, several tasks may require the kind of organization provided by a decision analysis methodology. This methodology combines integration of technical and value judgments. Technical judgments may involve environmental assessment measures, modeling assumptions, statistical assessments and estimates, and so forth, whereas value judgments may involve the objectives of the ER Program and Installation Work Plan, value tradeoffs among objectives, appropriate alternative measures, attitudes toward risk, and similar considerations. The following sections outline the specifics of the approach, consistent with documents provided by field investigations and corrective measures studies specified by RCRA. The approach outlined here incorporates one of the key components of the observational approach, namely the explicit recognition of uncertainty, as an element of uncertainty will be present throughout the site remediation process.

1.1 Structuring the Decision Problem

1.1.1 Establish Objectives, Evaluation Measures, and Threshold Values

ER Program staff will establish the ER Program objectives within the guidelines of the Environmental Protection Agency (EPA) by developing a hierarchy of objectives; the format allows input from decision makers, the various technical groups, and the community. ER Program staff will then establish evaluation measures to determine the degree to which various alternatives meet specified objectives. These measures are derived from actual measurements, results from computer models, opinion surveys, and other appropriate sources. The establishment of threshold values for the primary concerns will aid in the preliminary screening of site characterization requirements. Preliminary screening will reveal the level of effort required for different aspects of the characterization process to meet objectives and will assist in the evaluation of alternative corrective measures for the various waste disposal sites.

1.1.2 Specify Potential Scenarios

ER Program staff will specify the potential scenarios that may affect these measures. The ER Program must foresee not just expected future uses but also unexpected but reasonable future uses of the various waste disposal sites. The development of potential scenarios requires a systematic method for identifying specific possible site uses and estimating the likelihood of such uses on the basis of the construction of the site-use scenario. The clear

specification of a particular scenario is the analytical requirement for identifying (probabilistically) expected conditions and possible deviations from them. The latter are needed for the observational approach to be workable. The clear specification of a scenario also creates the structure for analyzing institutional control (as specified in the Superfund Report) as an option. Systematic analysis of potential future-use scenarios is an important aspect of both these considerations.

1.1.3 Generate Alternative Corrective Measures

ER Program staff will generate possible alternative corrective measures. A structured procedure makes it possible to generate alternatives that can be evaluated according to the evaluation measures (which are based on objectives) for the various scenarios developed. Structuring the problem allows the evaluation of proposed activities in the ER Program and the allocation of resources in a way that is consistent with the program objectives and acknowledges their relative importance. The basic premise of a structural procedure is the same as the premise for the RCRA field investigation/corrective measures study (RFI/CMS) procedure. The most desirable corrective measure is determined by the extent to which that activity achieves the objectives of the ER Program.

1.2 Conducting Preliminary Evaluation of Alternative Corrective Measures

The various alternative corrective measures developed as described in Section 1.1 are first screened according to the criteria also developed as described in Section 1.1. Those alternatives considered feasible are then more fully examined using the evaluation measures developed in Section 1.1. Each alternative is evaluated in view of specified future scenarios and time frames, including uncertainty in the analysis. Many alternatives will be eliminated from further analysis as a result of the activities described in Section 1.1 Section 1.2 incorporates most of the technical analysis. The form of the analysis during the preliminary evaluation of alternatives allows the inclusion of additional objectives: satisfying possible changes in future requirements, satisfying specific public or congressional concerns, meeting new budget requirements or schedules, and others. Evaluations of each of the alternatives can be performed for present (existing) conditions, for conditions after specified intervals or specified cleanup activities, or under estimated extreme conditions in the future with and without the corrective measures now being conducted.

If the expected conditions are identified early, not all possible aspects of all alternatives need be investigated, as is suggested by the observational approach. Thus, the number of alternatives that require evaluation is limited, and the process of identifying an appropriate corrective measure is completed more quickly.

1.3 Developing a Quantitative Overall Evaluation Model

Development of a quantitative overall evaluation model is consistent with the RFI requirement that alternative corrective measures be examined across all evaluation measures and that uncertainty or risk judgments be included. In particular, this function captures the individual evaluation measure scores for each alternative, the uncertainty in these measures,

the decision makers' attitudes toward risk (for example, their degree of risk aversion), and the relative tradeoff values between different objectives. The decision on appropriate measurement units aids in quantifying uncertainty, which is preferable to relying only on qualitative judgments. Also, a quantitative measure of attitude toward risk provides direction for risk combination judgments, which are difficult to define, quantify, and defend if not performed in a manner that is consistent with the structure of the overall RFI effort. A determination of the most appropriate units for defining risk measures is possible. For example, some possible units for measuring risk are excess dosages of toxic and nontoxic substances, excess latent fatal cancers, excess cancer deaths, and environmental impact measures.

1.4 Selecting a Corrective Measure

Each corrective measure can be given an overall evaluation that combines all evaluation measure concerns, public (community) inputs, and regulatory guidelines according to the model developed in Section 1.3. Specific remediation strategies can be evaluated under different scenarios and time frames. In addition, this evaluation process can estimate the effect of ER activities on the sites and show an optimal allocation of funds to achieve the maximum overall enhancement of the Los Alamos National Laboratory (the Laboratory) site, given time and budget constraints. Table I-1 illustrates the way individual measures are combined to provide a single expected performance (expected utility value) that represents the overall attractiveness of proposed research projects relative to a base-case project-acceptability threshold.

TABLE I-1
PHASE I SCHEDULE

Prepare for decision analysis.

- Organize relevant documentation and references including EPA, New Mexico Environmental Improvement Division (NMEID), RCRA, RFI, remedial investigations and feasibility studies, Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), and others.
- Identify personnel who will participate in setting objectives for the ER Program (personnel at Los Alamos, Department of Energy (DOE), EPA, and NMEID, state authorities, and others).
- Develop interview protocols for personnel within the ER Program (at all levels).
- Organize relevant public/community material, identify the interested stakeholders and positions, and develop community relations protocols.

Develop site model.

- Formulate objectives hierarchy through integration of relevant documentation and regulations with structured interview results.

- Establish evaluation measures, appropriate measurement scales, and sources of information for measurement.
- Use preliminary data and modeling results to check feasibility and appropriateness of evaluation measures and scales.
- Develop screening criteria using objective hierarchy, regulatory guides, evaluation measures, and cost analysis.
- Develop risk scenarios using scenario factors, levels, factor probabilities, and analysis of scenario probability bounds.
- Develop a strategy table for systematically generating corrective measure alternatives.

Develop structured method for resource allocation guidelines to aid in making allocation decisions that best serve the ER Program objectives.

Conduct initial screening of alternatives and test screening criteria.

Begin evaluation of corrective measure alternatives using data and the problem structure developed to this point in the process.

- Estimate data availability and appropriateness of measures.
- Consider dependent relationships among measures.
- Determine model availability for support of various measurement needs.
- Formalize coordination of technical assessments.

Begin development of overall evaluation model.

- Test independence/dependence structure of evaluation measures.
- Quantify tradeoff values and risk attitudes.
- Run consistency checks on model parameters and inputs.

Begin development of community input protocols.

- Format development for inclusion of community objectives.
- Format development for inclusion of community tradeoff values (value trees)
- Format development for inclusion of community contributions to alternative generation.

1.5 Conducting a Sensitivity Analysis

ER Program staff will conduct a sensitivity analysis to answer a number of important questions:

- Overall, what are the most significant contributors to contamination and the resulting risk to human health and the environment?

- What factors contribute most to the cost of remediation and compliance with regulatory guides?
- Which components of the ecosystem are most affected by the waste site contamination?
- What technical and value (preference) judgments are the most critical in the evaluation of the various alternatives?
- Where can additional money and time be spent to achieve the most dramatic improvements in waste site remediation?
- What is the value of additional information in the various technical activities making up the ER Program?

Sections 1.4 and 1.5, which outline the methodology for the overall evaluation of alternatives and the sensitivity analysis of this evaluation process, provide the basis for the narrative discussion describing "the analysis of the individual alternatives with respect to the specific evaluation criteria," specified in the RCRA permit. This comparative analysis provides insights for both the ER Program manager and the decision makers about the relative strengths and weaknesses of the alternative corrective measures; suggests ways to combine concerns for capital cost, total present cost, environmental impacts, and effects on human health; and suggests tradeoffs among alternative funding levels. In addition, the influence of uncertainty on risk and the decision makers' attitudes toward risk are explicit and can be included in the discussion.

1.6 Making Recommendations

The results of the analysis aid in selecting the appropriate corrective measures for each site based on the objectives of the ER Program, the technical and value judgments of the technical analysts and the ER Program administrators, and the risk attitudes of the decision makers. Design of these remediation activities can be enhanced by understanding the major influences on contamination and cleanup cost. The value of additional information can again be addressed.

2.0 Phased Plan for Completing Decision Analysis Activities

The application of the methodology outlined in Section 1 should be performed in a phased approach integrated with the RFI/CMS process. The structure of the decision analysis process will be detailed in the 1991 Installation Work Plan.

2.1 Phase I

During Phase I, the ER Program decision makers will initiate the following activities:

- development of a hierarchy of objectives;
- development of evaluation measures consistent with these objectives;
- establishment of priorities among the objectives;
- determination of the data bases, measurements, and models to be used;

- development of a systematic procedure for identifying scenarios of interest for evaluation of various sites; and
- development of a set of potential alternative corrective measures that provide a wide range of options to decision makers and help guide further technical investigation.

Also during Phase I, ER Program staff will begin preliminary study of evaluation measures to test their feasibility, precision, independence, and relevance to evaluating alternative corrective measures.

2.2 Phase II

ER Program staff will complete the study of the evaluation measures and develop the overall quantitative evaluation model for the Laboratory.

2.3 Phase III

ER Program staff will complete sensitivity analyses and make recommendations proposing and justifying the preferred corrective measure alternatives. They will engage in structured interaction with community representatives in final discussions of the corrective measures that will be implemented and implementation concerns. This phase involves benefit/cost analyses showing tradeoffs between aggregate net benefits and funding levels for each of the site-specific ER efforts.

3.0 Implementing the Decision Analysis Activities

Phase I will be completed in 18 months, beginning in FY91. This phase includes preliminary work that will form the basis for Phase III benefit/cost analysis. Some initial benefit/cost analysis will be included in the preliminary screening, although all measures and objectives are not converted to a strictly monetary measure. The most important part of this phase is the active involvement of the ER Program Office. Project leaders and technical team members will work with community representatives to develop a hierarchy of objectives; to determine evaluation measures consistent with these objectives; and to determine the data bases, technical efforts, and technical modeling capabilities for the overall ER effort. In addition, a structured procedure for aiding communication with the community through briefings and for evaluating public concerns using value trees begins at this early stage in the analysis. Preliminary evaluation of alternatives and an initial determination of the level of specific site characterization effort is performed in the screening analysis. These activities will be incorporated in ongoing RFIs, as appropriate.

The detailed outline in Table I-1 shows the sequence for each of the specific activities in Phase I.

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APPENDIX J

Cost-Effectiveness Analysis

COST-EFFECTIVENESS ANALYSIS

DOE/UC, while complying with the Los Alamos National Laboratory's permit to operate under the Resource Conservation and Recovery Act (RCRA) as amended by the Hazardous and Solid Wastes Amendments (HSWA), intends to perform activities in the most cost-effective manner. "Costs" include Department of Energy/University of California (DOE/UC) labor, materials, and capital equipment costs, as well as the social costs, of an alternative, such as decreases in private property values and the long-term, cumulative cost of health risks.

To achieve the goals of environmental restoration (ER) within the periods required by the permit and within a realistic budget, cost validation, cost-effectiveness analysis, and cost/benefit analysis will be performed. Cost validation involves specifying costs per unit (e.g., labor type and type of activity) followed by independent comparisons with local, regional, and national cost data bases, with adjustment factors for local conditions. Since few restorations of radioactive and mixed waste sites have occurred, the current cost data base is small but will grow.

Cost-effectiveness analysis involves comparison of costs of alternative strategies for corrective action. Cost and performance of alternatives to achieve goals are compared to identify the least-cost alternative. Uncertainties in cost, schedule, and performance must all be considered in the analysis, as well as the full life-cycle costs. For example, if excavation, treatment, and redisposal of soil to remove contamination from a site cost $100 million and protective caps, fences and long-term monitoring cost $50 million per site, and both alternatives result in the same risk reduction, the latter alternative would be selected in a cost-effectiveness analysis. Such cost comparisons willl be performed within the decision analysis matrix described in Appendix I of the Installation Work Plan to ensure that other criteria, such as public acceptability, are systematically considered in the final selection of corrective measures.

Cost-benefit analysis requires quantification in dollars of the costs and benefits of alternatives and selection of the alternative with the highest benefit/cost ratio. Because the benefits of alternatives are sometimes difficult to quantify, it is expected that cost-effectiveness analysis will be more commonly used than cost/benefit analysis. Both approaches will be coordinated with the decision analysis methodology. In some cases, it is expected that the cost/benefit technique may be able to quantify all decision criteria in monetary terms, using dose-response functions and average costs of illnesses for health effects and public willingness to pay. Surveys of the public are anticipated as part of the benefits estimation procedure. Additionally, results of surveys performed by other researchers for similar environmental goods may be also applicable.

The cost-effectiveness of alternative means of performing the RCRA field investigations at a solid waste management unit will be analyzed. In determining the value of additional information, the sensitivity of the results to the additional information will be analyzed. For some tasks that are especially costly, such as deep drilling to characterize the geohydrology

of the installation, it may be more cost-effective to determine the possibility of migration based upon worst-case assumptions about permeability before undertaking drilling. Such assumptions are consistent with the common sense or observational approach (Appendix K), which does not require total certainty in site characterization but defines probable site conceptual models, with allowable deviations and flexibility in remedial design. While the decision analysis methodology will systematically identify the data requirements and structure the data analysis, cost-effectiveness analysis may indicate that some data are too costly to collect and warrant that assumptions or approximations be used in the decision analysis process.

APPENDIX K

Streamlined Approach to the Resource Conservation and Recovery Act Process—Case Studies

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1.0 INTRODUCTION

1.1 Purpose and Scope of This Appendix

This appendix provides a general overview and summary of the application of the Streamlined Approach (also found in the literature as the Observational Method or Observational Approach) to the Environmental Restoration (ER) Program at the Los Alamos National Laboratory.

The appendix briefly overviews the tenants of the Streamlined Approach and elaborates on two hypothetical case examples, which were developed based on limited data and information. These examples are necessarily hypothetical because they were developed from the viewpoint of having completed site remediation. In other words, these two examples look back upon how the Streamlined Approach might have been used. The application of the Streamlined Approach with the use of all available data will be incorporated into the actual work plans and implementation of the Resource Conservation and Recovery Act (RCRA) tasks for each of the Laboratory facilities or operable units.

These case examples are not intended for use as a guidance document for implementation of the Streamlined Approach at the Laboratory nor are they intended as a prescriptive "how-to" guide for remedial planning and implementation. Rather, the case examples are intended to illustrate the philosophy, general approach, and thought processes necessary for developing the application of the Streamlined Approach at Laboratory facilities.

1.2 OVERVIEW OF THE STREAMLINED APPROACH

The basis of the Streamlined Approach to environmental restoration is the Observational Method, a technique used by geotechnical engineers to manage uncertainty in subsurface designs. The Observational Method was first formalized by Karl Terzaghi (Peck 1969; Dunnicliff and Deere 1984). More recently, the transfer and application of the Observational Method to waste remediation has been discussed in the literature (Wallace 1987, 1988; Sturges et al. 1988; Market et al. 1989; Myers and Gianti 1989; Duplancic and Buckle 1989). In addition, endorsements advocating a streamlined, flexible approach to waste site remediation are available (US National Research Council 1989). Specifically, the US Department of Energy (DOE) has endorsed the concept in application to ER in its recent Environmental Restoration and Waste Management 5 Year Plan (DOE 1990). Also, the Environmental Protection Agency (EPA), as part of its remedial investigation and feasibility studies (RI/FS) improvements project, has endorsed the Streamlined Approach in OSWER Directive 9355.3-06 (EPA 1989).

The essence, or philosophy, of the Streamlined Approach to waste remediation is that remedial action can and should be initiated without "full" characterization of the nature and extent of contamination. The basic philosophy of the approach includes the following ideas:

- Inherent uncertainties in waste remediation cannot be completely eliminated.

- Protracted investigations and characterization studies do little to reduce inherent uncertainties at waste sites.

- Confidence in any remediation effort is achieved only through field verification and monitoring the waste site during and following remediation.

Consistent with its philosophy, the Streamlined Approach provides a logical method through which planning, design, and implementation of remedial actions can proceed with increased confidence. The basic ingredients of the approach are as follows:

- Conducting sufficient characterization (investigation, modelling, etc.) to provide a general understanding of probable conditions and reasonable deviations. The level of site characterization depends on both the site itself and the general response actions.

- Evaluating remedial alternatives based on probable site conditions.

- Conducting site characterization until reasonable deviations can be accommodated by remedial alternatives (i.e., data sufficiency reached).

- Selecting waste site physical and chemical parameters used to monitor for probable conditions and reasonable deviations.

- Calculating or estimating the value of waste site physical and chemical parameters (e.g., hydraulic conductivity and contaminant concentrations) expected during remediation of both probable conditions and reasonable deviations.

- Selecting a remedial alternative based on the probable conditions and planning and designing contingency plans to address reasonable deviations.

- Constructing and implementing the remedial design based on probable conditions.

- Monitoring the selected physical and chemical parameters to identify reasonable deviations.

- Modifying the remedial action according to prepared contingency plans in response to the occurrence of reasonable deviations.

1.3 Overview of the General Case Examples

The two hypothetical case examples described here provide an illustration of the possible application of the Streamlined Approach in the Laboratory's ER efforts. Consistent with

these efforts, the regulatory basis used is the draft RCRA Subpart S – Corrective Action for Solid Waste Management Units [FR V55(145)].

The relationship between the RCRA Corrective Action Program (CAP) and the Streamlined Approach is illustrated in Fig. K-1. The Generalized Decision Diagram defines the steps in the corrective action process when the Streamlined Approach is used. The CAP components (i.e., RCRA Facility Assessment, RCRA Facility Investigation, Corrective Measure Study, and Corrective Measure Implementation) are shown with the approximate corresponding portions of the decision diagram. Although they appear as discrete units, the CAP components actually are interrelated and should not be treated as discrete components during remediation. The interrelationship of the components is shown in the decision diagram. For example, obtaining site characterization data is typically thought of as part of the RCRA facility assessment/RCRA facility investigation (RFA/RFI). However, additional site characterization data could be required in any part of the corrective action program. Indeed, in using the RCRA Streamlined Approach, action is initiated as soon as sufficient data are available. Additional data are expected to be collected at other stages of the corrective action process.

In this appendix, the hypothetical case examples are analyzed according to the process illustrated by the generalized decision diagram. The examples represent two remediation cases that illustrate some of the remedial alternatives anticipated to be implemented at the Laboratory. The examples begin with a description of a conceptual model based on existing information and on progress through the corrective action process as described by the decision diagram. Each case example is organized into sections that correspond approximately to the RCRA CAP components. The components are combined as section headings (e.g., RCRA/RFI, RCRA Facility Investigation/Corrective Measure Study, etc.) to emphasize the continuous nature of the RCRA corrective action program.

Measurable and visible benefits of using the Streamlined Approach to waste-site remediation at the Laboratory will vary considerably depending on site-specific conditions (e.g., surface contamination versus subsurface contamination). For instance, decommissioned firing sites are examples of when using the corrective action with the Approach may not look any different from how the corrective action would have been performed without it. It is important to realize the intangible benefits that are inherent when the Streamlined Approach is used. These benefits include the thought process advocated by the Streamlined Approach (i.e., recognizing that uncertainty exists, obtaining sufficient data, identifying probable conditions and reasonable deviations, preparing contingency plans, etc.). Using this approach in every case is important regardless of whether or not potential visible benefits exist. Without using this thought process it is not possible to know where data sufficiency exists, what deviations might occur, when they occur, and most importantly how to respond to them.

The two cases provide examples of remediation that vary in complexity. The first case is an example of possible surface soil contamination by radioactive and hazardous metals at a decommissioned firing site. Although the remediation process appears to be straightforward, this case is used to illustrate the benefit of using the Streamlined Approach

thought process to identify how to proceed with any remediation, complex or not, with a bias for action. The second case is a more complex problem of subsurface contamination by organics, corrosive gasses, and solid radioactive mixed waste at a material disposal area. Types of uncertainty are greater; therefore, possible deviations are more numerous. This case illustrates the use of the Streamlined Approach to identify, anticipate, and prepare for deviations. Together these cases form a picture of two possible applications of the streamlined approach to remediate Solid Waste Management Units (SWMUs). Although the general examples are representative of general scenarios known to occur at the Laboratory, they are hypothetical and are not intended to represent specific solid waste management units.

2.0 GENERAL CASE EXAMPLE 1—CLEAN TO ACCEPTABLE LEVELS

This general case example illustrates potential application of the Streamlined Approach to remedial planning and implementation for a Laboratory facility that may be remediated and restored to acceptable levels of contamination. An example of this type of facility at the Laboratory would include the decommissioned firing areas. This hypothetical case example describes the remediation effort at a specific decommissioned firing site. Many of the details in the actual operations of these sites are classified. Therefore, this hypothetical example's details about the facility operations are limited.

2.1 RCRA Facility Assessment/RCRA Facility Investigation

2.1.1 Facility Description

The decommissioned firing areas at the Laboratory vary in their history of operation and physical configuration. The hypothetical site used in this example is an inactive firing site that has been designated an SWMU. The SWMU is located on top of a mesa, with mesa top soil consisting primarily of low-permeability, fractured, welded tuft. Groundwater is generally on the order of 1000 ft beneath the mesa top. The Laboratory experiences precipitation events of short duration during the summer, primarily caused by thermal convection storms (i.e., thunder showers). These high-intensity events cause periods of significant surface runoff from the mesa tops, that provides the opportunity for overland transport of surface soils. In the adjacent canyon there is a surface water drainage course. Groundwater is present at considerable depth (more than 1000 feet) below the site.

Operations at this SWMU involved detonation of approximately 100 chemical explosive devices. The period of time the site was in use is not known. Surface soil within the detonation area is believed to be contaminated with radioactive mixed waste, including uranium, beryllium, thorium, barium, mercury, boron, cadmium, and lead. During operations, the detonation area was periodically cleared by grading, and the accumulation of rubble formed a talus bench adjacent to the area. Detonations were accomplished without airborne particulate controls, potentially resulting in particulate deposition within a 1500-foot radius of the site, including the canyon.

Contaminants of concern include uranium, beryllium, thorium, barium, mercury, boron, cadmium, and lead. Although this site has been designated an SWMU, it is not known if any contaminants are present above the levels defined in the draft RCRA Subpart S that require corrective action to be taken (i.e., action levels). It is believed that levels of some contaminants will exceed action levels at this site. The SWMU is believed to pose a relatively low threat to health and the environment at the Laboratory. Because, under the RCRA CAP, SWMUs are prioritized for remediation based on their threat to health and the environment, the SWMU is believed not to be an EPA priority for corrective action. Because a threat does exist and remediation is assumed to be straightforward at this site, it was decided to pursue a voluntary corrective action (VCA) rather than wait for EPA to designate this site as a CAMU.

2.1.2 Conceptual Model Development

As illustrated in the Generalized Decision Diagram (Fig. K-1), a conceptual model should be defined early in the planning process and should be used as a basis to

- Visualize the nature and extent of contamination (contaminated media, pathways, and receptors);
- Identify potentially viable general response actions;
- Understand overall uncertainties associated with the site as well as specific uncertainties associated with particular media, pathways, and/or general response actions
- Identify those uncertainties for which sufficient information exists to reasonably predict probable conditions and reasonable deviations; and
- Identify those uncertainties for which additional data gathering efforts are necessary for prediction of probable conditions and reasonable deviations.

Figure K-2 illustrates a conceptual model of the decommissioned firing area. The model considers the detonation zone as the source and the major release mechanisms (before being decommissioned) to have been airborne particulates release and direct contamination of surface and shallow soils in the detonation zone.

Information gained from the literature indicated that the explosions resulted in contamination that probably decreased with distance from the source. Numerical simulation of the detonation and particle trajectory also indicated similar contaminant deposition patterns. The conceptual model developed is based on the assumption that the contaminants were dispersed radially outward from the source. Probable conditions at the firing site, identified by using the conceptual model, included

- that the surface soil was contaminated with both hazardous (metals) and radioactive wastes.
- that the contamination is greatest at the detonation location and decreases with outward radial distance.
- that contaminants were probably deposited in the adjacent canyon during detonation of devices and after clearing of the area (i.e., when forming the talus bench). However, historic environmental monitoring records have not shown any evidence of any migration of contaminants down the adjacent stream.

Deviations from the probable conditions were identified by assessing the conceptual model and the identified probable conditions. These deviations include the following:

- Action levels are not exceeded for both hazardous and radioactive contaminants.
- The contamination distribution may be discontinuous and not radially dispersed because of directed blasts and the periodic clearing of detonation debris from the firing site.
- Contaminants may have migrated down the canyon wall to the stream.

2.2 RCRA Facility Investigation/Corrective Measure Study

2.2.1 Screen Viable General Response Actions

Response actions considered for remediation of inactive firing sites included the following:

- Institutional control (deed control, fencing or other barrier),
- Containment (capping, slurry walls),
- Removal and treatment (excavation/solidification and subsequent landfill), and
- In-situ treatment (in-situ vitrification, vapor extraction, stabilization, etc.).

In-situ treatments were eliminated from consideration because they were not deemed appropriate for the surface contamination at this site. Containment (capping) and removal (excavation/solidification and landfill) were considered the two most appropriate response actions based on the probable conditions.

2.2.2 Sampling and Action Plans

For this firing site, data needs are (1) confirmation of the probable conditions and (2) data to enable the preferred corrective action to be identified from the general response actions. The choice between the potential corrective actions will be distinguished by evaluating the primary areas of uncertainty in the conceptual model. For this discussion, because contamination is limited to surface soils, surface area is considered equivalent to volume. The areas of uncertainty to be evaluated include the following:

- The volume of contaminated soil — large volumes would favor capping as a corrective action.
- The type of contaminants present — some contaminants (organics) are not amenable to solidification.

- The assumed spatial distribution of contaminants — if the contaminants are located in isolated spots over a large area, it may be more effective to identify the overall extent of contamination and cap, rather than to sample extensively for each isolated contaminant spot and excavate.

The sampling plan was designed to provide sufficient data to address these uncertainties, not to intensively characterize the firing site. The sampling plan was performed in two phases. The first phase was designed to provide a reconnaissance (coarse) sampling to provide data for confirming or refining the conceptual model. The objectives were as follows:

- Identifying the probable extent of contamination - The objective was to roughly identify the boundary of the area above action levels. Also of concern was the possibility of contamination in the canyon.

- Verifying the presence of expected contaminants.

- Providing calibration samples for field equipment — To expedite corrective action, real-time sampling to identify areas above action levels will be conducted; to ensure the accuracy of the measurements, calibration of the field equipment is required.

Following the first phase of sampling, the corrective actions will be evaluated again. The second phase of sampling will differ according to the results of this evaluation.

2.2.2.1 Results of Reconnaissance Sampling

Reconnaissance sampling indicated the following:

- The contamination was radially distributed.

- The approximate volume and depth of contamination was amenable to excavation.

- The levels of radioactive and hazardous contaminants found were above action levels.

- No organics were detected.

- Contamination appears to be present on the side of the adjacent canyon. The steepness of the canyon wall created very difficult and dangerous sampling conditions. Although the samples that were taken had contaminants above action levels, no samples that provided the extent of contamination could be taken.

- Field instruments could be calibrated.

2.2.2.2 Conceptual Model Revisions

The conceptual model was revised to reflect the results of the reconnaissance sampling. The additional data appeared to support the previously identified probable conditions. The data also confirmed that action levels had been exceeded at the firing site. Because the data suggested the canyon also had contamination exceeding action levels, the Laboratory requested that the firing site and the canyon wall be designated as a CAMU by the EPA.

The data also provided enough information to address most of the possible deviations. The remaining uncertainty is primarily associated with the extent and level of contamination of soils in the canyon. Further data will be difficult to gather because of the steep slopes.

The possibility of contamination in the canyon is of concern if (1) it is above action levels and (2) it moves off site via the stream. While considering the reasonable deviations, it was discovered that a sediment monitoring station is currently maintained at the mouth of the canyon as a part of routine environmental surveillance at the Laboratory. No historical evidence of contaminant migration has been found; however, the sediments from the canyon will be monitored to confirm this. The existing sediment-monitoring station will be relied on to identify any off-site migration of contaminants from the canyon wall. The contingency plan for this deviation will be to notify the regulatory authorities and initiate an investigation of the release. This was considered an appropriate contingency plan based on the distance between the CAMU's sediment-monitoring station and the Lab boundary at the canyon mouth. The distance was considered adequate to allow the deviation to be assessed and addressed. Addressing the possible migration of canyon wall contamination as a deviation allows the evaluation of possible corrective action without delays for more sampling.

2.3 Corrective Measure Study/Corrective Measure Implementation

2.3.1 Corrective Action Evaluation

Following the reconnaissance sampling, sufficient data existed to allow evaluation and selection of the corrective measure. The evaluation was based on criteria specified in RCRA Subpart S. Types of information evaluated included (1) the extent of treatment provided by the general response action and (2) evaluation of cost versus volume. For large volumes of contaminated soil, capping is more cost effective than excavation. Conversely, if the extent of contamination is small enough, excavation is preferred.

Based on the types of contaminants and volume of material expected, the physical and chemical properties of the contaminants, and the climatic conditions, the preferred corrective action is excavation/solidification and subsequent landfill. The second phase of sampling was used to provide real-time data for guidance during excavation of the firing site. The real-time sampling and monitoring will allow the remediation to be expedited. It should be noted that the bias for action initiated in this hypothetical example is possible

because of the thought process conducted when using the Streamlined Approach. After identifying probable conditions and selecting a preferred corrective action, the ramification of reasonable deviations occurring was assessed. Because the impact of reasonable deviations occurring did not affect the preferred remediation, implementation of the remediation was possible without further delay. Instead, real-time sampling during excavation was possible at this site.

Consistent with the preference for expediting corrective measure actions as described in Subpart S, the second sampling phase was designed to provide data during implementation of the corrective measure. During excavation and solidification it was necessary to refine the delineation of the contaminated area requiring excavation (i.e., above action levels). Field instruments (e.g., XRF probe, surface radiation survey) calibrated during the reconnaissance sampling were used to provide real-time definition of the required excavation area and depth. An on-site lab was also used to provide short-time turnaround of sample analysis for verifications and calibration of the field equipment.

2.3.2 Corrective Measure Implementation/Monitoring

During implementation of the second phase, monitoring at the canyon mouth was continued to detect any migration of contamination above action levels. Excavation proceeded in conjunction with the real-time monitoring until the site was remediated to acceptable levels. Samples were then taken to confirm that the soil contamination in the area was below remediation levels. The remedy was considered complete under the guidelines specified in RCRA Subpart S, and subsequently corrective action was terminated.

It is important to realize the intangible benefits that are inherent when the Streamlined Approach is used. These benefits include the thought process advocated by the Streamlined Approach (i.e., recognizing that uncertainty exists, obtaining sufficient data, identifying probable conditions and reasonable deviations, preparing contingency plans, etc.). The use of this Approach in every case is important regardless of whether or not potential visible benefits exist. Without using this thought process it is not possible to know where data sufficiency exists, what deviations might occur, when they occur, and most importantly how to respond to them. Specifically in this example, evaluation of the reasonable deviations showed that their occurrence would not require any contingency plans during excavation. Without this approach, this particular evaluation would not have been performed.

3.0 CASE EXAMPLE 2—IN-SITU CONTAINMENT

This general case example is intended to illustrate potential application of the Streamlined Approach for remedial planning and implementation at Laboratory facilities using containment technology. Examples of this type of facility at the Laboratory include material disposal areas and landfills.

3.1 RCRA Facility Assessment/RCRA Facility Investigation

3.1.1 Facility Description

Material disposal areas (MDAs) at the Laboratory typically contain a wide range of hazardous wastes and low-level radioactive wastes (LLW) (i.e., mixed wastes). Both solid and liquid wastes were disposed of in pits, trenches, adsorption beds, and shafts at MDAs. In general, the Laboratory sited the MDAs on mesa tops adjacent to technical areas.

The hypothetical MDA examined in this case example was identified as an SWMU during the Laboratory RFA. The MDA covers about 5 acres and is located on a mesa top (Fig. K-3). The soil on the mesa top primarily consists of low-permeability, fractured, welded tuft. Groundwater is approximately 1000 ft beneath the mesa top. Precipitation during the summer is primarily caused by thermal convection storms (i.e., thunder showers). These storms result in high-intensity precipitation events known to cause periods of significant surface run-off from the mesa tops, resulting in overland transport of surface soils. In addition, the southern edge of the mesa top is also experiencing persistent erosion of surface soils. The eroded soil from the southern edge and possibly soil suspended in runoff could be transported into the adjacent canyon. Environmental monitoring records indicate that the canyon has intermittent streamflow during thunderstorms.

Laboratory records show that the MDA was used as a landfill in the late 1940's to dispose of radioactive solid waste and hazardous liquid and corrosive gas chemical waste. The MDA consists of a pit and trenches that have received different wastes during their use. It is not clear if the pit is actually a series of distinct and separate pits or one large pit that was expanded as necessary. The pit comprises the majority of the MDA's surface area. The western portion of the MDA (which included some of the inactive pit area) was leased to the county in the 1960s and subsequently paved with asphalt for use as parking space. Wastes buried in the pits are thought to consist primarily of solid LLW generated during ordinary lab operations (e.g., contaminated clothing, pumps, etc.). Solid waste known to be disposed of includes one truck, contaminated with fission products, and various radionuclides of plutonium, polonium, uranium, americium, curium, and actinium. An unknown number and size of trenches are thought to be located along the eastern edge of the MDA. Bottles disposed of in the trenches are thought to contain various mixtures of unknown volatile organic chemicals and corrosive gases.

There is no indication that contaminant migration has occurred at the MDA. No knowledge exists of surface contamination nor is there any indication of groundwater contamination.

The RFA determined that the SWMU constituted a release to the environment as defined by RCRA Draft Subtitle S. During the RFA, portions of the MDA were found to have volatile organic concentrations in the soil that exceeded action levels. Assessment of the level of other possible mixed waste contaminants was not possible because of a lack of data. However, because action levels were exceeded for the volatile organics, a corrective measures study (CMS) will probably be required by EPA following the RFI. Anticipating this, the Laboratory requested and received from EPA the designation of the entire MDA as a CAMU.

3.1.2 Conceptual Model Development

Using existing knowledge, a conceptual model of the CAMU was developed to identify possible contaminant sources, release mechanisms, contaminated media, migration pathways, and receptors. During development of the conceptual model, sources, pathways, and contaminated media that were determined to be unreasonable were screened out. The resulting conceptual model (Fig. K-4) identifies the expected probable conditions at the site based on available data, information, and technical judgment at that time.

The conceptual model of the MDA identified three possible contaminant sources: the pit(s) used for solid waste, the trenches used for bottled liquids and corrosive gases, and the paved portion of the MDA. Probable release mechanisms from these sources include unsaturated flow and transport, volatilization of organics, and erosion of surface soils. These release mechanisms may result in contamination of biota, vadose zone soils, surface soils, and air. Migration of the contaminants can occur through the vadose zone soils, surface soils, overland run-off, and air. The contamination could reach human and environmental receptors through direct dermal contact with soil, biota, and air; ingestion of soil, biota, and air; and inhalation of air. Contaminant migration to the groundwater is assumed to be of no concern because of the more than 1000-ft depth to the water table.

Using the conceptual model, the probable conditions have been identified as including the following:

- Contamination of vadose zone soils above action levels with volatile organics.
- Contamination above action levels of the southern mesa edge from overland flow during storm events.
- Limited migration of the solid waste — Because of the extremely dry ambient soil moisture condition, there is little opportunity for the solid waste to migrate. Evidence at other MDA sites enforces this assumption.
- Contaminant concentration levels in the air below action levels

- No migration of contaminants to the groundwater — The distance to the water table is so great that this is not a realistic pathway.

- A very complex and dangerous source-term covering a large area — The source-term probably includes organic liquids, volatilized organics, corrosive gases, and LLW (e.g., clothing, metal, pumps, trucks).

Major uncertainties in the conceptual model are as follows:

- The extent of lateral and vertical movement of the volatile organics,

- The extent of contamination of the mesa's southern edge and the canyon,

- The nature of chemicals, and

- The volume of liquid in the sources.

3.2 RCRA Facility Investigation/Corrective Measure Study

3.2.1 Screen Viable Response Actions

Even though there are uncertainties in the conceptual model that must be addressed, preliminary screening of general response actions was possible. Following RCRA Subpart S guidelines, it is appropriate to identify response actions that are probable based on existing data. The following general response actions are technically feasible and appropriate for use in MDAs:

- Institutional control (fencing, deed control)

- Removal (excavation to RCRA landfill)

- Containment (capping, slurry walls)

- In-situ treatment (vapor extraction, in-situ vitrification, stabilization).

Because of the level of physical hazard that could be associated with sampling the source-term, the ability to perform a corrective action without needing this sampling was considered a primary screening item. For instance, removal and some in-situ treatments (e.g., in-situ vitrification) require more extensive knowledge of the source-term. These general response actions were eliminated from further consideration.

In this case, preferred general response actions will probably consist of a combination of response actions (i.e., institutional control in conjunction with containment and in-situ treatment).

3.2.2 Sampling and Action Plans

The goal of the sampling plan is to identify the appropriate combination of corrective actions. Refinement of the conceptual model was required to do this. Uncertainties in the conceptual model include the location, size, and number of pits and trenches and the types of contaminants. Further evaluation of the general response actions can be conducted until these uncertainties are reduced. The goal is to reduce the uncertainties to a sufficient level so that the probable conditions can be identified, reasonable deviations predicted, and contingency plans prepared. To do this, data requirements include the following:

- Identification of the probable location and size of the sources (i.e., pit and trenches). Characterization of the source-term is not necessary for the response actions under consideration. However, knowledge of the extent of the source is required to evaluate corrective actions. Specific factors include the distance from the sources to the boundaries of the MDA and the mesa edge.

- Better identification of the type and extent of contaminant migration. The specific parameters include lateral and vertical migration of volatile and solid contaminants.

The sampling plan to gather these data includes the following actions:

- Using surface geophysical techniques to identify the location of the pits and trenches;

- Conducting surface contamination surveys;

- Using soil gas surveys to identify the extent of volatile contaminant migration. Because volatiles are much more mobile than solutes, the extent of volatile contaminant migration will be used as an indication of the maximum extent of contaminant migration; and

- Drilling slant boreholes under the sources to confirm the probable condition (i.e., that vertical migration of contaminants is negligible).

3.2.3 Results of Reconnaissance Sampling

The data gathered in the reconnaissance sampling is illustrated in Fig. K-5. Specifically the data indicated that

- The MDA consists of one large pit covering approximately 2.5 acres in the fenced portion and under the paved portion of the MDA; and two trenches, 40 feet long and 2–3 feet wide, approximately 200 feet from the southern edge of the mesa.

- No surface contamination was found.

- Soil gas surveys indicated limited migration of volatiles. Samples showed migration a maximum of 5 feet laterally from the outside boundary of the trenches. The volatile migration appears to be discontinuous and isolated. Between the southern edge of the mesa and the trenches, the migration also appears to be limited to 5 feet.

- Slant borehole samples did not reveal any indication of downward vertical movement of contaminants.

3.2.4 Conceptual Model Revisions

Using the newly acquired data, the probable conditions were revised to reflect the following:

- No contamination of the surface soils or the southern mesa edge,

- Negligible downward vertical migration to groundwater,

- Limited lateral and vertical migration of volatiles, and

- Negligible lateral and vertical migration of solutes.

Uncertainties still exist as to the amount of organic and mixed liquids and corrosive gases remaining in the trenches. Two possibilities exist: (1) either the liquids and gases are still contained in their original containers in the trenches and have not migrated yet, or (2) the organic liquids have volatilized and were previously released with the corrosive gases.

Characterization of the source-term could establish the existence of organic liquids and corrosive gases in the trenches, or their presence could also be a deviation. Because a physical hazard still exists with source characterization efforts, corrective actions will be evaluated with the possible presence of organic liquids and corrosive gases attempted to be addressed as a reasonable deviation.

3.3 Corrective Measures Study/Corrective Measure Implementation

3.3.1 Corrective Action Evaluation and Contingency Plan Preparation

Following the criteria specified in RCRA Subpart S, 40 CFR Part 264.525 (a,b), possible corrective actions were evaluated. Specifically, the possible corrective actions were evaluated to determine if they allowed the presence of organic liquids and corrosive gases to be handled as a reasonable deviation. As previously noted, a combination of corrective actions were assumed to be most appropriate for the MDA. An evaluation of the data gathered during the reconnaissance sampling supported combining corrective actions.

The following information was used to evaluate the corrective actions:

- The extent of the MDA (pit and trenches),
- The danger involved in establishing further source characterization, and
- The ability of the corrective actions to address the presence of liquids and gases as a reasonable deviation.

Based on these criteria, a combination of institutional control and containment were selected as the preferred corrective action. The paved portion of the MDA will be reacquired by the DOE, and a fence will be constructed around the entire CAMU. A modified cap was identified as a corrective action to establish containment of the source and to address the reasonable deviation of organic liquids and corrosive gases existing in the trench. The cap will be designed to inhibit infiltration of water and erosion of the soil covering the CAMU and to divert surface run-off around the CAMU.

To determine what level of detail was required for the contingency plans, cost, technical feasibility, and impact of the reasonable deviation were evaluated. To monitor for the deviation, a series of soil gas monitors were installed under the cap. Another part of the contingency plan is how to respond to the deviation. Even though the initial cost is greater the cap was designed to include a network of pipes to capture the volatilized organics and corrosive gases as they move out of the soil surface. This was determined to be more feasible technically than attempting soil gas extraction through the installed cap. If migration of the contaminants is detected, an air-stripping treatment train will be established to treat the off-gas removed via the pipe network built in the cap.

The level of detail required for the contingency plan varies. The soil gas monitors and pipe network will be designed and installed with the construction of the cap. The treatment train (i.e., air stripper, activated carbon filter, etc.) will be designed but not built. The monitoring system will allow advanced notice of migration movement to allow the treatment train to be constructed.

3.3.2 Corrective Measure Implementation/Monitoring

The corrective actions were implemented as designed. Monitoring of the soil gas between the cap and the trenches was initiated and is continuing. Monitoring for a deviation will continue for the length of time specified in the closure permit.

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APPENDIX L

Development, Validation, and Use of the Mobile Gas Chromatograph/Mass Spectrometer

1.0 Introduction

A transportable gas chromatograph/mass spectrometer (GC/MS) is being developed and evaluated for field analysis of volatile and semivolatile organic contaminants. This instrumentation can be used for Phase I, II, and III sampling as outlined in Section 3.5 of the Installation Work Plan (IWP). The transportable instrumentation will be mounted in a motor vehicle or trailer for transport to a potential or known solid waste management unit (SWMU) or corrective action management unit (CAMU). A mobile laboratory (trailer) will be transported to sites and used as a base of operations for site investigations lasting more than one day. The instrumentation will operate in a semicontinuous mode, pausing only for sample introduction and data file identification. Analytical results will be reported automatically, immediately after analysis and data reduction have been completed. Analysis time is projected to be 20-40 min. This transportable instrumentation will be used to improve operations associated with Resource Convservation and Recovery Act (RCRA) facility field investigations (RFI) and support the performance of a corrective measures study (CMS) or design of a corrective action alternative. Automated field analysis provides the following advantages.

- Significantly reduced data-turnaround time compared with analyses performed at a remote laboratory. (Receipt of analytical results from a remote laboratory can take many weeks.) Timely analytical data support guidance of ongoing work.
- Reduced cost per analysis. Personnel time associated with sample handling and documentation are minimized.
- On-site data for continuous sampling grid delineation.

The sampling system GC/MS operation will be extensively automated for operation by a field technician. Instrument control and preliminary data reduction will be performed by a dedicated computer. All data will be archived on machine-readable media for subsequent review by an analyst skilled in the use of GC/MS and in interpretation of mass spectra and their use for quantitation.

Instrument deployment will be phased. Phase I will be dedicated to development of a transportable purge-and-trap GC/MS and associated field protocols for analysis of volatile organics. Phase II will be dedicated to development of a transportable sampling module and associated protocols for semivolatile organics and integration of this sampling module with the transportable GC/MS developed in Phase I. Methods developed for volatile and semivolatile organics will parallel Methods 8260 and 8270, of EPA's test methods for evaluating solid wastes (EPA 1986), respectively. The methods used will be validated as outlined in Chapter I (EPA 1986), if field analyses are to be used for compliance. Practical quantitation limits for volatile organics are currently estimated to be 50 ng/kg (wet weight) for soil and sediment samples and 50 ng/L for water samples.

Practical quantitation limits for semivolatile organics will be determined at a later date.

2.0 Technical Approach for Volatile Organics

2.1.1 Scope and Application

The transportable purge-and-trap GC/MS will be used for the qualitative and quantitative analyses of volatile organics listed in Appendix M. Most volatile organic compounds with boiling points below 200°C that exhibit low or slight solubility in water can be detected via purge-and-trap GC/MS. Volatile water-soluble compounds can also be detected, albeit with higher detection limits.

2.1.2 Method Summary

Volatile organics will be extracted from the sample matrix by the purge-and-trap method. Soil and sediment or water samples are purged with an inert gas, and the extracted volatile organics are swept through a sorbent resin cartridge and trapped. This resin cartridge is subsequently heated and backflushed with helium or hydrogen to desorb sample components directly to the gas chromatograph. The capillary gas chromatograph (GC) is temperature-programmed to separate analytes, which are the detected by a mass spectrometer directly coupled to the GC.

Qualitative identification will be performed by analyzing standards under the same conditions used for samples and comparing GC retention times and resultant mass spectra. Quantitation will be accomplished by relating the response of a selected quantitation ion to that of an ion derived from the appropriate internal standard.

2.1.3 Instrumentation

A purge-and-trap GC/MS data system will be fabricated to meet the requirements outlined in Section 4, Method 8260 (EPA 1986). The purge-and-trap GC will be integrated into a sampling module and directly coupled to a Finnigan MAT Model 800A ion trap detector (ITD). The sampling module will be microprocessor-controlled, and sampling module control software will be integrated with ITD control software. Software integration will allow semiautomated system operation. After the sample has been loaded, extraction, analysis, data reduction, and preliminary report generation will proceed automatically.

2.2 Procedure

2.2.1 Initial Calibration

The GC/MS system will be tuned to meet mass spectral abundance criteria for a 5-ng purging of 4-bromofluorobenzene (BFB) as outlined in method 8260, or other tuning criteria promulgated by the Environmental Protection Agency (EPA). Alternatively, petition for variance on BFB abundance criteria will be submitted to the EPA. Use of new abundance criteria will be used only if a variance is granted. After tuning criteria have been met, five calibration standards will be analyzed to establish a calibration curve.

2.2.2 Daily GC/MS Calibration

Daily GC/MS calibration will be performed as outlined in Method 8260. Before analysis of samples, purge of 5 ng of BFB standard must meet BFB ion abundance criteria as discussed in Section 2.2.1. Subsequently, the calibration curve will be checked by analyzing a calibration standard that is near the midpoint of the working concentration range. The above criteria will be demonstrated each 12-hr shift.

2.2.3 GC/MS Analysis

Soil and sediment and water samples will be analyzed according to methods outlined in Section 7.4, method 8260. Soil and sediment analysis will be reported on a wet weight basis. Soil and sediment samples with expected concentrations >1.0 mg/kg will be analyzed using the high-level method discussed in Section 7.4.3, Method 8260.

2.2.4 Data Interpretation

Qualitative and quantitative analysis will be performed according to Section 7.5, Method 8260.

2.3 Quality Control and Method Validation

The precision, accuracy, and the detection limits obtained with the transportable purge-and-trap GC/MS will be determined using methods discussed in Sections 8 and 9, Method 8260. The method used will be validated as outlined in Chapter I, SW-846. Performance of the transportable purge-and-trap GC ion trap mass spectrometer will be compared with that obtained using laboratory benchtop purge-and-trap GC quadrupole mass spectrometers on the basis of data precision, accuracy, and method detection limits. The use of field-transportable instrumentation for support of remedial activities reflects state-of-the-art technology in analytical instrumentation. Use of new analytical technologies is implicit in Section 8.11, Method 8260, and is acceptable, provided instrument quality control requirements can be met as outlined in Section 8.4, Method 8260 and Chapter I.

3.0 Technical Approach for Semivolatile Organics

3.1.1 Scope and Application

The transportable instrumentation for semivolatile organics will be used for the qualitative and quantitative analysis of the semivolatile compounds listed in Appendix M.

3.1.2 Method Summary

Semivolatile organics will be extracted from solid sample matrices using a supercritical fluid extraction (SFE) technique. Current sampling methods used for the extraction of semivolatile organics from water or soil samples are based on liquid extraction from the sample matrix using an organic solvent. Liquid extraction is the basis of Methods 3510,

3520, 3540, and 3550. These methods take hours to complete, and because they require large volumes of solvent, they are not practical field extraction methods. An alternative to extracting organic compounds with organic solvents involves using supercritical fluids as an extraction solvent. Additionally, because the SFE apparatus is small, SFE is well suited to field extractions. Most analytical-scale SFE performed today uses supercritical fluid CO_2 as the extraction solvent. Supercritical CO_2 is particularly attractive because it is relatively inexpensive, nonflammable, and critical pressures and temperatures are readily accessible with commercially available technology. SFE for analytical extractions has several advantages over organic-solvent-based technologies. It has been demonstrated that analytical SFE provides extraction efficiencies comparable to or better than organic-solvent-based extraction methods. Furthermore, SFE provides an order-of-magnitude increase in the rate of extraction.

SFE is an emerging technology, and the exact apparatus design and operation protocols for field transportable instrumentation have not been determined. It is expected that 5-g samples will be loaded into a high-pressure extraction cell and that 15-30 mls of supercritical CO_2 will be used as the extraction solvent. It is expected that SFE of environmental solids will result in the co-extraction of interfering compounds (e.g., humic material), and it is likely that a sample cleanup method will have to be incorporated as part of the sampling module. Supercritical fluid chromatography (SFC) will be evaluated as an extract cleanup method as an alternative to Method 3600. The proposed SFE sampling module will be directly coupled to the transportable GC/MS constructed in Phase I, replacing the purge-and-trap sampling module used for volatile organics. Software and hardware would be expanded from what is developed for the volatile organic analyzer to accommodate SFE sampling. Sample collection, sample loading, GC/MS data acquisition and reduction, and report generation will be nearly equivalent to that used for the Phase I volatile organics analysis. Qualitative identification will be performed by analyzing standards under the same conditions used for samples and by comparing GC retention times and resultant mass spectra. Quantitation will be accomplished by relating the response of a selected quantitation ion to that of an ion derived from the appropriate internal standard.

3.1.3 Instrumentation

The instrumentation for semivolatile organic analysis will be precisely defined at a later date, However, the Laboratory will attempt to meet the performance criteria outlined in Method 8270 where possible. The sampling module will be microprocessor-controlled, and sampling module control software will be integrated with ITD control software. Software integration will allow semi-automated system operation. Following sample loading, sample extraction, analysis, data reduction, and preliminary report generation will proceed automatically.

3.2 Procedure

3.2.1 Initial Calibration

Decafluorotriphenylphosphine (DFTPP) will be used as the tuning standard for the GC/MS as outlined in Method 8270. The abundance criteria for DFTPP in Method 8270 or other tuning criteria promulgated by the EPA will be used, if possible. Alternatively, a petition for a variance on DFTPP abundance criteria will be submitted to the EPA. New abundance criteria will be used only if a variance is granted. After tuning criteria have been met, five calibration standards will be analyzed to establish a calibration curve.

3.2.2 Daily GC/MS Calibration

Daily GC/MS calibration will be performed as outlined in Section 7.4, Method 8270 Before analysis of samples, 50 ng of DFTPP standard must meet DFTPP ion abundance criteria as discussed in Section 3.2.1. Subsequently, the calibration curve will be checked by analyzing a calibration standard that is near the midpoint of the working concentration range. The above criteria will be demonstrated each 12-hr shift.

3.2.3 GC/MS Analysis

Soil and sediment samples will be analyzed according to methods outlined in Section 7.5, Method 8270. Soil and sediment analysis will be reported on a dry-weight basis.

3.2.4 Data Interpretation

Qualitative and quantitative analysis will be performed according to Section 7.6, Method 8270.

3.3 Quality Control and Method Validation

The precision, accuracy and the detection limits obtained with the transportable purge-and-trap GC/MS will be determined using methods discussed in Sections 8 and 9, Method 8270. The method used will be validated as outlined in Chapter I. Performance of the transportable mass spectrometer will be compared with that obtained using Methods 3540 and 8270 and laboratory benchtop GC/quadrupole mass spectrometers on the basis of data precision, accuracy, and method detection limits.

REFERENCES

EPA (Environmental Protection Agency) 1986. "Test Methods for Evaluating Solid Wastes," SW-846, Revision 0, Washington, DC.

APPENDIX M

List of Standard Operating Procedures for Implementation of Environmental Restoration Program at Los Alamos National Laboratory

0.0 GENERAL INSTRUCTIONS FOR FIELD PERSONNEL

- 0.1 Containers, Sampling, and Preservation
- 0.2 Guide to Handling, Packaging, and Shipping of Samples
- 0.3 Sample Control and Documentation
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1.0 HEALTH AND SAFETY IN THE FIELD

- 1.1 Training
- 1.2 Medical Surveillance of Personnel
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- 1.4 On–Site Health and Safety Indoctrination
  - 1.4.1 Pre–Entry Briefings for Site Personnel and Visitors
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- 1.5 On–Site Monitoring
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  - 1.5.2 Non–Radiological Monitoring
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    - 1.5.3.1 Alpha Radiation
      - 1.5.3.1.1 Total Alpha Surface Contamination Measurements
      - 1.5.3.1.2 Screening Soil Samples for Alpha Emitters
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      - 1.5.3.2.2 Near Surface and Soil Sample Screening for Low Energy Gamma Radiation using FIDLER

1.5.3.2 Beta and Gamma Radiation (Continued)

1.5.3.2.3 In Situ Gamma–Ray Measurements Using a Shielded Delta–Gamma Detector

1.5.3.2.4 Exposure Rate Measurements Using a Pressurized Ionization Chamber

1.5.3.2.5 Measurement of Gamma Radiation Using a Sodium Iodide (Nal) Detector

1.5.3.2.6 Correlation of a Sodium Iodide Detector to a Pressure Ionization Chamber

1.5.3.2.7 Beta–Gamma Radiation Measurements Using a Geiger–Mueller Detector

1.5.3.3 Radon–222 Species Monitoring

1.5.3.3.1 Radon–222 Flux Measurement Using Charcoal Canisters

1.5.3.3.2 Radon–222 Measurement Using Track–Etch Detectors

1.5.3.3.3 Air Grab Samples for Radon–222 Concentration

1.5.3.3.4 Air Sampling of Particulates for Radon Daughter Concentrations

1.5.4 Heat/Cold Stress

1.5.4.1 Heat Stress Monitoring

1.5.4.2 Cold Stress Monitoring

1.6 Decontamination of Equipment and Personnel

1.6.1 General Equipment Decontamination

1.6.2 Personnel Decontamination

1.6.3 Radiological Decontamination

1.6.3.1 Sampling for Removable Alpha Contamination

2.0 RECONNAISSANCE/FIELD SURVEY TECHNIQUES

2.1 Biological/Vegetation Survey Methods

2.2 Surface Geophysical Methods

2.3 Soil Gas Survey

3.0 DRILLING/EXCAVATING TECHNIQUES

3.1 Siting

3.2 Drilling Methods

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3.2.2 Solid–Stem Auger

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3.2.4 Cable Tool Drilling

3.3 Excavating Methods
3.4 Logging Methods
3.4.1 Test Pit Logging, Mapping, Sampling
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4.0 WELL INSTALLATION/DEVELOPMENT/TECHNIQUES

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5.1.2 Field Analytical Measurements of Ground Water
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5.1.4 Sampling Commercial/Municipal/Domestic Wells
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5.2.3 Soil Moisture Monitor Installation and Measurement
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5.3.2 Hand Auger and Thin–Wall Sampler
5.3.3 Stainless Steel Surface Soil Sampler
5.3.4 Split Spoon Method
5.3.5 Hollow–Stem Auger Method
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5.4 Surface Water and Sediment Sampling Methods
5.4.1 Surface Water Sampling
5.4.2 Sediment Material Collection
5.5 Waste Sampling Methods
5.5.1 Coliwasa Sampler for Liquids and Slurries
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5.5.5 Weighted Bottle Sampler for Liquids and Slurries in Tanks

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- 5.7.1 Draeger Tubes
- 5.7.2 Volatile Organic Sampling Tray
- 5.7.3 Canister Sampling for Organics
- 5.7.4 Air Particulate Sampling with Real–Time Aerosol Monitor

6.0 SUBSURFACE HYDROGEOLOGIC SITE CHARACTERIZATION

6.1 Saturated Zone Aquifer Characteristics
- 6.1.1 Pressure Transducers
- 6.1.2 Water Level Measurements
- 6.1.3 Well Slug Tests
- 6.1.4 Aquifer Pumping Tests
- 6.1.5 Tracer Tests

6.2 Vadose Zone Characteristics

7.0 SURFACE SITE CHARACTERIZATION

7.1 Archaeological Survey
7.2 Cultural Survey
7.3 Biological/Vegetation Survey

`0 TECHNICAL DATA MANAGEMENT

8.1 Hard Copy Records

8.0 TECHNICAL DATA MANAGEMENT (Continued)

8.2 Electronic Data Base

APPENDIX N

Perched Zone Monitoring Well Installation

PERCHED ZONE MONITORING WELL INSTALLATION

by
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Los Alamos National Laboratory
September 1990

I. INTRODUCTION

The Hazardous Waste Permit (Hazardous and Solid Waste Amendments, 1984) issued to the United States Department of Energy (owner) and the University of California (operator) contains several Special Conditions in Module VIII, Sec. C. The first condition relates to Perched Zone Monitoring. This condition required the installation of monitoring wells or borings in the principal canyons of the Pajarito Plateau as follows: Pueblo Canyon (one exploratory boring); Los Alamos Canyon (three monitoring wells near existing wells LAO-3, LAO-4.5, and LAO-5); Sandia Canyon (two monitoring wells near water supply wells PM-1 and PM-3); Mortandad Canyon (three monitoring wells near existing wells MCO-4, MCO-6, and MCO-7); Potrillo Canyon (one monitoring well near State Road 4); Fence Canyon (one monitoring well near State Road 4); and Water Canyon (three monitoring wells: one near State Road 4, one 1 mile west of State Road 4, and one 2 miles west of State Road 4). Water samples will be collected from the wells in September 1990 and analyzed for specific constituents in accordance with the timetable specified in the permit.

These canyons were created by southeast-trending intermittent streams that have cut deeply into the surface of the plateau. The intermittent stream flow has eroded, transported, and deposited alluvium in the stream channel of these canyons. The origin of the drainage area of the canyons determines the general type of alluvium. Canyons that head on the flanks of the mountains west of the plateau contain mainly sands, gravels, cobbles, and boulders derived from dense, hard rock eroded from the flanks of the mountains. These canyons include three specified in the special condition: Pueblo, Los Alamos, and Water. Canyons that head on the plateau contain clays, silts, sands, and some gravels derived from the softer tuff that forms the plateau. These canyons include four specified in the special condition: Sandia, Mortandad, Potrillo, and Fence.

The shallow aquifers in the alluvium of the canyons are in the sands, gravels, cobbles, and boulders of canyons heading on the mountains or in the reworked and weathered clays, silts, sands, and gravels of canyons heading on the plateau.

The aquifers in the alluvium exist as a narrow ribbon of saturation along the canyon bottoms and are perched on the underlying silts and clays. The aquifers are of limited horizontal extent and are dependent on surface water for recharge. The spring snowmelt run-off causes water levels in the aquifer to rise and the aquifer to advance down the canyon. In early summer, the water levels typically decline and the aquifers retreat up the canyon. Summer run-off causes the water levels to rise and aquifers to advance down the canyon; the lack of run-off in the fall and winter causes the water level to decline and the aquifer to retreat up the canyon. These same hydrologic effects take place in canyons that also receive treated industrial and/or sanitary effluents. Thus, dependent on the amount of recharge, the thickness of the saturated part of the aquifer will vary and at times may be dry. The water levels in an aquifer may vary by 10 or more feet in the course of a year.

II. WELL DRILLING AND COMPLETION

All of the wells or borings were drilled and completed using the same basic equipment and methods. The methods generally followed the recommendations of the Resource Conservation and Recovery Act (RCRA) Ground-Water Monitoring Technical Enforcement Guidance Document (TEGD) to the extent practicable and allowing for some modifications based on more than 40 years of experience with monitoring initiated by the U.S. Geological Survey. These methods are described in this section and are applicable to all of the wells. Details of each individual well completion are provided in individual figures discussed later in this report. A pilot hole was drilled with either a standard continuous-flight auger (4.5 in. diameter) or cored with a hollow-stem auger (7.25-in. hole diameter). The depth to the base of the aquifer was determined by the cuttings and drilling pressure or by direct inspection of the continuous core retrieved from the hole.

The characteristics of the alluvium (hole collapse) require construction of the well through a hollow-stem auger. Accordingly, the pilot hole provided a guide for reaming the hole using a larger diameter hollow-stem auger (6.25 in. i.d., 9.625 in. o.d., with a 10.375-in. o.d. bit). This bit was run in the pilot hole with a knockout plate, and the auger joints were equipped with O-Ring seals. The hole was reamed below the base of the aquifer.

If water was encountered in the pilot hole, it was necessary to fill the 6.25-in. i.d. hollow-stem auger with water to a level equal to the top of the aquifer to keep sands and gravels from running into the hollow stem when the plate in the bit was knocked out. The plate was knocked out and the auger raised 0.5 to 1.0 ft to anchor the casing on the bottom of the hole. The 2-in.-diameter casing was set through the hollow stem and rested on the plate. The lowest portion of the casing consisted of one or two 10-ft lengths of screen with a plug at the bottom. (In

three wells, a 5-ft blank section was extended below the screen to provide for bailer descent to assist in collecting adequate sample volumes.)

The annulus between the hollow-stem auger and casing screen was filled with the gravel pack (sand) in increments of 2 to 3 ft, at which time the auger was pulled up a corresponding amount. Keeping the sand in the auger while raising the auger assured a continuous gravel pack between the borehole wall and the screen by preventing any formation material from caving in around the casing. Accordingly, this method is believed to be preferable to using a tremie after removal of the entire length of auger. The gravel pack was continued up to a point 2 to 3 ft above the top of the screened section. At this point, a seal of bentonite and/or cement was extended to the surface using the same method of emplacement through the auger to assure a continuous seal with no formation material collapsing in around the blank tubing.

At a depth of about 3 to 5 ft, the auger was removed from the hole. The upper part of the well was filled with cement and the wellhead security cap was set about 1.5 to 2 ft into the cement. A brass cap was set in a 2-ft-square concrete pad poured around the wellhead security cap.

III. WELL CONSTRUCTION MATERIALS

The materials used in well construction include the casing, the sand or gravel pack, the bentonite seal material, and cement. Also considered as part of the construction is the wellhead security cap that permits only authorized personnel to access the well for water-level measurements or sampling.

The casing, screen, plugs, and caps were made of polyvinyl chloride (PVC), using flush-joint, internal, upset-threaded-type connections. The casing and screen were 2 in. i.d. (2.375 in. o.d.), in 5- or 10-ft lengths. The screen openings were 0.010 in. The casing, screen, plugs, and caps were manufactured by TIMCO Manufacturing, Inc. (851 15th Street, Prairie Du Sac, Wisconsin 53578, phone 608-643-8534).

The sand used for the gravel pack was sized from 0.010 to 0.020 in. and is compatible with the screen openings in the casing of 0.010 in. Because of the nature of the aquifer material (very fine suspended particles), the smallest screen opening and appropriate size gravel pack were used. The sand used as a gravel pack came in 50- or 100-lb bags. The 100-lb bag contained about 0.97 ft^3 of pure Colorado silica sand. The sand was processed and marketed by Silica Sand, Inc. (P.O. Box 15615, Colorado Springs, Colorado 80935).

The bentonite was brand name Hole Plug, coarse-grade Wyoming bentonite, and was supplied in 50-lb bags, 0.69 ft^3 per bag (dry), and was marketed by Baroid Division (N.L. Petroleum Surveys, Inc., P.O. Box 1675, Houston, Texas).

A premix cement (1 to 5) was used to seal part of the hole and to construct the wellhead and accompanying security cap. The cement mix came in 60-lb bags, about 0.5 ft^3 per bag. The brand name of the mixture was Quikrete, marketed by the Quikrete Company, Atlanta, Georgia 30234.

Two types of well security caps were used in completion of the observation wells. The first type was a standard 8.625-in. o.d. steel casing set into the cement. The top of the casing was secured with a hinged plate and hasp welded to the casing. The other type of well security was the 8.625-in. o.d. steel casing set into the cement, covered by a removable "mushroom" cap made from a 13-in. steel casing about 0.5 ft long with a steel plate welded to one end. The 13-in. casing with cap was set on the 8.625-in. casing. Slots cut through the side of the cap and the casing were aligned to receive a steel bar that secures the cap to the top of the casing. A hole through the bar allows a lock to secure the cap and prevent removal of the bar. Both types of caps are shown in Fig. 1.

IV. WELL DEVELOPMENT

Well development was carried out using several techniques in combination. However, none of the wells that have water in them has yet been able to meet the turbidity requirement of 5 nephelometric turbidity units. This was as expected, based on previous experience with the 25- to 30-year-old U.S. Geological Survey wells, which still yield samples with considerable turbidity. The turbidity results from the fine suspended clays and silts found in the aquifer. These clays and silts are derived from weathering of the ash matrix of the tuff. As a result, the smallest size screen generally available from commercial sources (0.010 in.), with matched sand size (0.010 to 0.020 in.), was used in completing all the new wells. The presence of these suspended sediments and the fluctuation of the thickness of the aquifer have hampered or prevented well development, even without suspended sediments entering the wells during bailing.

The wells were developed using a surge block, pumping, bailing, and jetting. At least two methods were used in each well. The choice of methods depended on the depth to water and observations of the saturated thickness. Jetting was the most commonly used method and was applied to all of the Mortandad and Los Alamos canyon wells. The Pueblo Canyon well was developed mainly by pumping.

V. OBSERVATION WELLS

The observation well elevations, measuring points (MPs), and coordinates (New Mexico State Plane system) are shown in Table I. Well characteristics are presented in Table II. The log, casing schedule, and construction details for each well are found in Figs. 2 through 15. Locations of the observation wells and

holes are indicated in Fig. 16. The map in Fig. 16 also shows locations of existing monitoring wells that indicate the extent of perched ground water in the canyon alluvial systems. Some alluvial perched ground water can also be inferred to exist in portions of canyons within the facility boundaries where surface stream flow occurs throughout the year. These canyons include the portion of Pueblo Canyon (fed by effluent from the Los Alamos County sanitary sewage treatment plant), Los Alamos Canyon (fed by flow from the mountains and released from the reservoir), Sandia Canyon (fed by effluent from the TA-3 sanitary sewage treatment plant), Pajarito Canyon (fed by surface run-off from the mountains to the west), and Water Canyon (fed by springs on the flanks of the mountains to the west). These locations are generally further upstream than any of the new monitoring wells, as can be seen by the locations of old monitoring wells that contain water in Los Alamos and Pajarito Canyons (see Fig. 16).

The wells were located along the eastern third of the plateau. Seven of wells were dry when drilled, and three additional wells (two in Mortandad Canyon and one in Los Alamos Canyon) became dry during the summer because of the lack of surface run-off. Two additional wells were drilled in Mortandad Canyon because the old U.S. Geological Survey wells indicated that the water level had declined beneath the lowest part of the 10-ft screen installed in the first new wells. The replacement wells were equipped with 20-ft screen sections to allow for the considerable fluctuation in water level. The well in Los Alamos Canyon that is now dry was completed into the top of the underlying basalt, and the aquifer has receded upstream because of limited recharge from run-off. Details of individual wells are discussed below or are shown in the referenced figures.

A. Pueblo Canyon

Pueblo Canyon observation well APCO-1 was completed in alluvium underlain by siltstone and claystone. Water was perched in the alluvium (Fig. 2).

B. Los Alamos Canyon

Los Alamos Canyon observation well LAO-3A was completed in alluvium underlain by tuff. Water was perched on the weathered tuff (Fig. 3).

Three wells were completed near LAO-4.5. Two of the wells were dry but were completed as wells because there is a possibility of the alluvium or sand lens in the underlying siltstone and claystone becoming saturated with an increase of storm run-off [Fig. 4(a) and 4(b)]. The siltstone and claystone underlying the alluvium is associated with the basalt that underlies the alluvium to the east. Water occurs in a sand lens within the siltstone and claystone [Fig. 4(c)].

Los Alamos Canyon observation well LAO-6A was completed through the alluvium into the top of a basalt flow (Fig. 5). The well contained water when

completed but went dry during the summer as the aquifer retreated up the canyon.

C. Sandia Canyon

Sandia Canyon observation well SCO-1 was completed in alluvium underlain by a weathered tuff. The alluvium was dry (Fig. 6).

Sandia Canyon observation well SCO-2 was completed in alluvium underlain by a weathered tuff. The alluvium was dry (Fig. 7).

Although the alluvium was dry at both locations. the holes were finished as wells because there is a possibility an increase in run-off could saturate part of the alluvium.

D. Mortandad Canyon

Mortandad Canyon observation well MCO-4A was completed in the alluvium and contained water when completed [Fig. 8(a)]. The well went dry during the summer, and a second well (MCO-4B) was constructed through the alluvium and into the top of the weathered tuff [Fig. 8(b)]. Water was encountered in the alluvium perched above the tuff. The second well was constructed with a 20-ft screen section to allow sampling even with the wide range of water-level fluctuation in the canyon.

Mortandad Canyon observation well MCO-6A was completed in the alluvium and contained water when completed [Fig. 9(a)]. The well went dry during the summer, and a second well (MCO-6B) was drilled through the alluvium into the top of the weathered tuff [Fig. 9(b)]. Water was encountered in the alluvium above the tuff. The well was equipped with a 20-ft screen section.

Mortandad Canyon observation well MCO-7A was completed in the alluvium (Fig. 10). The well encountered water in the alluvium.

E. Potrillo Canyon

Potrillo Canyon test hole PCTH-1 was cored to a depth of 74 ft (Fig. 11). The hole penetrated a thin soil zone of reworked material and a thick section of weathered to unweathered tuff. The entire section was dry and indicated no presence of past water. The hole was abandoned and plugged with a cement-bentonite slurry.

F. Fence Canyon

Fence Canyon observation well FCO-1 penetrated a sandy soil underlain by weathered and unweathered tuff (Fig. 12). The hole was dry, but was completed as a well.

G. Water Canyon

Water Canyon observation well WCO-1 was completed through the alluvium into the top of weathered tuff (Fig 13). The well was dry.

Water Canyon observation well WCO-2 was completed through the alluvium into the top of weathered tuff (Fig. 14). The well was dry.

Water Canyon observation well WCO-3 was completed through the alluvium into the top of basalt (Fig. 15). The well was dry.

The three wells in Water Canyon were dry, but were completed as wells. Water Canyon heads high on the flanks of the mountains west of the plateau. Snowmelt run-off could recharge the alluvium to the extent the wells could contain water.

Table I. Observation Well Elevations and Measuring Points

	Top of Steel Casing	PVC Casing, Measuring Point	Land Surface Datum, or Brass Cap	Measuring Point to Land Surface Datum	New Mexico State Plane Coordinates (Brass Cap)	
					Northing	Easting
Pueblo Canyon						
APCO-1	6368.95	6368.19	6367.53	–0.66	1 772 957.956	508 965.347
Los Alamos Canyon						
LAO-3A	6580.38	6579.83	6579.40	–0.43	1 773 037.645	497 736.545
LAO-4.5A	6461.58	6460.38	6459.89	–0.49	1 771 989.595	503 255.968
LAO-4.5B	6461.76	6460.59	6459.37	–1.22	1 771 992.471	503 268.080
LAO-4.5C	6459.23	6458.72	6457.63	–1.11	1 772 014.413	503 303.058
LAO-6A	6396.73	6396.26	6395.88	–0.38	1 771 281.902	505 977.349
Sandia Canyon						
SCO-1	6619.85	6619.33	6618.67	–0.66	1 769 440.143	502 053.375
SCO-2	6502.02	6501.52	6500.67	–0.85	1 767 801.850	507 014.910
Mortandad Canyon						
MCO-4A	6889.00	6888.24	6887.53	–0.71	1 769 638.132	491 784.644
MCO-4B	6889.13	6888.71	6887.56	–1.15	1 769 634.899	491 792.173
MCO-6A	6851.80	6851.45	6850.18	–1.27	1 768 899.886	493 388.651
MCO-6B	6851.84	6851.08	6850.37	–0.71	1 768 921.493	493 386.276
MCO-7A	6829.27	6828.75	6827.71	–1.04	1 768 447.198	494 259.239
Potrillo Canyon						
PCTH-1[a]	—	—	6493.40	—	1 753 105.358	503 902.595
Fence Canyon						
FCO-1	6510.41	6509.99	6509.24	–0.75	1 751 120.043	502 168.229
Water Canyon						
WCO-1	6617.75	6617.06	6616.41	–0.65	1 755 007.161	492 514.547
WCO-2	6526.07	6625.25	6524.57	–0.68	1 753 166.432	496 626.165
WCO-3	6437.73	6437.25	6436.43	–0.82	1 750 558.320	498 968.371

[a]Cored test hole; plugged.

Table II. Well Characteristics and Water Levels

	Date Drilled	Date Completed	Depth Drilled (ft)	Depth Completed (ft)	Water Levels Below Land Surface Datum (ft)			
					Date	Water Level	Date	Water Level
Pueblo Canyon								
APCO-1	8-15-90	8-17-90	20	19.7	—	—	8-17-90	6.2
Los Alamos Canyon								
LAO-3A	9-14-89	9-14-89	18	14.7	9-14-89	6.7	6-21-90	5.5
LAO-4.5A	9-13-89	9-14-89	20	18.5	9-14-89	Dry	6-21-90	Dry
LAO-4.5B	9-15-89	9-16-89	35	34.9	9-16-90	Dry	6-21-90	Dry
LAO-4.5C	11-21-89	11-22-89	25	23.3	11-22-89	10.6	6-21-90	10.7
LAO-6A	8-17-89	8-17-89	15	14.2	8-17-89	9.0	6-21-90	Dry
Sandia Canyon								
SCO-1	8-14-89	8-15-89	79	19.3	8-15-89	Dry	6-22-90	Dry
SCO-2	8-16-89	8-16-89	29	18.4	8-16-89	Dry	6-22-90	Dry
Mortandad Canyon								
MCO-4A	11-01-89	11-01-89	24	19.4	11-14-89	5.1	8-15-90	Dry
MCO-4B	8-20-90	8-21-90	34	33.9	—	—	8-21-90	21.7
MCO-6A	11-02-89	11-06-89	33	32.7	11-09-89	30.3	6-02-90	Dry
MCO-6B	8-09-90	8-13-90	48	47.1	—	—	8-13-90	33.2
MCO-7A	11-06-89	11-14-89	47	44.8	11-09-89	35.2	6-21-90	37.2
Potrillo Canyon								
PCTH-1[a]	10-18-89	10-20-89	74	—	10-20-89	Dry	—	—
Fence Canyon								
FCO-1	8-22-89	8-22-89	29	12.4	8-22-89	Dry	8-24-90	Dry
Water Canyon								
WCO-1	10-26-89	10-31-89	37	34.4	11-01-89	Dry	8-24-90	Dry
WCO-2	10-26-89	10-26-89	38	23.5	10-26-89	Dry	8-24-90	Dry
WCO-3	10-25-89	10-25-89	14	12.4	10-25-89	Dry	8-24-90	Dry

[a]Cored test hole; plugged.

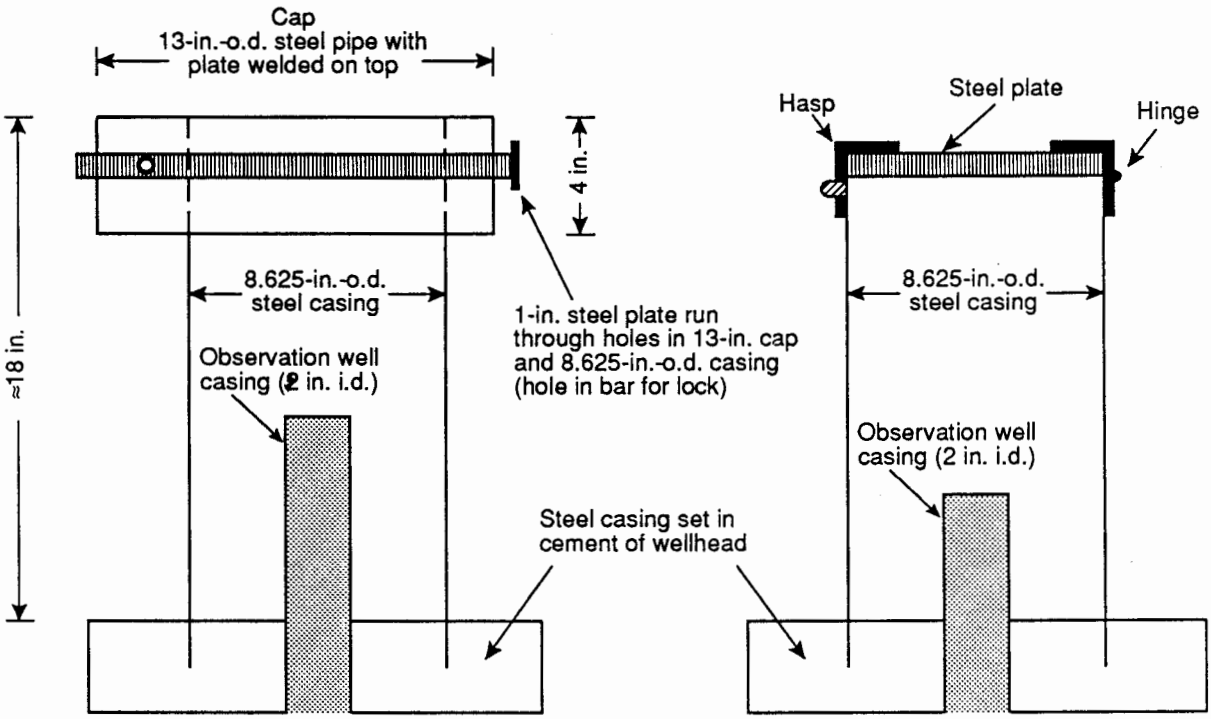


Fig. 1. Two types of wellhead security locks used on canyon observation wells.

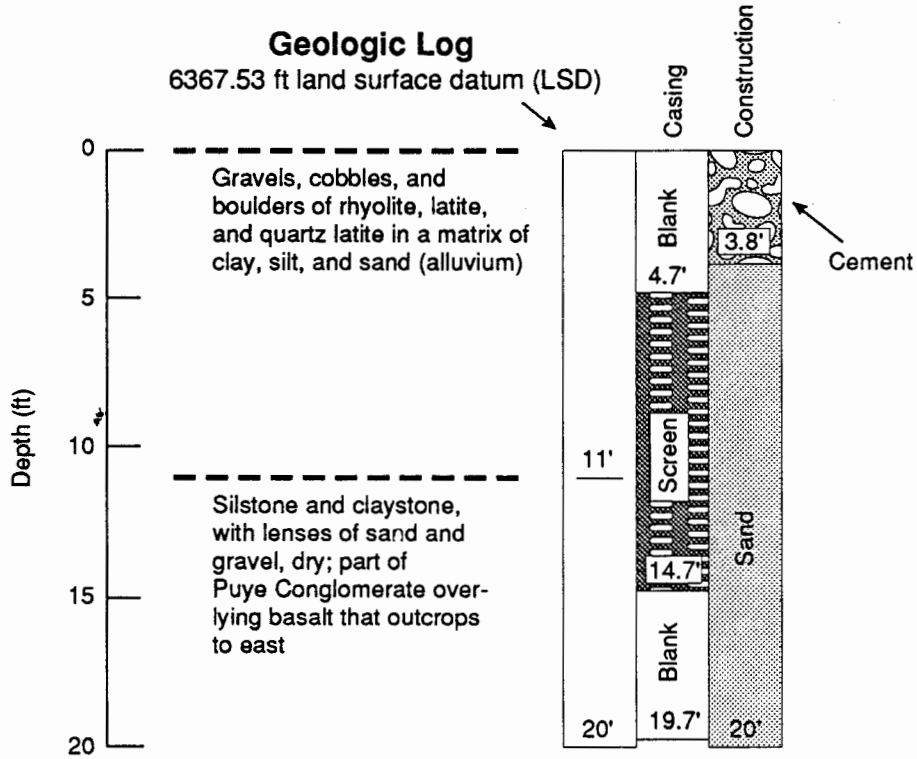


Fig. 2. Pueblo Canyon observation well APCO-1 (completed August 17, 1990, water level 6 ft).

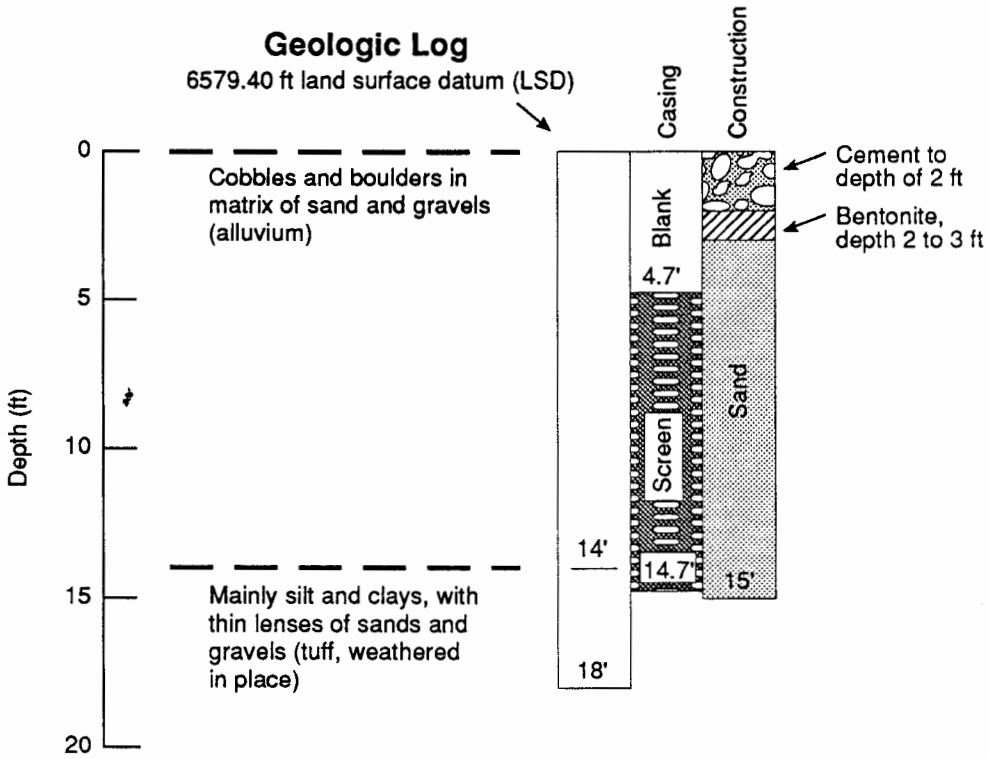


Fig. 3. Los Alamos Canyon observation well LAO-3A (completed September 14, 1989, water level 7 ft).

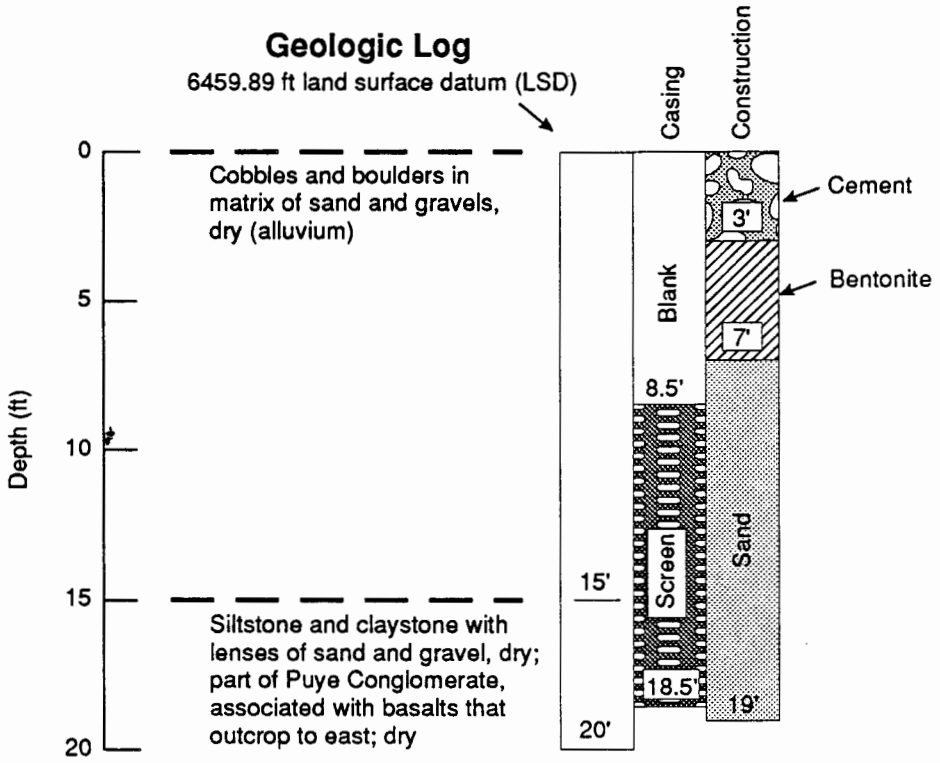


Fig. 4(a). Los Alamos Canyon observation well LAO-4.5A (completed September 14, 1989, dry).

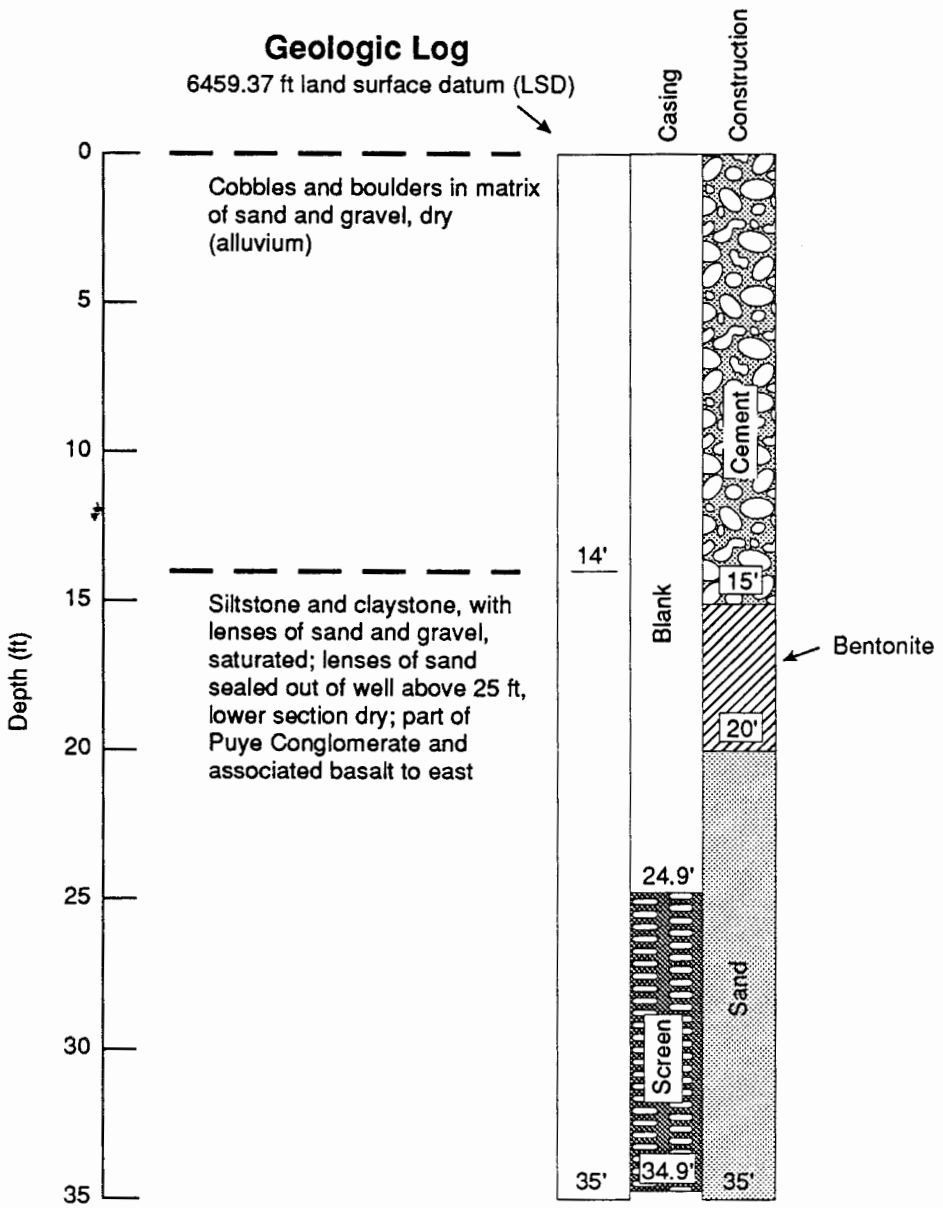


Fig. 4(b). Los Alamos Canyon observation well LAO-4.5B (completed September 16, 1989, dry).

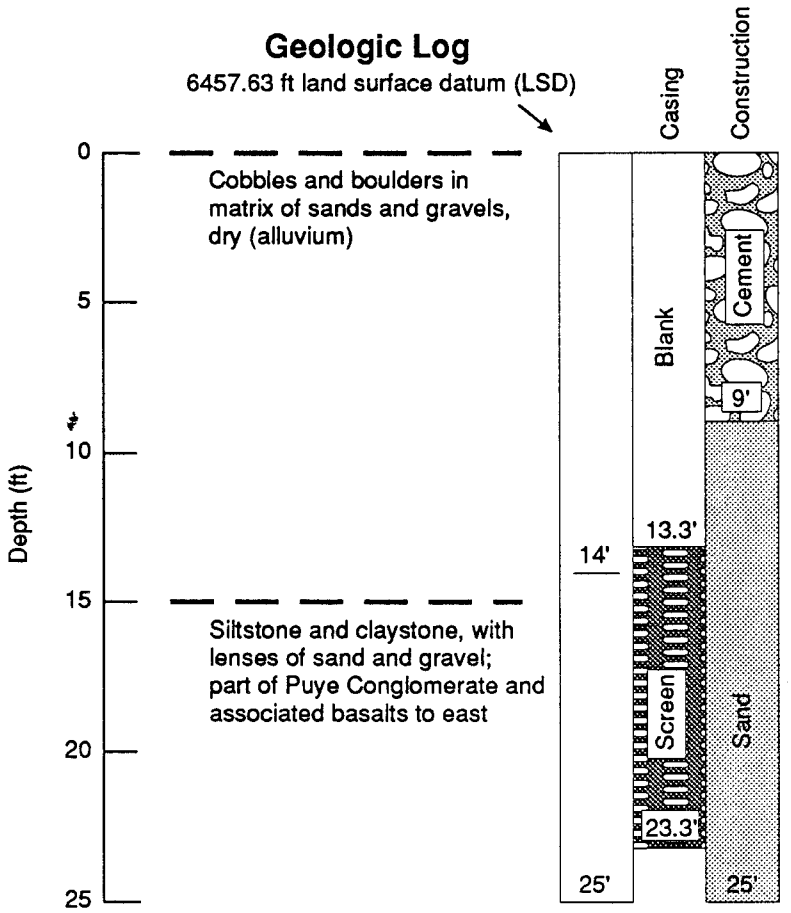


Fig. 4(c). Los Alamos Canyon observation well LAO-4.5C (completed November 22, 1989, water level 11 ft).

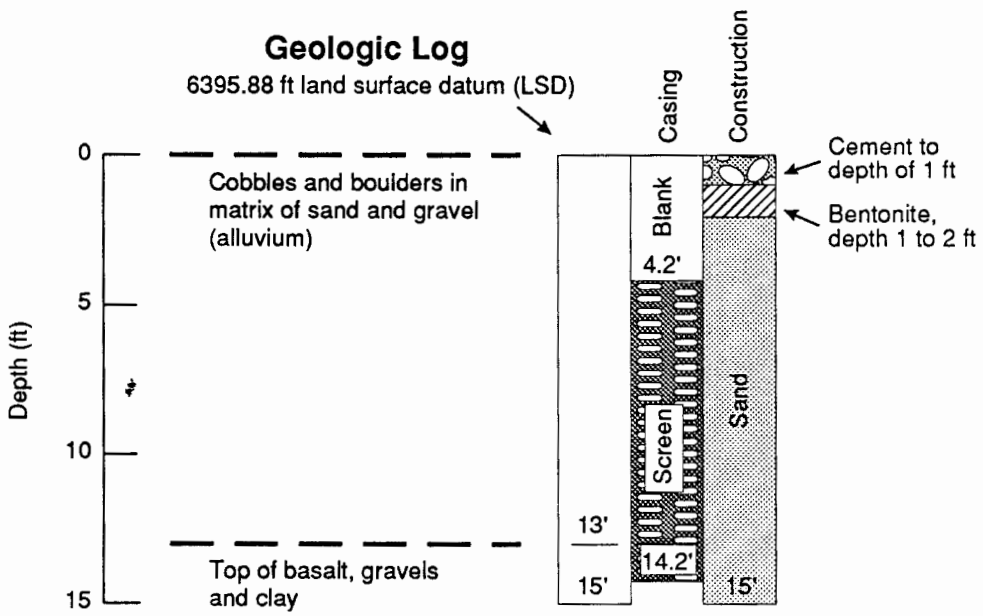


Fig. 5. Los Alamos Canyon observation well LAO-6A (completed August 17, 1989, water level 9.0 ft).

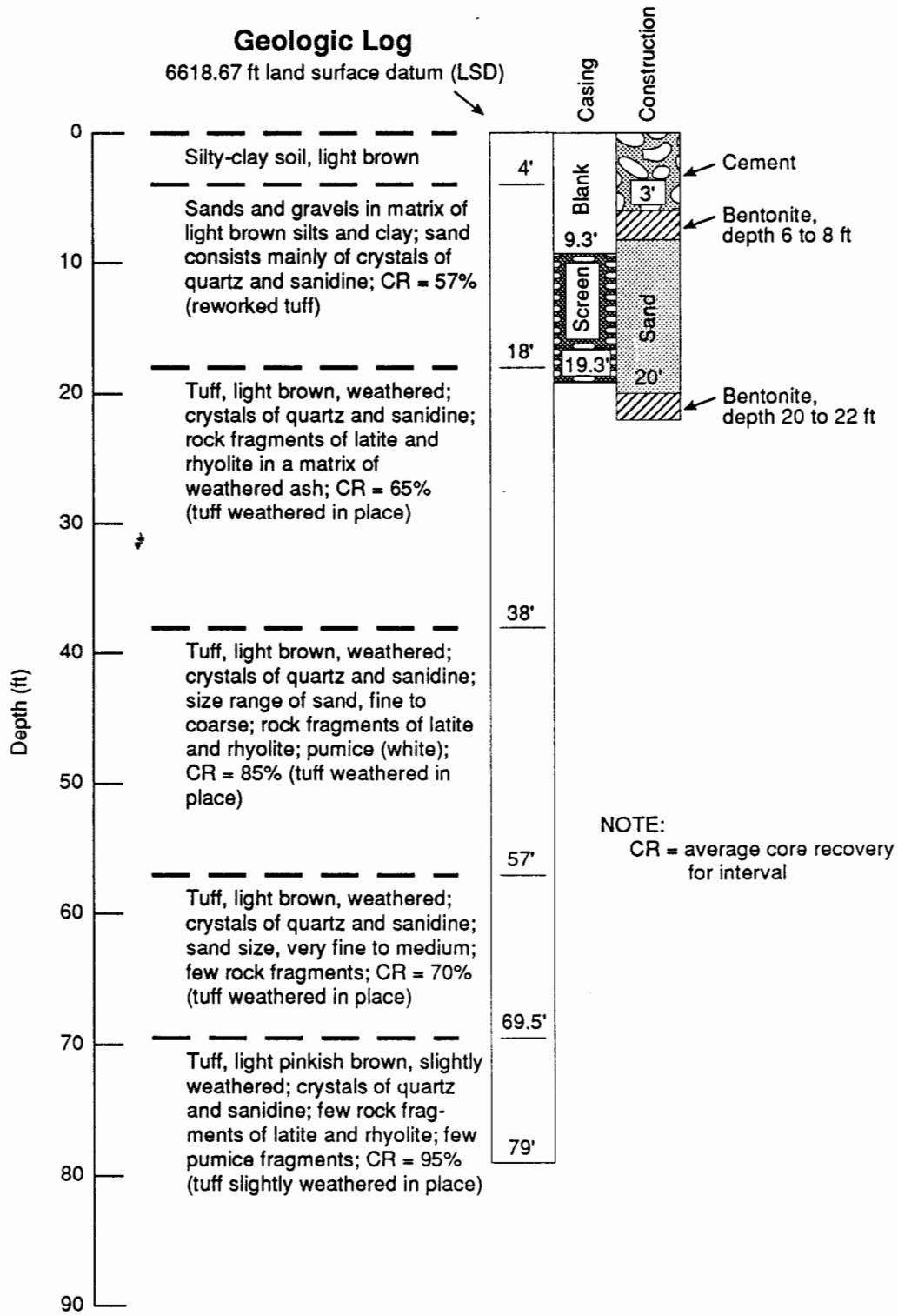
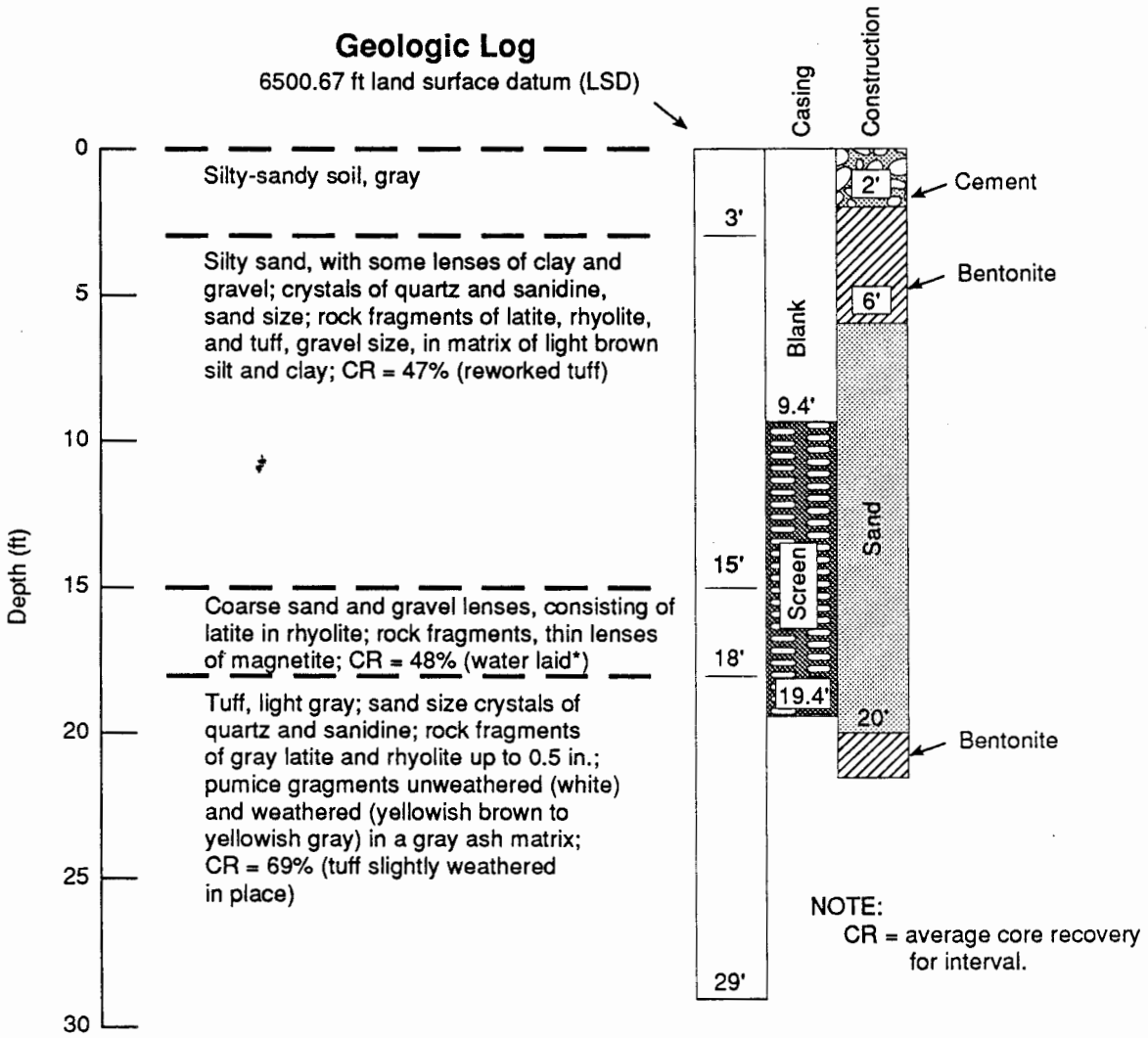


Fig. 6. Sandia Canyon observation well SCO-1 (completed August 15, 1989, dry).



*This 3-ft interval is apparently at the bottom of the Tshirege Member of the Bandelier Tuff (Tsankawi Member, Bailey 1967).

Fig. 7. Sandia Canyon observation well SCO-2 (completed August 16, 1989, dry).

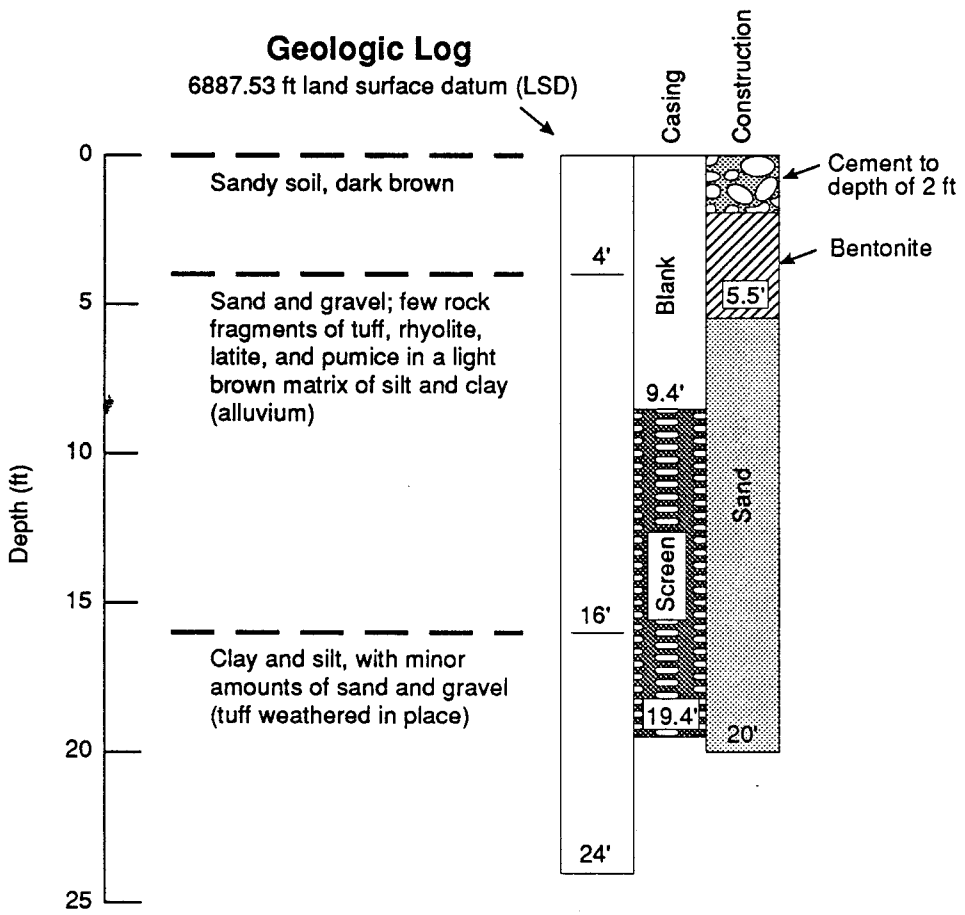


Fig. 8(a). Mortandad Canyon observation well MCO-4A (completed November 1, 1989, water level 5 ft).

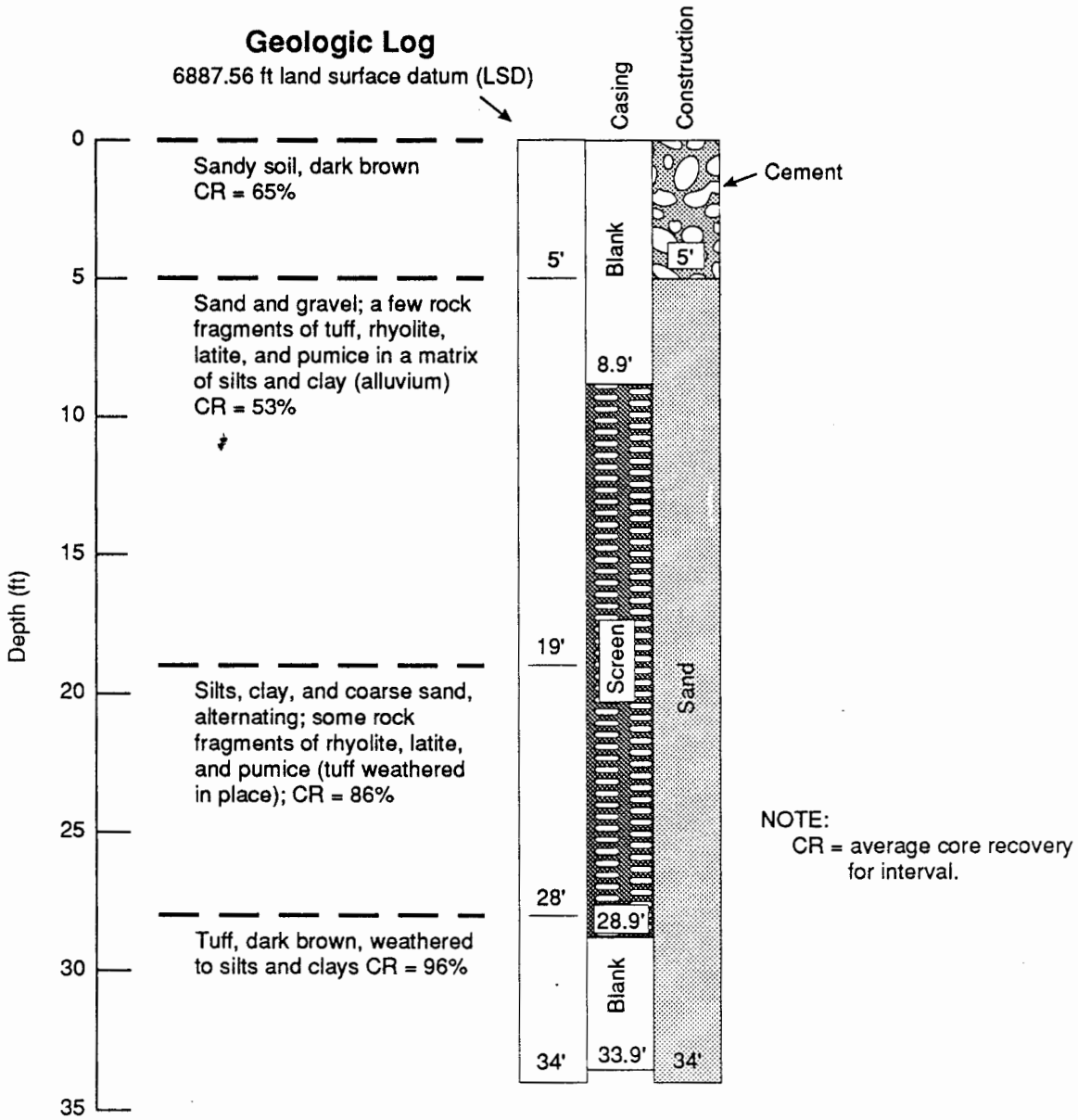


Fig. 8(b). Mortandad Canyon observation well MCO-4B (completed August 21, 1990, water level 22 ft).

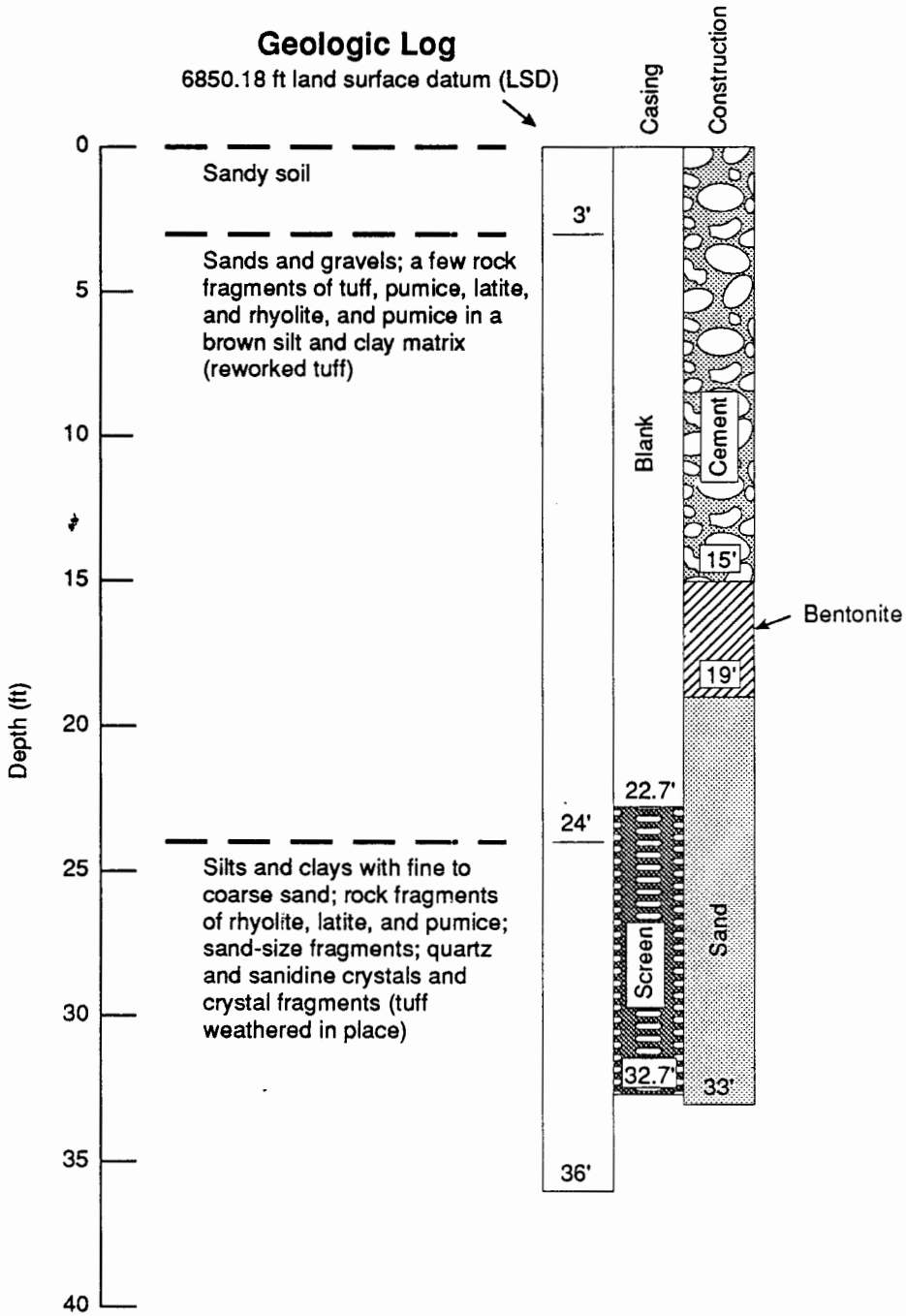


Fig. 9(a). Mortandad Canyon observation well MCO-6A (completed November 6, 1989, water level 30 ft).

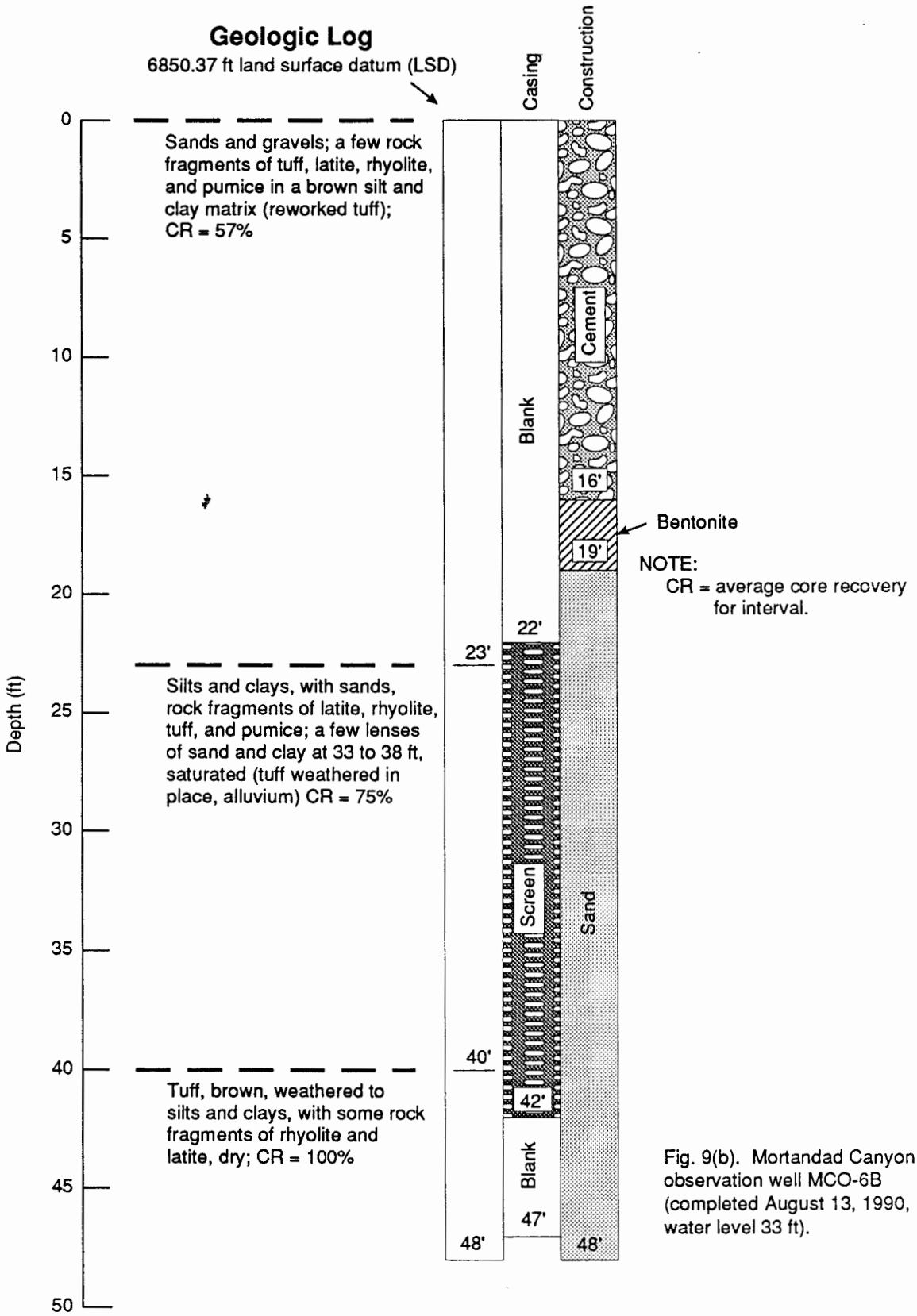


Fig. 9(b). Mortandad Canyon observation well MCO-6B (completed August 13, 1990, water level 33 ft).

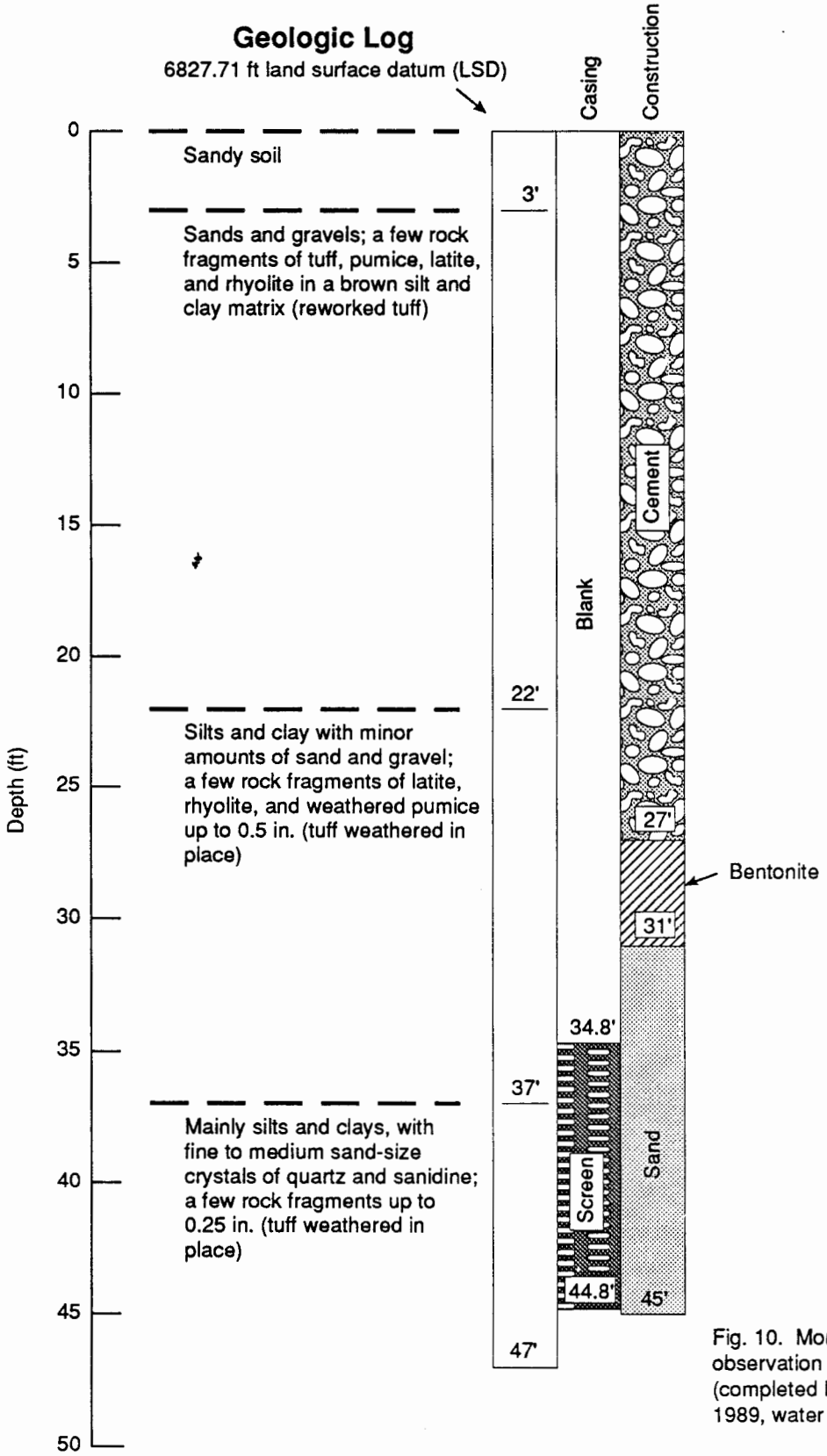


Fig. 10. Mortandad Canyon observation well MCO-7A (completed November 14, 1989, water level 35 ft).

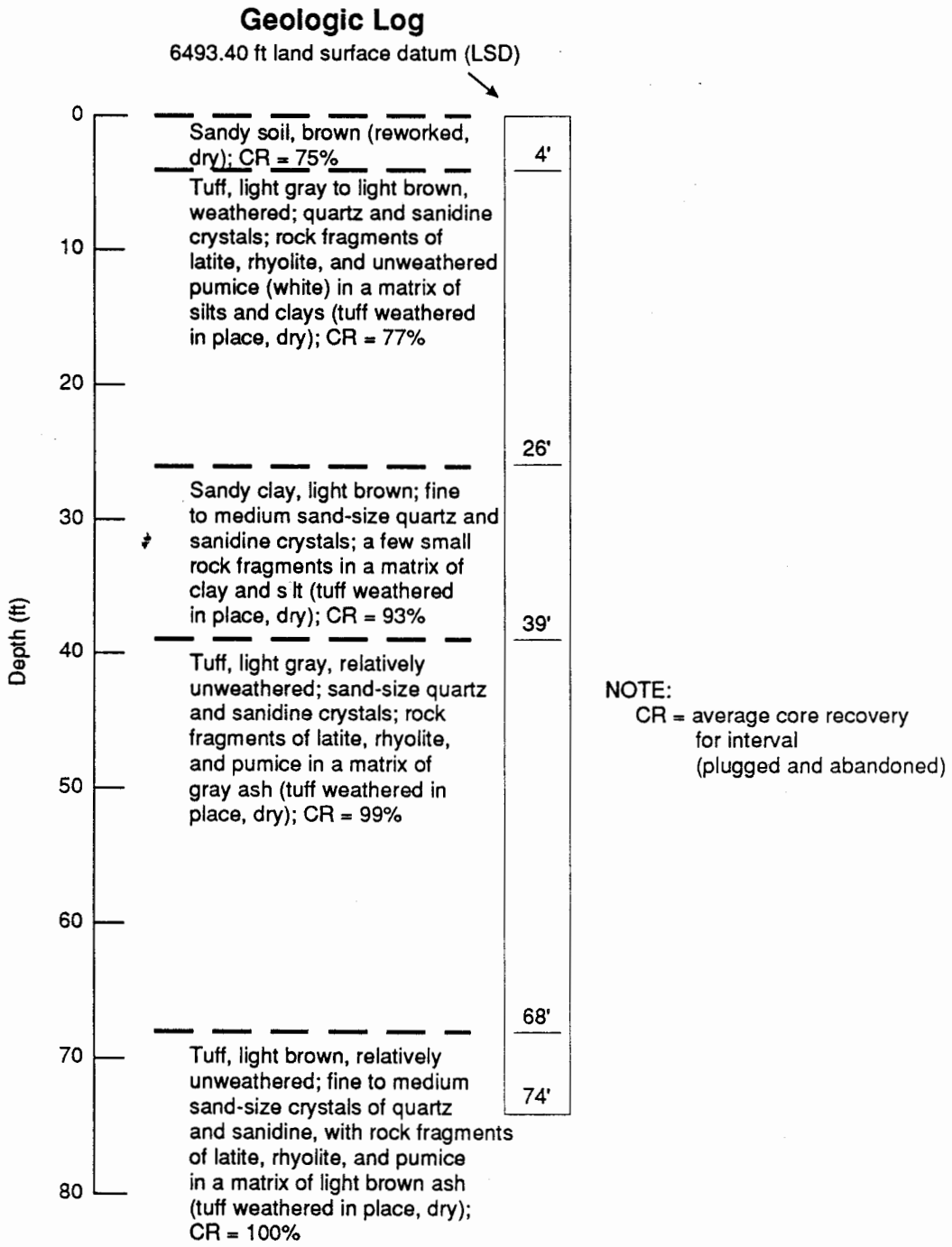


Fig. 11. Potrillo Canyon test hole PCTH-1 (completed October 20, 1989, dry).

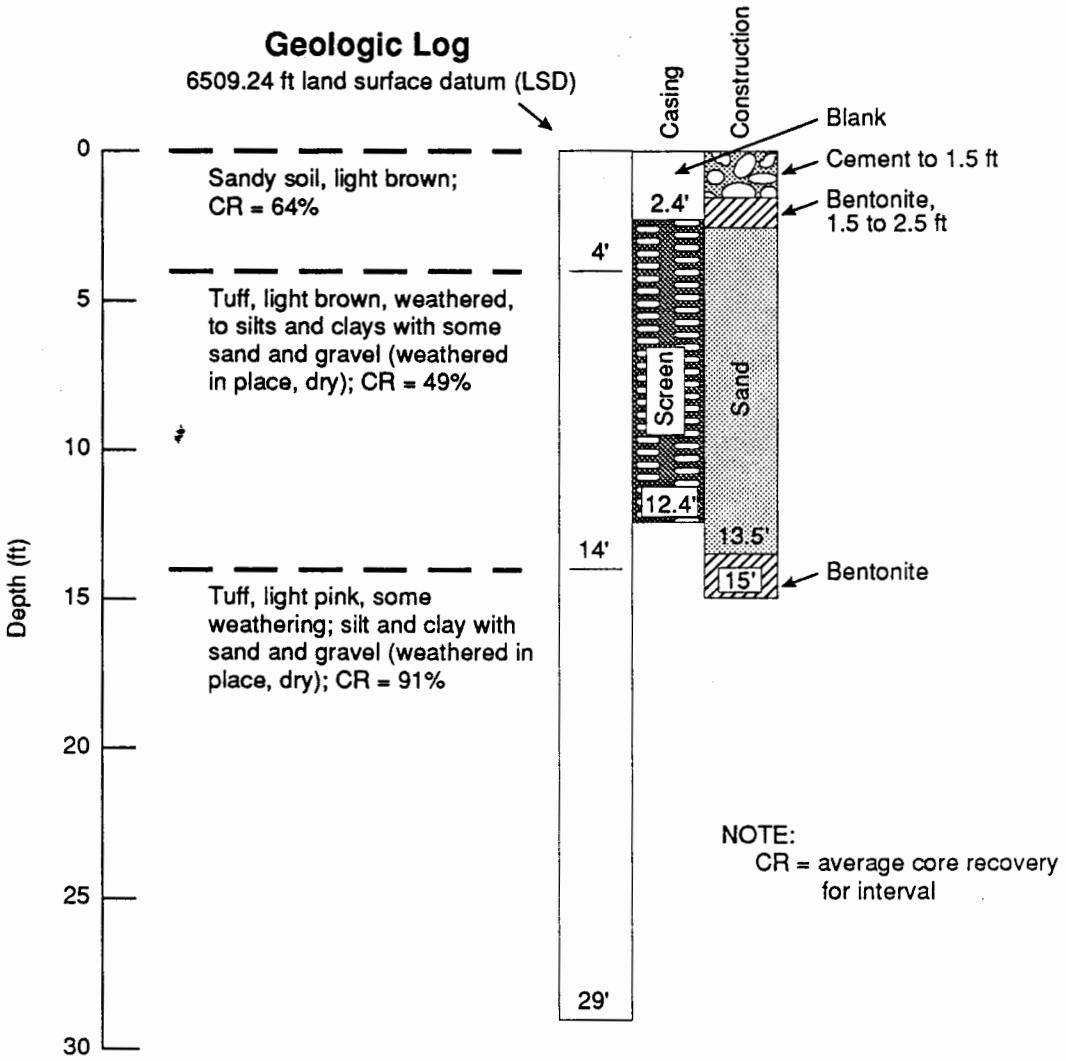


Fig. 12. Fence Canyon observation well FCO-1 (completed August 22, 1989, dry).

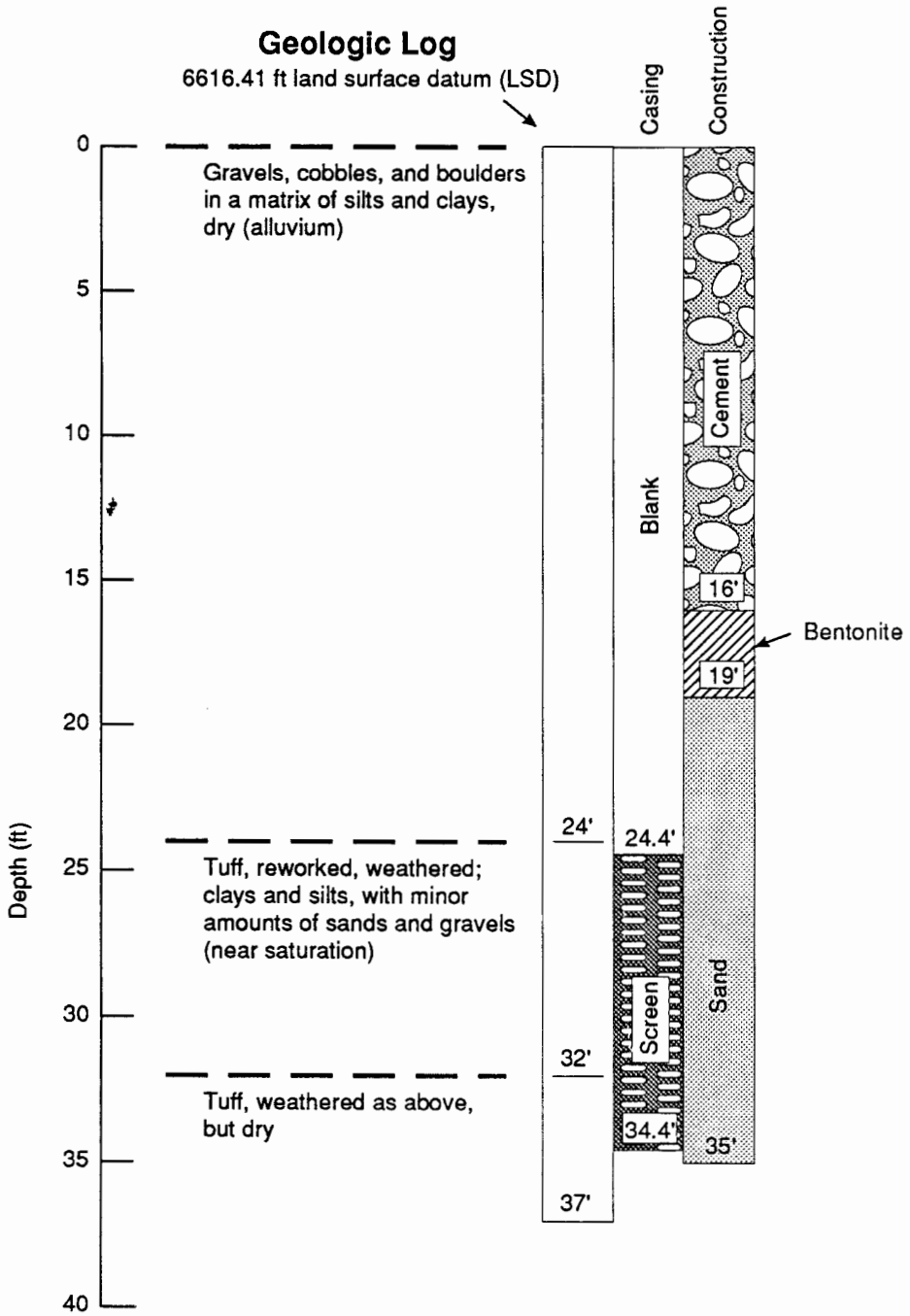


Fig. 13. Water Canyon observation well WCO-1 (completed October 31, 1989, dry).

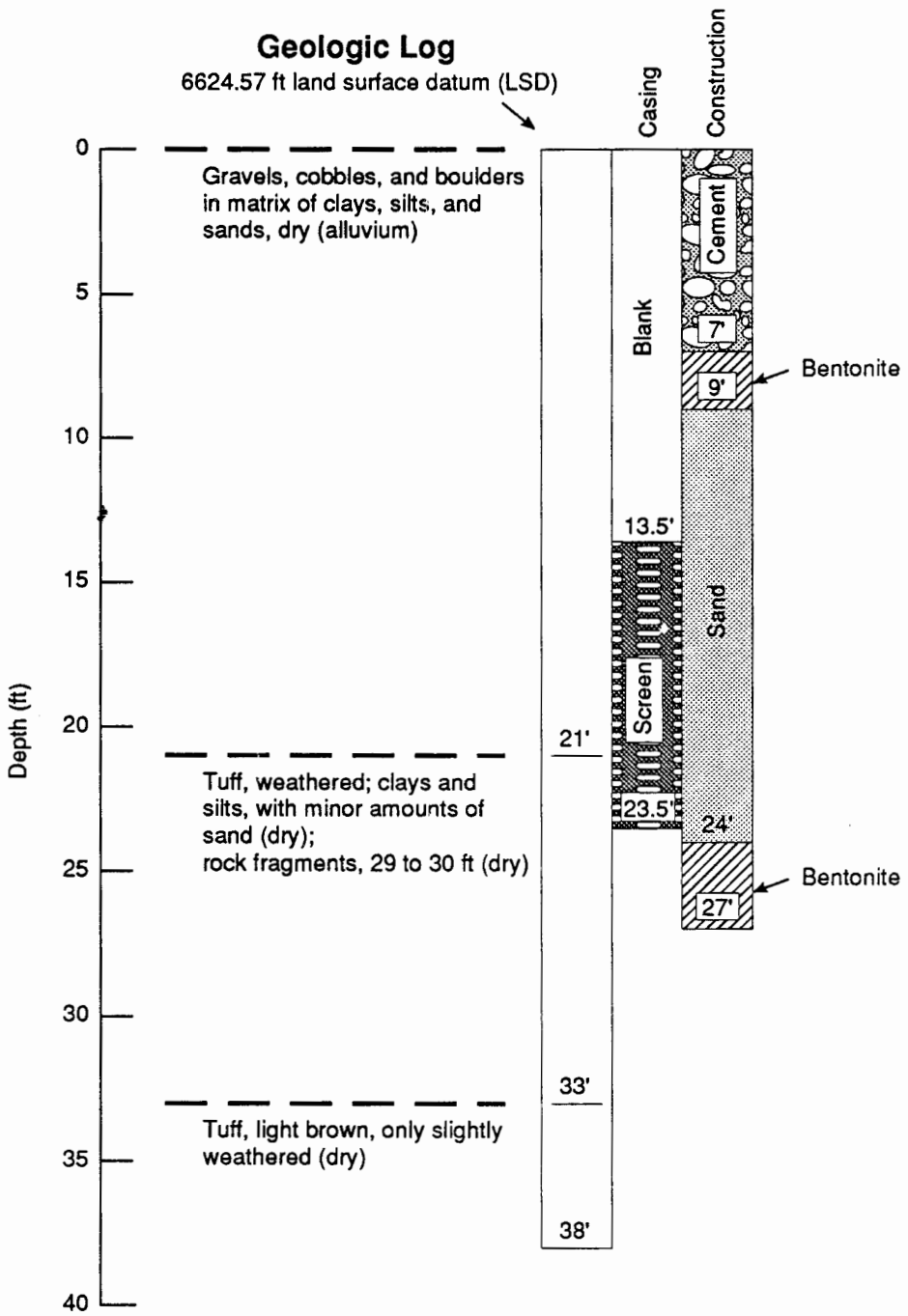


Fig. 14. Water Canyon observation well WCO-2 (completed October 26, 1989, dry).

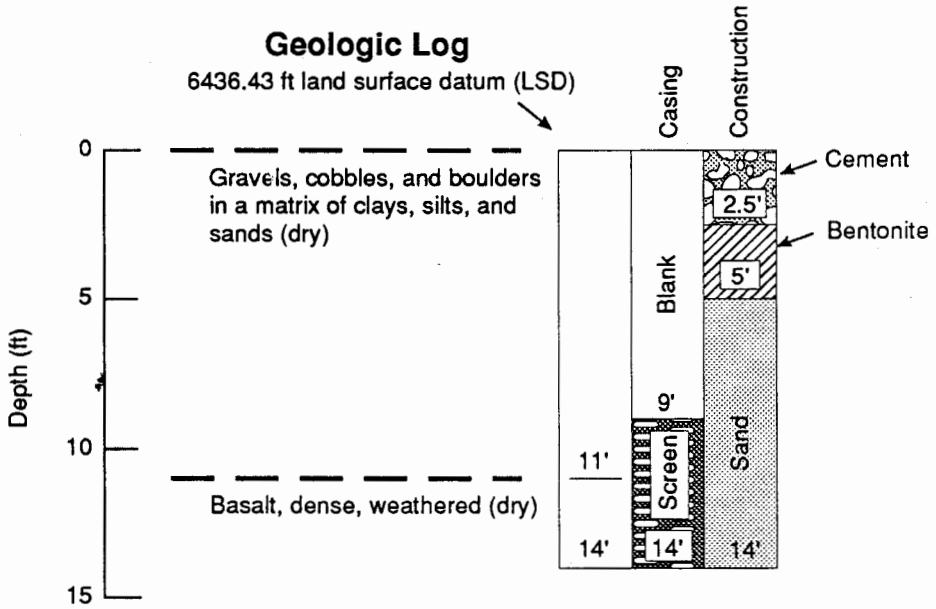


Fig. 15. Water Canyon observation well WCO-3 (completed October 25, 1989, dry).

APPENDIX O

Sample Coordination Facility

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INTRODUCTION

It is projected that several hundred thousand samples may be collected for chemical analysis in support of Environmental Restoration (ER) Program activities at Los Alamos National Laboratory (the Laboratory). The coordination between the proposed sampling activities and the requested analytical support for each sampling project is critical to the success of these programs.

The University of California (UC) Sample Coordination Facility (SCF) Coordinator will coordinate the ER Program's sample collection activities and analytical chemical analysis. This facility is staffed and operated by the Health and Environmental Chemistry Group (HSE-9) in the Health, Safety and Environment (HSE) Division. The SCF Coordinator coordinates ER Program activities in the following areas:

- review of project sampling plans that include requests for analytical chemistry support,
- centralization of a sample-receiving facility for all ER Program sampling activities that require analytical chemistry support,
- validation of samples collected for completeness,
- selection of laboratories to provide analytical chemistry services,
- insertion of blind quality control (QC) samples in each batch of samples,
- transportation of samples to selected analytical chemistry laboratories for chemical analysis,
- validation of analytical results received from selected analytical laboratories,
- electronic transfer of validated analytical results to project leaders,
- disposition of unused environmental samples, and
- coordination of the transfer of analytical chemistry data packages to the ER Program's Facility for Information Mangement, Analysis, and Display..

The protocols required for the successful operation of the SCF are outlined in the following sections. Detailed operational procedures are located in the individually referenced standard operating procedures (SOPs).

Summary of Sample Coordination Program Management

The SCF Coordinator will be an active participant in the design and implementation of project sampling plans, the allocation of samples for chemical analysis to both UC and commercial laboratories, and the validation of analytical data packages.

All proposed ER Program sampling plans are reviewed at the SCF for adherence to sampling protocols mandated by all applicable Environmental Protection Agency (EPA) regulations and analytical methods. The topics of concern include the sampling schedule, proper sample sizes and containers, correct preservation techniques, chain-of-custody requirements, and transportation of samples to the SCF.

All samples collected for chemical analyses are transported to the SCF for validation and scheduling of analytical services. A sample-receiving custodian (SRC) validates each sample for proper sample size, container, preservative, and labels. The SRC documents any discrepancies in these areas and notifies the project leader of the possible consequences of these discrepancies and possible corrective actions. The custody of validated samples is then transferred to the SRC Coordinator, and the samples are prepared for distribution to the appropriate laboratories for chemical analysis.

The SCF staff assign a unique UC sample number to each sample and schedule the chemical analysis of all samples in cooperation with participating UC and commercial analytical laboratories. These assignments are made on the basis of the participating laboratory's area of expertise (organics, inorganics, radiochemistry, mixed waste, etc.); type of analysis requested; participating laboratory's sample-handling capacity; existing backlog of samples at each participating laboratory; and the required turnaround time as specified in the applicable project plan. The SCF staff will insert an appropriate number of blind quality control samples in each batch of samples.

The SCF will notify all appropriate laboratories by telephone of the pending shipment of samples for chemical analysis. The samples will be packaged in accordance with all applicable EPA preservation and Department of Transportation (DOT) shipping requirements and will be transported under chain-of-custody procedures to the assigned laboratories for chemical analysis. Each participating laboratory will telephone the UC SCF to acknowledge the receipt of samples and to identify any discrepancies in the chain-of-custody documentation. If needed, the SCF Coordinator will initiate and document all necessary corrective actions.

The participating laboratories will deliver a final data package to LANL's SCF staff for review and validation. Once validated, a final report on the chemical analysis will be electronically transferred to the ER Program's information management computer system.

All unused portions of samples will be returned to the SCF for final disposition. All documentation deemed relevant by ER Program management will be released to the ER Program's document control facility for archiving.

Project Sampling Plan Review

The SCF staff will review all ER Program project sampling plans for compliance with sampling and sample preservation protocols as outlined by EPA's SW-846. The review of each project sampling plan will focus on the following subjects:

- sampling method(s) to be used,
- number of samples to be collected,
- types of samples to be collected (water, sludge, soil, sediment, etc.),
- types of sample containers to be used,
- chain-of-custody procedures to be used,
- chemical analyses to be performed,

- sample preservation techniques,
- schedule of sampling event(s), and
- field contact name and phone number.

The appropriate ER Program project leader will be notified, in writing, of any special requirements or inconsistencies in the project sampling plan under review. The ER Program project leader will direct any corrective actions required.

Delivery of Samples

All samples collected for chemical analysis by ER Program participants will be delivered to the SCF, Room 190, Building OH-1, TA-59. Samples that contain radioactivity above background require special handling. The ER Program project leader should consult with the SCF Coordinator before delivery of samples. Special arrangements will be made to properly receive these types of samples.

Proper packaging and transporting of samples to the SCF is important in maintaining sample integrity. All samples are to be collected and transported under chain-of-custody procedures, properly packaged, and preserved. These procedures are addressed in the appropriate project sampling plan.

Samples can be delivered to the SCF during any legal workday between the hours of 8:00 a.m. and 12:00 p.m. and 1:00 p.m. and 5:00 p.m. Special arrangements can be made with the SCF Coordinator for sample delivery during off hours.

Sample Validation

Upon the initial receipt of samples, the SCF will validate the integrity and completeness of the samples for chemical analysis. All samples must meet the regulatory protocols for sample size, container type, preservation, and labeling as established in EPA's SW-846. Samples that fail to meet these minimum specifications will be noted on a Sample-Receiving Discrepancy Report. This report will indicate the sample submitter's decision to either schedule these samples for chemical analysis or resample.

After the sample validation process is completed, the custody of these samples will be transferred to the SCF by the sample submitter. A copy of the custody transfer form will be retained by the sample submitter for his/her records. The specific chain-of-custody procedures are documented in the chain-of-custody SOP. The specific sample validation procedures are documented in the HSE-9 Sample Coordination Procedures Manual.

Scheduling of Chemical Analyses

All samples will be stored at the SCF under chain-of-custody requirements until they are packaged and shipped to the assigned laboratories for chemical analysis. The SCF will maintain a list of qualified laboratories to be used in the assignment of samples for chemical analysis. This list will include a detailed description of each laboratory's analytical capabilities (e.g., specific EPA methods and non-EPA methods) and sample-handling capacity. This list will comprise both UC divisional laboratories [HSE, Chemical and Laser Sciences (CLS), Isotope and Nuclear Chemistry (INC), etc.] at the Laboratory and commercial environmental laboratories. The commercial environmental laboratories will be chosen through a request for bid in support of UC's ER Program statement of work (SOW). The SOW lists the specific criteria to be used in the commercial laboratory selection process.

Commercial laboratory assignments will be based on a particular laboratory's expertise, current sample backlog, and UC's requested sample turnaround time. The SCF Coordinator will try to match the appropriate analytical laboratory with the needs of each individual project.

UC laboratory assignments will also be based on the particular laboratory's expertise, current sample backlog, and requested sample turnaround time. In addition, samples requiring special analytical services (mixed waste characterization, transuranic (TRU) waste characterization, high-resolution mass spectrometry, etc.) and samples exhibiting a high degree of potential liability will be assigned to an appropriate UC laboratory at Los Alamos for chemical analysis.

The SCF Coordinator will be the single point of contact on all matters involving the scheduling and assignment of ER Program samples for chemical analysis.

Sample Packaging and Shipment

All environmental samples to be shipped off-site for chemical analysis will be packaged at the SCF in accordance with all applicable DOT regulations (49 CFR, Parts 100-199, October 1,1978).

All on-site shipments of environmental samples for chemical analysis will be packaged at the SCF in accordance with the UC On-Site Transportation Manual. The specific procedures are detailed in the On-Site Transportation of Environmental Laboratory Samples SOP.

All nonenvironmental samples will be packaged and shipped in accordance with DOT regulations and UC's On-Site Transportation Manual. The SCF Coordinator will consult the following individuals about regulations concerning the packaging and shipment of the following materials:

- Hazardous materials—Shirley O'Rourke, MAT-14, (505) 667-5115
- Hazardous waste—Karen Balo, HSE-7, (505) 667-6095
- Explosives—Humberto Martinez, WX-3, (505) 667-6792
- Radioactive material—Nate King, HSE-1, (505) 667-4127

In addition, all samples will be packaged in accordance with the EPA's sample preservation protocols as specified in SW-846. The specific procedures are detailed in the Procedures for Shipment of Environmental Laboratory Samples SOP.

The SCF staff will insert appropriate blind quality control samples with the shipment of all samples for chemical analysis. The QC samples will be inserted at a frequency of 10% (1 QC sample for every 10 samples submitted for chemical analysis) and will be both matrix- and analyte-specific.

All samples will be maintained and transported to the assigned laboratories for chemical analysis under chain-of-custody procedures as outlined in the chain-of-custody SOP.

Validation of Data

All laboratories will submit a final data package to the SCF upon completion of the requested chemical analysis. These data packages will be reviewed and evaluated by SCF personnel for the following:

- completeness of work: was the requested chemical analysis performed?
- chain-of-custody requirements: did the laboratory maintain chain-of-custody procedures?
- accuracy and precision: did the laboratory perform the required QC checks and were they within EPA's acceptance control limits?
- correctness of work: were the specific method protocols followed (holding times, extraction procedures, calibration procedures, etc.)?

Upon successful completion of the validation process, the analytical results will be electronically transferred to the ER Program's data base system. The appropriate ER project leader will be notified when data packages fail the validation process. The SCF Coordinator, the specific ER Program project leader, and the ER Program's Quality Project Leader will discuss the possible corrective actions and implement those actions that best meet the data quality objectives of the project.

Specific data validation criteria and procedures are listed in the Validation of Analytical Data SOP.

Disposition of Samples

All samples will be returned to the SCF for proper disposal upon completion of the requested chemical analysis. Samples will be maintained under chain-of-custody procedures for up to 15 days after the data package has been validated and will be electronically transferred to the appropriate ER Program project leader.

Samples for data packages that fail the validation process will be maintained under chain-of-

custody procedures until the corrective action process is completed. The final disposition of these samples will be determined by the SCF Coordinator, the specific ER Program project leader, and the ER Program's Project Leader Coordinator.

The specific disposal procedures are listed in the SOP for Disposal of Excess Samples and Sample Containers. These procedures are performed with the cooperation of the Waste Management Group (HSE-7) at the Laboratory.

Document Control

All documents generated by the SCF during the sample coordination process will be collected at the completion of each project. These documents include, but are not limited to,

- chain-of-custody documents;
- data packages (analytical reports, calibration forms, analog outputs from chemical instrumentation, computer printouts, etc.);
- correspondence, memorandums, letters, etc.;
- shipping documents, manifests, etc.; and
- validation forms and reports.

Records will be managed as requested by the Records Management Program Plan and implementing procedures.

Those documents not released to the ER Program will be handled and stored in accordance with the Laboratory's HSE-9 QAP.

REFERENCES

EPA (US Environmental Protection Agency) "Test Methods for Evaluating Solid Waste (SW-846)," Office of Solid Waste, Washington, DC.

DOT (Department of Transportation) 1978. 49 CFR, Parts 100–199.

On-Site Transportation Manual, Los Alamos National Laboratory.

EPA (US Environmental Protection Agency) December 1988. User's Guide to Contract Laboratory Program, Office of Emergency and Remedial Response, EPA/540/8-89/012, Washington, DC.

EPA (US Environmental Protection Agency) May 1978. "NEIC Policies and Procedures," Office of Support and Compliance Monitoring, EPA-330/9-78-001-R.

APPENDIX P

Capabilities at Los Alamos National Laboratory for Analyzing Compounds Listed in Resource Conservation and Recovery Act Regulations Appendixes VIII and IX

COMPARISON OF APPENDICES VIII AND IX WITH SW-846 METHODS

EPA APPENDIX VIII 40 CFR PART 261	EPA APPENDIX IX 40 CFR PART 264	SW-846 NUMBER	HSE-9 PERFORMS
	ACENAPHTHENE	8270	Y
	ACENAPHTHALENE	8270	Y
	ACETONE	8260	Y
ACETONITRILE	ACETONITRILE	8260	Y*
ACETOPHENONE	ACETOPHENONE	8270	
2-ACETAMINEFLUORENE	2-ACETYLAMINOFLUORENE	8270	
ACETYL CHLORIDE			
1-ACETYL-2-THIORUREA		8270	
ACROLEIN	ACROLEIN	8260	Y
ACRYLAMIDE			
ACRYLONITRILE	ACRYLONITRILE	8260	Y
AFLATOXINS			
ALDICARB			
ALDRIN	ALDRIN	8080	Y
ALLYL ALCOHOL			
ALLYL CHLORIDE	ALLYL CHLORIDE	8260	Y*
ALUMINUM PHOSPHIDE			
4-AMINOBIPHENYL	4-AMINOBIPHENYL	8270	
5-(AMINOMETHYL)-3-ISOOXAZOLOL			
4-AMINOPYRIDINE			
AMITROLE			
AMMONIUM VANADATE			
ANILINE	ANILINE	8270	Y
	ANTHRACENE	8270	Y
ANTIMONY	ANTIMONY	6000/7000	Y
ANTIMONY COMPOUNDS NOS		6000/7000	Y
ARAMITE	ARAMITE	8270	
ARSENIC	ARSENIC	6000/7000	Y
ARSENIC COMPOUNDS, NOS		6000/7000	Y
ARSENIC ACID		6000/7000	Y
ARSENIC PENTOXIDE		6000/7000	Y

ARSENIC TRIOXIDE		6000/7000	Y
AURAMINE			
AZASERINE			
BARIUM	BARIUM	6000/7000	Y
BARIUM COMPOUNDS NOS		6000/7000	Y
BARIUM CYANIDE		6000/7000	Y
BENZ(C)ACRIDINE			
BENZ(A)ANTHRACENE	BENZ(A)ANTHRACENE	8270	Y
BENZAL CHLORIDE			
BENZENE	BENZENE	8260	Y
BENZENEARSONIC ACID			
BENZIDINE		8270	Y
BENZO(b)FLUORANTHENE	BENZO(b)FLUORANTHENE	8270	Y
BENZO(j)FLUORANTHENE			
	BENZO(k)FLUORANTHENE	8270	Y
	BENZO(ghi)PERYLENE	8270	Y
BENZO(a)PYRENE	BENZO(a)PYRENE	8270	Y
p-BENZOQUINONE			
BENZOTRICHLORIDE			
	BENZYL ALCOHOL	8270	Y
BENZYL CHLORIDE			
BERYLLIUM	BERYLLIUM	6000/7000	Y
BERYLLIUM COMPOUNDS, N.O.S.		6000/7000	Y
	ALPHA-BHC	8080	Y
	BETA-BHC	8080	Y
	DELTA-BHC	8080	Y
	BIS(2-CHLOROETHOXY)METHANE	8270	Y
	BIS(2-CHLOROETHYL)ETHER	8270	Y
	BIS(2-CHLORO-1-METHYLETHYL)ETHER	8270	
BROMOACETONE			
	BROMODICHLOROMETHANE	8260	Y
BROMOFORM	BROMOFORM	8260	Y
4-BROMOPHENYL PHENYL ETHER	4-BROMOPHENYL PHENYL ETHER	8270	Y
BRUCINE			
BUTYL BENZYL PHTHALATE	BUTYL BENZYL PHTHALATE	8270	Y
CACODYLIC ACID			
CADMIUM	CADMIUM	6000/7000	Y
CADMIUM COMPOUNDS, NOS		6000/7000	Y
CALCIUM CHROMATE		6000/7000	Y

CALCIUM CYANIDE		6000/7000	Y
CARBON DISULFIDE	CARBON DISULFIDE	8260	Y
CARBON OXYFLUORIDE			
CARBON TETRACHLORIDE	CARBON TETRACHLORIDE	8260	Y
CHLORAL			
CHLORDANE	CHLORDANE	8080	Y
CHLORDANE (A AND G ISOMERS)			
CHLORINATED BENZENES NOS			
CHLORINATED ETHANE NOS		8260	Y
CHLORINATED FLUOROCARBONS NOS			
CHLORINATED NAPHTHALENE NOS		8270	Y
CHLORINATED PHENOL NOS			
CHLORNAPHAZIN			
CHLOROACETALDEH YDE			
CHLOROALKYL ETHERS NOS			
p-CHLOROANILINE	p-CHLOROANILINE	8270	Y
CHLOROBENZENE	CHLOROBENZENE	8260	Y
CHLOROBENZILATE	CHLOROBENZILATE	8270	
p-CHLORO-m-CRESOL	p-CHLORO-m-CRESOL	8270	Y
	CHLOROETHANE	8260	Y
2-CHLOROETHYL VINYL ETHER		8260	Y
CHLOROFORM	CHLOROFORM	8260	Y
CHLOROMETHYL METHYL ETHER			
beta-CHLORONAPHTHALENE	beta-CHLORONAPHTHALENE	8270	Y
o-CHLOROPHENOL	o-CHLOROPHENOL	8270	Y
	4-CHLOROPHENYL PHENYL ETHER	8270	Y
1-(o-CHLOROPHENYL)THIOUREA			
CHLOROPRENE	CHLOROPRENE		
3-CHLOROPROPIONITRILE			
CHROMIUM	CHROMIUM	6000/7000	Y
CHROMIUM COMPOUNDS NOS		6000/7000	Y
CHRYSENE	CHRYSENE	8270	Y
CITRUS RED No. 2			
COAL TAR CREOSOTE			
	COBALT	6000/7000	Y
	COPPER	6000/7000	Y
COPPER CYANIDE			
CREOSOTE			
CRESOLS, NOS	CRESOL, NOS	8270	Y

CROTONALDEHYDE			
CYANIDES NOS	CYANIDES NOS		
CYANOGEN			
CYANOGEN BROMIDE			
CYANOGEN CHLORIDE			
CYCASIN			
2-CYCLOHEXYL-2,6-DINITROPHENOL			
CYCLOPHOSPHAMIDE			
2,4-D	2,4-D	8150	Y
2,4-D SALTS AND ESTERS		8150	Y
DAUNOMYCIN			
DDD	DDD	8080	Y
DDE	DDE	8080	Y
DDT	DDT	8080	Y
DIALLATE	DIALLATE	8270	
DIBENZ(a,h)ACRIDINE			
DIBENZ(a,j)ACRIDINE		8270	
DIBENZ(a,h)ANTHRACENE	DIBENZ(a,h)ANTHRACENE	8270	Y
DIBENZO CARBAZOLE			
	DIBENZOFURAN	8270	Y
DIBENZO(a,e)PYRENE			
DIBENZO(a,h)PYRENE			
DIBENZO(a,i)PYRENE			
	DIBROMOCHLOROMETHANE	8260	Y
1,2-DIBROMO-3-CHLOROPROPANE	1,2-DIBROMO-3-CHLOROPROPANE	8260	Y
DIBUTYL PHTHALATE	DIBUTYL PHTHALATE	8270	Y
o-DICHLOROBENZENE	o-DICHLOROBENZENE	8270	Y
m-DICHLOROBENZENE	m-DICHLOROBENZENE	8270	Y
p-DICHLOROBENZENE	p-DICHLOROBENZENE	8270	Y
DICHLOROBENZENE NOS	DICHLOROBENZENE NOS	8270	Y
3,3-DICHLOROBENZIDINE	3,3-DICHLOROBENZIDINE	8270	Y
1,4-DICHLORO-2-BUTENE	1,4-DICHLORO-2-BUTENE	8260	Y*
DICHLORODIFLUOROMETHANE	DICHLORODIFLUOROMETHANE	8260	Y
	1,1-DICHLOROETHANE	8260	Y
DICHLOROETHYLENE NOS	DICHLOROETHYLENE NOS	8260	Y
1,1-DICHLOROETHYLENE	1,1-DICHLOROETHYLENE	8260	Y
1,2-DICHLOROETHYLENE	1,2-DICHLOROETHYLENE	8260	Y
DICHLOROETHYL ETHER			
DICHLOROISOPROPYL ETHER			

DICHLOROMETHOXY ETHANE			
DICHLOROMETHYL ETHER			
2,4-DICHLOROPHENOL	2,4-DICHLOROPHENOL	8270	Y
2,6-DICHLOROPHENOL	2,6-DICHLOROPHENOL	8270	
DICHLOROPHENYLARSINE			
DICHLOROPROPANE NOS	DICHLOROPROPANE NOS	8260	Y
DICHLOROPROPANOL NOS			
DICHLOROPROPENE NOS		8260	Y
1,3-DICHLOROPROPENE		8260	Y
DIELDRIN	DIELDRIN	8080	Y
1,2,3,4-DIEPOXYBUTANE			
DIETHYLARSINE			
1,4-DIETHYLENEOXIDE			
DIETHYLHEXYLPHTHALATE	DIETHYLHEXYLPHTHALATE	8270	Y
N,N-DIETHYL HYDRAZINE			
O,O-DIETHYL S-METHYL DITHIOPHOSPHATE			
DIETHYL-p-NITROPHENYL PHOSPHATE			
DIETHYL PHTHALATE	DIETHYL PHTHALATE	8270	Y
DIETHYL PYRAZINYL PHOSPHOROTHIOATE	(both)		
DIETHYLSTILBESTEROL			
DIHYDROSAFROLE			
DIISOPROPYLFLUROPHOSPHATE			
DIMETHOATE	DIMETHOATE	8270	
3,3'-DIMETHOXYBENZIDINE			
p-DIMETHYLAMINOAZOBENZENE	p-DIMETHYLAMINOAZOBENZENE	8270	
7,12-DIMETHYLBENZ(a)ANTHRACENE	7,12-DIMETHYLBENZ(a)ANTHRACENE	8270	
3,3'-DIMETHYLBENZIDINE	3,3'-DIMETHYLBENZIDINE	8270	
DIMETHYLCARBAMOYL CHLORIDE			
1,1-DIMETHYL HYDRAZINE			
1,2-DIMETHYL HYDRAZINE			
a,a-DIMETHYLPHENETHYLAMINE	a,a-DIMETHYLPHENETHYLAMINE	8270	
2,4-DIMETHYLPHENOL	2,4-DIMETHYLPHENOL	8270	Y
DIMETHYL PHTHALATE	DIMETHYL PHTHALATE	8270	Y
DIMETHYL SULFATE	DIMETHYL SULFATE		
DINITROBENZENE NOS	DINITROBENZENE NOS	8270	
4,6-DINITRO-o-CRESOL	4,6-DINITRO-o-CRESOL	8270	Y
4,6-DINITRO-o-CRESOL SALTS			
2,4-DINITROPHENOL	2,4-DINITROPHENOL	8270	Y
2,4-DINITROTOLUENE	2,4-DINITROTOLUENE	8270	Y

2,6-DINITROTOLUENE	2,6-DINITROTOLUENE	8270	Y
DINOSEB	DINOSEB	8150	Y
DI-n-OCTYL PHTHALATE	DI-n-OCTYL PHTHALATE	8270	Y
	1,4-DIOXANE	8260	Y*
DIPHENYLAMINE	DIPHENYLAMINE	8270	
1,2-DIPHENYLHYDRAZINE		8270	
DI-n-PROPYLNITROSAMINE			
DISULFOTON	DISULFOTON	8270	
DITHIOBIURET			
ENDOSULFAN I AND II	ENDOSULFAN I AND II	8080	Y
	ENDOSULFAN SULFATE	8080	Y
ENDOTHALL			
ENDRIN	ENDRIN	8080	Y
ENDRIN METABOLITES	ENDRIN METABOLITES	8080	Y
EPICHLOROHYDRIN			
EPINEPHRINE			
	ETHYL BENZENE	8260	Y
ETHYL CARBAMATE			
ETHYL CYANIDE			
ETHYLENEBISDITHIOCARBAMIC ACID			
ETHYLENEBISDITHIOCARBAMIC ACID,	SALTS AND ESTERS		
ETHYLENE DIBROMIDE	ETHYLENE DIBROMIDE		
ETHYLENE DICHLORIDE			
ETHYLENE GLYCOL MONOETHYL ETHER			
ETHYLENEIMINE			
ETHYLENE OXIDE			
ETHYLENETHIOUREA			
ETHYLIDENE DICHLORIDE			
ETHYL METHACRYLATE	ETHYL METHACRYLATE	8260	Y*
ETHYL METHANESULFONATE	ETHYL METHANESULFONATE	8270	
FAMPHUR	FAMPHUR	8270	
FLUORANTHENE	FLUORANTHENE	8270	Y
	FLUORENE	8270	Y
FLUORINE			
FLUOROACETAMIDE			
FLUOROACETIC ACID SODIUM SALT			
FORMALDEHYDE			
FORMIC ACID			
GLYCIDYALDEHYDE			

HALOMETHANES NOS			
HEPTACHLOR	HEPTACHLOR	8080	Y
HEPTACHLOR EPOXIDE	HEPTACHLOR EPOXIDE	8080	Y
HEPTACHLOR EPOXIDE a,b,g ISOMERS		8080	Y
HEXACHLOROBENZENE	HEXACHLOROBENZENE	8270	Y
HEXACHLOROBUTADIENE	HEXACHLOROBUTADIENE	8270	Y
HEXACHLOROCYCLOPENTADIENE	HEXACHLOROCYCLOPENTADIENE	8270	Y
HEXACHLORODIBENZO-p-DIOXIN	HEXACHLORODIBENZO-p-DIOXIN	8280	
HEXACLORODIBENZOFURANS	HEXACLORODIBENZOFURANS	8280	
HEXACLOROETHANE	HEXACLOROETHANE	8270	Y
HEXACLOROPHENE	HEXACLOROPHENE	8270	
HEXACHLOROPROPENE	HEXACHLOROPROPENE	8270	
HEXAETHYL TETRAPHOSPHATE			
	2-HEXANONE	8260	Y
HYDRAZINE			
HYDROGEN CYANIDE			
HYDROGEN FLUORIDE			
HYDROGEN SULFIDE			
INDENO(1,2,3-cd)PYRENE	INDENO(1,2,3-cd)PYRENE	8270	Y
ISOBUTYL ALCOHOL	ISOBUTYL ALCOHOL	8260	Y*
ISODRIN	ISODRIN	8270	
	ISOPHORONE	8270	Y
ISOSAFROLE	ISOSAFROLE	8270	
KEPONE	KEPONE	8270	
LASIOCARPINE			
LEAD	LEAD	6000/7000	Y
LEAD COMPOUNDS NOS		6000/7000	Y
LEAD ACETATE		6000/7000	Y
LEAD PHOSPHATE		6000/7000	Y
LEAD SUBACETATE		6000/7000	Y
LINDANE	LINDANE	8080	Y
MALEIC ANHYDRIDE			
MALEIC HYDRAZIDE			
MALONONITRILE			
MELPHALAN			
MERCURY	MERCURY	7000	Y
MERCURY COMPOUNDS NOS			
MERCURY FULMINATE			
METHYACRYLONITRILE	METHYACRYLONITRILE	8260	Y*

METHAPYRILENE	METHAPYRILENE	8270	
METHOMYL			
METHOXYCHLOR	METHOXYCHLOR	8080	Y
METHYL BROMIDE	METHYL BROMIDE	8260	Y
METHYL CHLORIDE	METHYL CHLORIDE	8260	Y
METHYL CHLOROCARBONATE			
METHYL CHLOROFORM	METHYL CHLOROFORM	8260	Y
METHYLCHOLANTHRENE	METHYLCHOLANTHRENE	8270	
METHYLENEBIS(2-CHLOROANILINE)		8270	
METHYLENE BROMIDE	METHYLENE BROMIDE	8260	Y
METHYLENE CHLORIDE	METHYLENE CHLORIDE	8260	Y
METHYL ETHYL KETONE	METHYL ETHYL KETONE	8260	Y
METHYLETHYL KETONE PEROXIDE			
METHYL HYDRAZINE			
METHYL IODIDE	METHYL IODIDE	8260	Y
METHYL ISOCYANATE			
METHYLACRYLONITRILE		8260	Y*
METHYL METHACRYLATE	METHYL METHACRYLATE	8260	
METHYL METHANESULFONATE	METHYL METHANESULFONATE	8270	
	2-METHYL NAPHTHALENE	8270	Y
METHYL PARATHION	METHYL PARATHION	8270	
	4-METHYL-2-PENTANONE	8260	Y
METHYLTHIOURACIL			
MITOMYCIN C			
MNNG			
MUSTARD GAS			
NAPHTHALENE	NAPHTHALENE	8270	Y
1,4-NAPTHOQUINONE	1,4-NAPTHOQUINONE	8270	
a-NAPTHYLAMINE	a-NAPTHYLAMINE	8270	
b-NAPTHYLAMINE	b-NAPTHYLAMINE	8270	
a-NAPHTHYLTHIOUREA			
NICKEL	NICKEL	6000/7000	Y
NICKEL COMPOUNDS NOS		6000/7000	Y
NICKEL CARBONYL			
NICKEL CYANIDE		6000/7000	Y
NICOTINE			
NICOTINE SALTS			
	o-NITROANILINE	8270	Y

NITRIC OXIDE	m-NITROANILINE	8270	Y
p-NITROANILINE	p-NITROANILINE	8270	Y
NITROBENZENE	NITROBENZENE	8270	Y
NITROGEN DIOXIDE			
NITROGEN MUSTARD			
NITROGEN MUSTARD, HYDROCHLORIC ACID SALT			
NITROGEN MUSTARD N-OXIDE			
NITROGEN MUSTARD, N-OXIDE, HYDROCHLORIDE SALT			
NITROGLYCERIN			
	o-NITROPHENOL	8270	Y
p-NITROPHENOL	p-NITROPHENOL	8270	Y
2-NITROPROPANE			
	4-NITROQUINOLINE 1-OXIDE	8270	
NITROSOAMINES NOS		8270	
N-NITROSODI-n-BUTYLAMINE	N-NITROSODI-n-BUTYLAMINE	8270	
N-NITROSODIETHANOLAMINE			
N-NITROSODIETHYLAMINE	N-NITROSODIETHYLAMINE	8270	
N-NITROSODIMETHYLAMINE	N-NITROSODIMETHYLAMINE	8270	Y
	N-NITROSODIPHENYLAMINE	8270	Y
	N-NITROSODIPROPYLAMINE	8270	Y
N-NITROSO-N-ETHYLUREA			
N-NITROSOMETHYLETHYLAMINE	N-NITROSOMETHYLETHYLAMINE	8270	
N-NITROSO-N-METHYLUREA			
N-NITROSO-N-METHYLURETHANE			
N-NITROSOMETHYLVINYLAMINE			
N-NITROSOMORPHOLINE	N-NITROSOMORPHOLINE	8270	
N-NITROSONORNICOTINE			
N-NITROSOPIPERIDINE	N-NITROSOPIPERIDINE	8270	
N-NITROSOPYRROLIDINE	N-NITROSOPYRROLIDINE	8270	
N-NITROSOSARCOSINE			
5-NITRO-o-TOLUIDINE	5-NITRO-o-TOLUIDINE	8270	
OCTAMETHYLPYROPHOSPHORAMIDE		8270	
OSMIUM TETROXIDE			
PARALDEHYDE			
PARATHION	PARATHION	8270	
PENTACHLOROBENZENE	PENTACHLOROBENZENE	8270	
PENTACHLORODIBENZO-p-DIOXINS	PENTACHLORODIBENZO-p-DIOXINS	8280	
PENTACHLORODIBENZOFURANS	PENTACHLORODIBENZOFURANS	8280	
PENTACHLOROETHANE	PENTACHLOROETHANE	8260/8270	

PENTACHLORONITROBENZENE	PENTACHLORONITROBENZENE	8270	
PENTACHLOROPHENOL	PENTACHLOROPHENOL	8270	Y
PHENACETIN	PHENACETIN	8270	
	PHENANTHRENE	8270	Y
PHENOL	PHENOL	8270	Y
PHENYLENEDIAMINE	PHENYLENEDIAMINE	8270	
PHENYLMERCURY ACETATE			
PHENYLTHIOUREA			
PHOSGENE			
PHOSPHINE			
PHORATE	PHORATE	8270	
PHTHALIC ACID ESTERS NOS		8270	Y
PHTHALIC ANHYDRIDE		8270	
2-PICOLINE	2-PICOLINE	8270	
POLYCHLORINATED BIPHENYLS NOS	POLYCHLORINATED BIPHENYLS NOS	8080	Y
POTASSIUM CYANIDE	POTASSIUM CYANIDE		
POTASSIUM SILVER CYANIDE	POTASSIUM SILVER CYANIDE		
PRONAMIDE	PRONAMIDE	8270	
1,3-PROPANE SULFONE			
	PROPRIONITRILE	8260	Y*
n-PROPYLAMINE			
PROPARGYL ALCOHOL			
PROPYLENE DICHLORIDE			
1,2-PROPYLENEIMINE			
PROPYLTHIOURACIL			
	PYRENE	8270	Y
PYRIDINE	PYRIDINE	8270	
RESERPINE			
RESORCINOL		8270	
SACCHARIN			
SACCARIN SALTS			
SAFROLE	SAFROLE	8270	
SELENIUM COMPOUNDS NOS	SELENIUM COMPOUNDS NOS	6000/7000	Y
SELENIUM DIOXIDE	SELENIUM DIOXIDE	6000/7000	Y
SELENIUM SULFIDE	SELENIUM SULFIDE	6000/7000	Y
SELENOUREA	SELENOUREA		
SILVER	SILVER	6000/7000	Y
SILVER COMPOUNDS NOS		6000/7000	Y
SILVER C YANIDE		6000/7000	Y

SILVEX (2,4,5-tp)	SILVEX (2,4,5-tp)	8150	Y
SODIUM CYANIDE			
STREPTOZOTOCIN			
	STYRENE	8260	Y
STRYCHNINE			
STRYCHNINE SALTS			
	SULFIDE		
2,3,7,8-TCDD	2,3,7,8-TCDD	8280	
1,2,4,5-TETRACHLOROBENZENE	1,2,4,5-TETRACHLOROBENZENE	8270	
TETRACHLORODIBENZO-p-DIOXINS	TETRACHLORODIBENZO-p-DIOXINS	8280	
TETRACHLORODIBENZOFURANS	TETRACHLORODIBENZOFURANS	8280	
TETRACHLOROETHANE NOS		8260	Y
1,1,1,2-TETRACHLOROETHANE	1,1,1,2-TETRACHLOROETHANE	8260	Y
1,1,2,2-TETRACHLOROETHANE	1,1,2,2-TETRACHLOROETHANE	8260	Y
TETRACHLOROETHYLENE	TETRACHLOROETHYLENE	8260	Y
2,3,4,6-TETRACHLOROPHENOL	2,3,4,6-TETRACHLOROPHENOL	8270	
TETRAETHYLDITHIOPYROPHOSPHATE	TETRAETHYLDITHIOPYROPHOSPHATE		
TETRAETHYL LEAD			
TETRAETHYL PYROPHOSPHATE			
TETRANITROMETHANE			
THALLIUM	THALLIUM	6000/7000	Y
THALLIUM COMPOUNDS NOS	THALLIUM COMPOUNDS NOS	6000/7000	Y
THALLIC OXIDE	THALLIC OXIDE	6000/7000	Y
THALLIUM (I) ACETATE	THALLIUM (I) ACETATE	6000/7000	Y
THALLIUM (I) CARBONATE	THALLIUM (I) CARBONATE	6000/7000	Y
THALLIUM (I) CHLORIDE	THALLIUM (I) CHLORIDE	6000/7000	Y
THALLIUM (I) NITRATE	THALLIUM (I) NITRATE	6000/7000	Y
THALLIUM SELENITE	THALLIUM SELENITE	6000/7000	Y
THALLIUM (I) SULFATE	THALLIUM (I) SULFATE	6000/7000	Y
THIOACETAMIDE			
THIOFANOX			
THIOMETHANOL			
THIOPHENOL		8270	
THIOSEMICARBIZIDE			
THIOUREA			
THIRAM			
	TIN	6000/7000	Y
TOLUENE	TOLUENE	8260	Y
TOLUENEDIAMINE			

TOLUENE -2,4-DIAMINE			
TOLUENE-2,6-DIAMINE			
TOLUENE-3,4-DIAMINE			
TOLUENE DIISOCYANATE			
o-TOLUIDINE	o-TOLUIDINE	8270	
o-TOLUIDINE HYDROCHLORIDE			
p-TOLUIDINE			
TOXAPHENE	TOXAPHENE	8080	Y
1,2,4-TRICHLOROBENZENE	1,2,4-TRICHLOROBENZENE	8270	Y
1,1,2-TRICHLOROETHANE	1,1,2-TRICHLOROETHANE	8260	Y
TRICHLOROETHYLENE	TRICHLOROETHYLENE	8260	Y
TRICHLOROMETHANETHIOL			
TRICHLOROMONOFLUOROMETHANE	TRICHLOROMONOFLUOROMETHANE	8260	Y
2,4,5-TRICHLOROPHENOL	2,4,5-TRICHLOROPHENOL	8270	Y
2,4,6-TRICHLOROPHENOL	2,4,6-TRICHLOROPHENOL	8270	Y
2,4,5-T	2,4,5-T	8150	Y
TRICHLOROPROPANE NOS	TRICHLOROPROPANE NOS	8260	Y
	O,O-TRIETHYL PHOSPHOROTHIOATE	8270	
	1,3,5-TRINITROBENZENE	8270	
TRIS(1-AZIRIDINYL)PHOSPHINE SULFIDE			
TRIS(2,3-DIBROMOPROPYL) PHOSPHATE		8270	
TRYPAN BLUE			
URACIL MUSTARD			
	VANADIUM	6000/7000	Y
VANADIUM PENTOXIDE			
	VINYL ACETATE	8260	Y
VINYL CHLORIDE	VINYL CHLORIDE	8260	Y
WARFARIN			
WARFARIN SALTS AT CONC. < 0.3%			
WARFARIN SALTS AT CONC. > 0.3%			
	XYLENE	8260	Y
	ZINC	6000/7000	Y
ZINC CYANIDE			
ZINC PHOSPHIDE			

APPENDIX P

LANL ANALYTICAL CAPABILITIES FOR COMPOUNDS LISTED IN RCRA REGULATIONS APPENDICES VIII AND IX

APPENDIX Q

Cover and Stabilization Pilot Studies

1.0 INTRODUCTION

Field and Laboratory research funded by the US Department of Energy (DOE) at Los Alamos National Laboratory (the Laboratory) over the last eight years has provided a basic understanding of the many environmental factors that influence the hydrologic response of landfills. That research has led to the development of landfill cover technology for controlling the behavior of precipitation that falls on a landfill. This cover technology is based upon the combined results of studies on soil erosion (Nyhan 1984, 1986a, 1986b), subsidence (Abeele 1984a, 1984b, 1984c), biointrusion barriers (Hakonson et al. 1982a, 1982b, 1983, 1986; Felthaser and McInroy 1983; Peterson 1980) and capillary and hydraulic barriers (Abeele and DePoorter 1984, Nyhan et al. 1986).

This plan describes field pilot-scale demonstrations of landfill cover technology at the Laboratory. Several cover designs will be evaluated including a conventional landfill cover that will be compared with an Environmental Protection Agency (EPA) recommended multilayered design and two other landfill cover designs. These demonstrations will be constructed and instrumented so that complete water budgets can be estimated at field locations adjacent to material disposal areas (MDAs) G and F. Results will be compared to determine which design best controls percolation and erosion and maximizes maintenance-free performance. Field tests aimed at studying long-term performance of shallow land burial systems will be completed at the Experimental Engineered Test Facility (EETF), at MDA B, and within both the piñon-juniper and the ponderosa pine woodland transects.

2.0 Objectives and Milestones

Several approaches will be used to address the long-term stability and performance of protective barriers as described in the project milestone chart (Fig. Q-1). The landfill cover designs at MDA B and at the ITP Demonstration will continue to be monitored starting in FY91, resulting in a long, continuous data base which started in 1984 for the ITP plots and in 1987 for Area B. Since we will probably not be able to observe how the landfill cover components will perform in a one-in-a-hundred-year precipitation event, a separate study to be performed in FY91 will address the hydrologic aspects of cover performance (capillary/hydraulic barriers) with augmented precipitation events. These same plots will be used, starting in FY92, to determine long-term interactions between capillary/hydraulic barriers and plant cover.

Long-term relationships will also be studied in the natural piñon-juniper transect (adjacent to the ITP plots), and in other naturally vegetated areas pertinent to the plant covers existing at MDA G (FY90 through life of study). A long-term woodland transect will be established and instrumented in the ponderosa pine woodland adjacent to MDA F in FY91 and will be monitored through the life of the study. One of the key functions of these pilot studies will be to incorporate results of satellite studies in the pilot program into a regional model for evaluating site integrity over the long term. We will ensure comparability in all measurement techniques of hydrologic components, surface characterization, and surface processes by employing the most advanced reliable technology available. This will also involve activities to (1) initiate a conceptual model for succession of woodland vegetation onto remediated sites and (2) integrate satellite natural-area studies and results

MILESTONE CHART FOR PILOT STUDIES

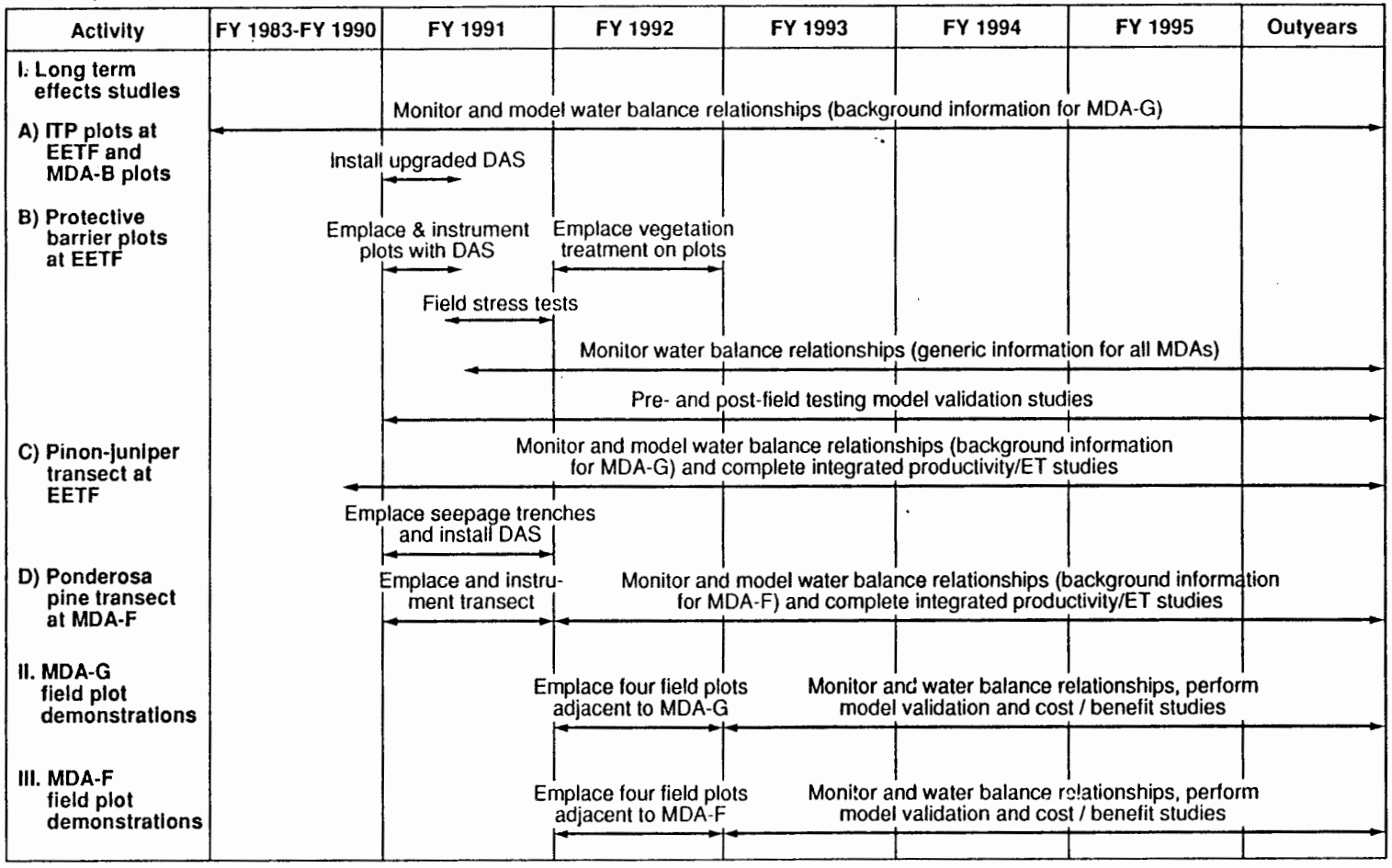


Figure Q-1.

from vegetated demonstration plots (as at MDAs G and F) into a regional model for evaluating and predicting function and stability of cup designs.

The complex nature of the whole program (see milestone chart, Fig. Q-1) can be represented by a conceptual flowchart (Fig. Q-2) that shows the interdependence of the modeling and field study aspects of the whole study. A more detailed flow chart (Fig. Q-2) shows the existing data bases from the MDA B pilot study, and ITP plots are an essential driving force for the initial design of further studies of water balance in cover systems. It is essential to maintain these two studies to obtain long-term data bases on the performance of the cover technologies being tested at these two sites. Climate variability from year to year is an important complicating factor at Los Alamos, as are vegetation changes in response to climate variability. Not only the amount of precipitation is important, but the seasonal distribution and the very short-term precipitation rates can have a profound effect on site water balance. During the 3 years that the pilot study at MDA B has been operating, we have observed significant changes from year to year in the vegetation on the plots. These changes affect runoff, interception, and evapotranspiration and thus impact soil water storage capacity and leachate production. Preliminary comparisons between the evapotranspiration rates at Area B and the piñon-juniper woodland site show that evapotranspiration is relatively higher in the late winter and early spring in the woodland.

3.0 DESCRIPTION AND WASTE USE HISTORIES OF STUDY AREAS

Much of Los Alamos County is located on the Pajarito Plateau, which occupies the eastern flank of the Jemez Mountains in north-central New Mexico. The Plateau occupies about 47% of the land area of the County from 6800-8000 ft, with the Jemez Mountains occupying about 32% of the land area above 8000 ft. Topography is an important factor in determining the pattern and distribution of the soils, plants, and other biota of a landscape. Pronounced precipitation and climatic changes also occur with topographic changes. Candidate sites, MDAs selected from both ends of this water balance/topographic continuum, were chosen, to bracket the final design recommendations and potential risks for *in-situ* containment.

3.1 Materials Disposal Area F (SWMU Number 6-007)

MDA F was chosen as a study site because it has high elevation and precipitation, and is in a ponderosa pine forest typical of disposal areas located in the western portions of the Laboratory.

MDA F is located on Two-Mile Mesa centered between two tributaries of the northern branch of Pajarito Canyon (Environmental Surveillance Group 1989, Rogers 1977). The area lies at an elevation of about 7575 ft with native vegetation consisting of ponderosa pine, and blue and black grama. It is at a distance of approximately 1500 ft from either canyon and lies about 45 ft above the canyon floors. Although the site boundaries are not strictly defined, MDA F contains two burial sites inside fenced areas (Fig. Q-3), both of which are located immediately north of Two-Mile Mesa Road (1.3 mi east of the intersection of Two-Mile Mesa Road and West Road). It is believed that another landfill may be just outside of these fenced areas, including a landfill estimated to be about 40 x 70 ft from an aerial survey conducted in the 1940s (Environmental Surveillance Group 1989).

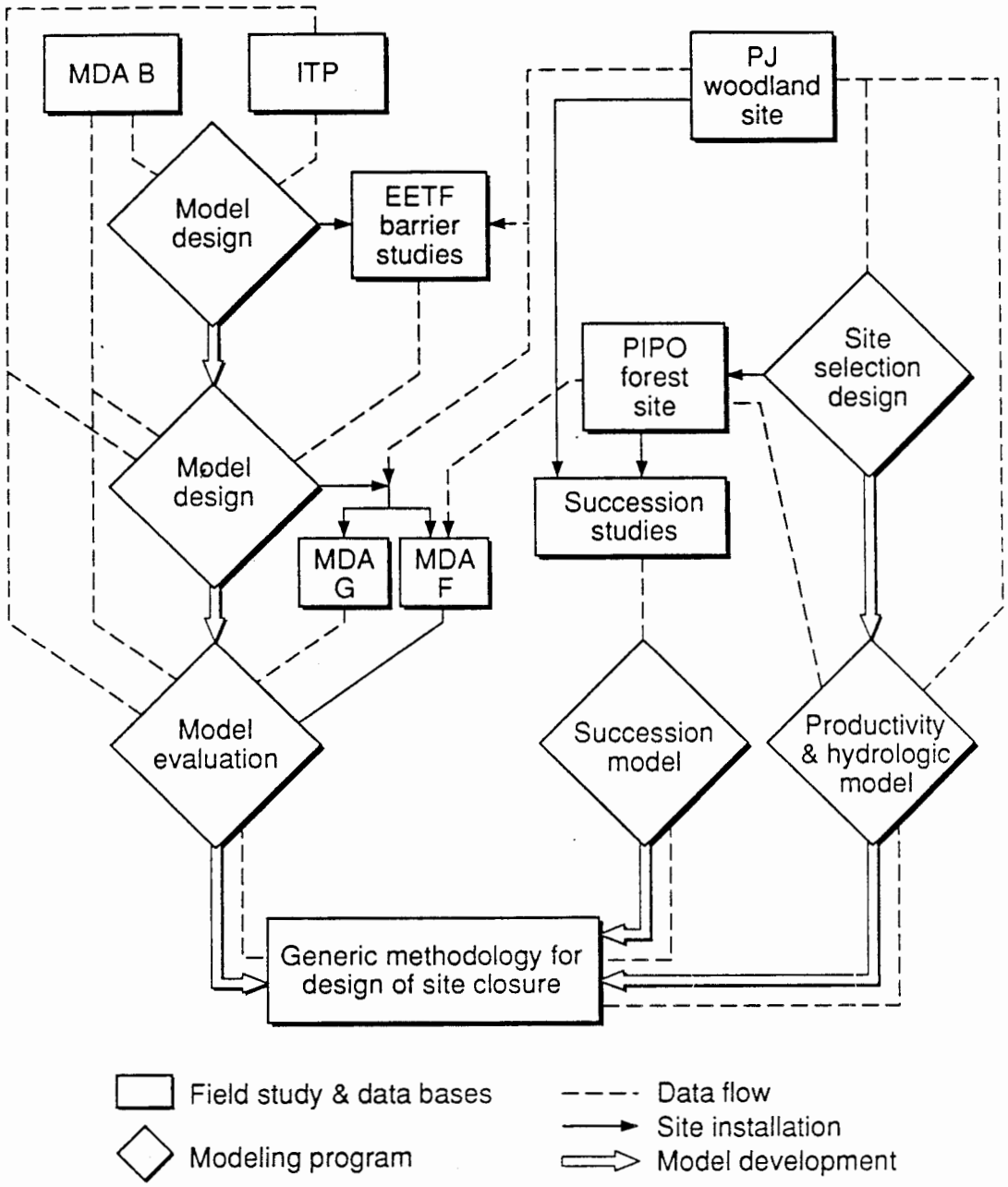
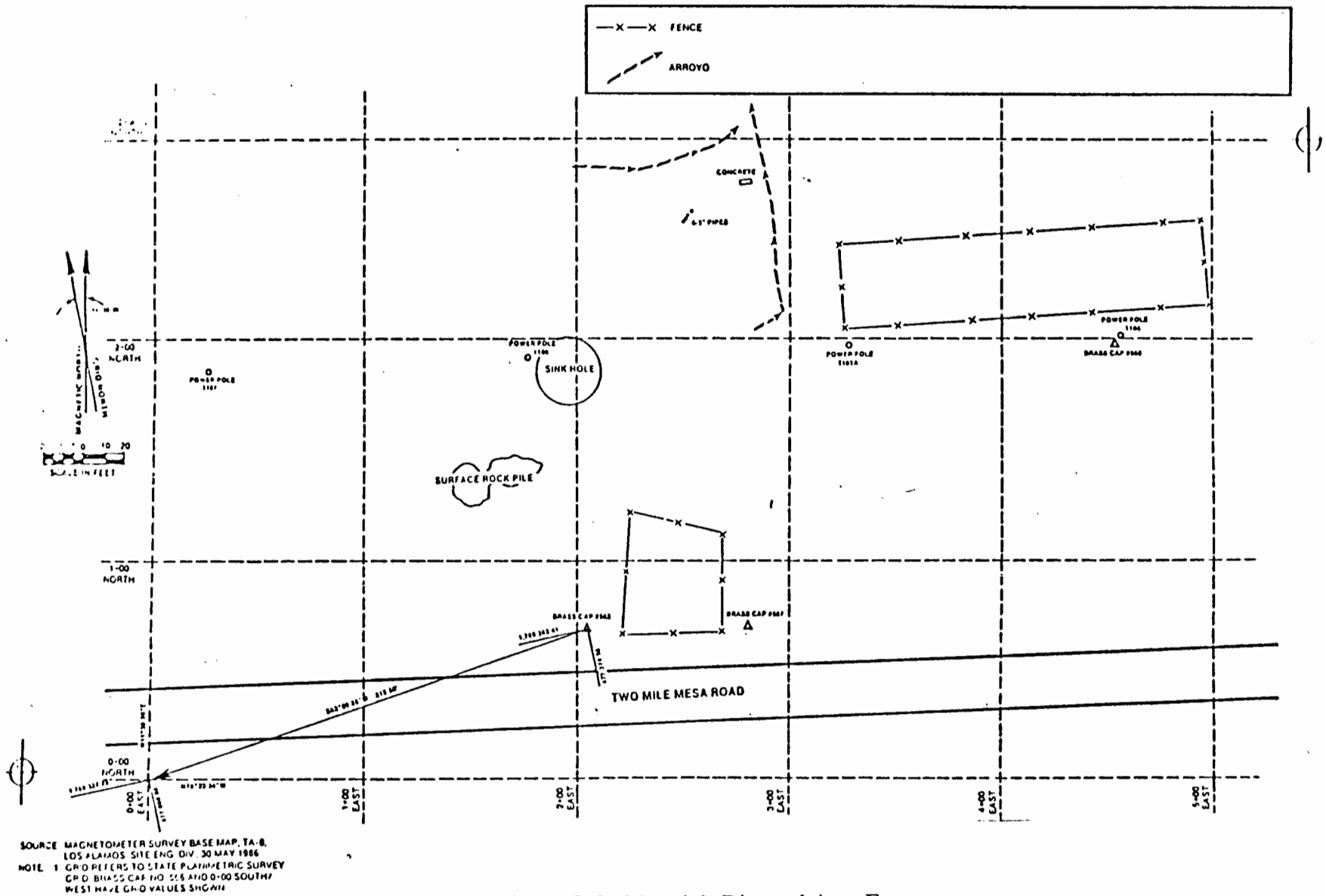


Figure Q-2. Independence of field and modeling studies in pilot study program.



SOURCE MAGNETOMETER SURVEY BASE MAP, TA-8, LOS ALAMOS SITE ENG DIV. 30 MAY 1986
NOTE 1 GRID REFERS TO STATE PLANIMETRIC SURVEY GRID BRASS CAP NO 556 AND 0-00 SOUTH/WEST HAVE GRID VALUES SHOWN

Figure Q-3. Materials Disposal Area F.

MDA F was established on or about 1946 and functioned as a disposal site through 1954. The disposal debris included high explosive (HE) shapes, squibs, detonators, spark gaps, and blocks of HE. There are also depleted uranium-contaminated materials which can be described as construction and equipment debris. Some debris may also be contaminated with Sr-90 and Cs-137.

3.2 Materials Disposal Area G (SWMU Number 54-00)

MDA G was chosen as a study site because it has low elevation and precipitation, and is in a piñon-juniper woodland typical of the disposal areas located in the eastern portions of the Laboratory. MDA G is the main active radioactive waste burial/storage/disposal site for the Laboratory (Fig. Q-4). MDA G is located on Mesita del Buey, which is bounded by Canada del Buey on the north and by Pajarito Canyon on the south (Environmental Surveillance Group 1989, Rogers 1977). The area lies at elevations between 6650 and 6890 m with native vegetation consisting of piñon pine, one-seed juniper, and blue grama. Since the first landfill trench was dug in 1957, the extent of the disposal area grew to 64 acres in 1977; 100 additional acres have been currently dedicated for future expansions.

The burial/storage facilities at MDA G include trenches, shafts, pits, pads, and storage buildings of varying dimensions (Environmental Surveillance Group 1989, Rogers 1977).

MDA G is used for burial of wastes contaminated with radioactivity having less than 100 nCi/g of transuranic wastes. The principal radioactive wastes are plutonium, uranium, tritium, and fission products. From 1971 to 1983, solid waste contaminated with transuranic radionuclides at activity levels greater than 10 nCi/g (greater than 100 nCi/g for ^{238}Pu) has been retrievably stored for possible transport to a final repository. The activity level limit for all transuranic waste to be stored for retrieval was changed to greater than 100 nCi/g in 1983. Otherwise, this disposal area has served as a mixed waste disposal site, and in addition, has received wastes containing asbestos and PCBs.

3.3 Integrated Test Plot Landfill Cover Demonstration

The Environmental Science Group (EES-15) has had experience testing the performance of landfill cover designs in Los Alamos since 1984, such as in the Integrated Test Plot Demonstration at the Environmental Engineering Test Facility (EETF).

The purpose of the cover demonstration was to monitor and compare water balance on the conventional landfill cover design (Fig. Q-5), similar to that used at the Laboratory and the waste management industry (Jacobs et al. 1980) for waste disposal, with that on an improved design (Fig. Q-6). The demonstration plots (two plots per cover design) were installed during the spring and summer of 1984 in our 20-acre field test facility (the EETF; see DePoorter 1981), about 2 mi west of MDA G. The four plots were instrumented so that a complete accounting of precipitation falling on the plots could be measured (Nyhan 1989). The plots were constructed and instrumented (Fig. Q-5 and Q-6) to provide measures of runoff, soil water storage, and seepage, as measured by leachate production from the French drains emplaced in the plots. Except for a small amount of water added to the plots in mid 1984 to aid in establishing vegetation, the plots received only natural precipitation during the course of the study.

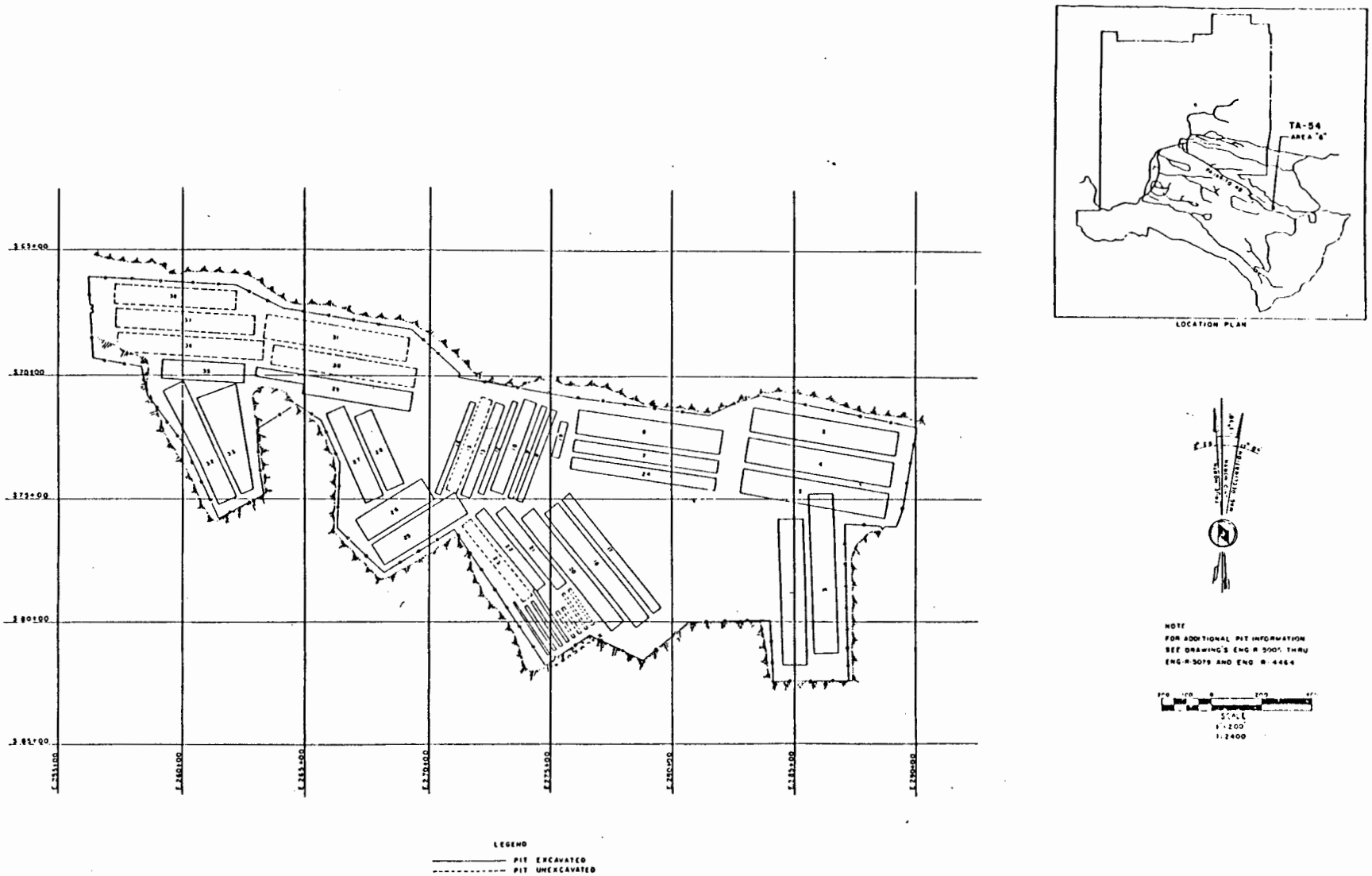


Figure Q-4. Materials Disposal Area G.

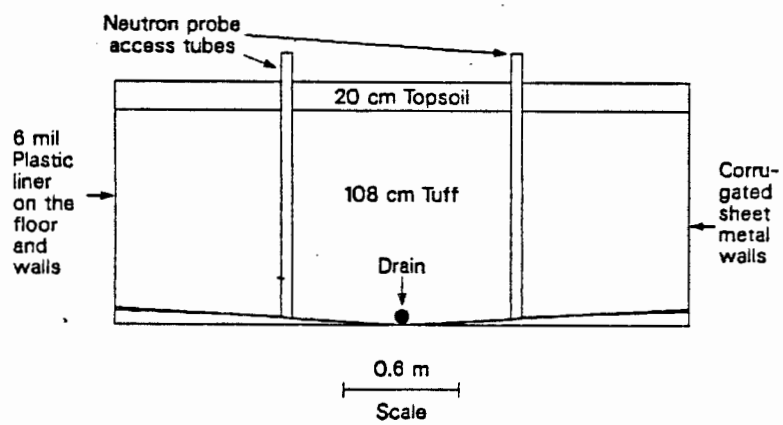


Figure Q-5. Conventional landfill cover design in the ITP experiement.

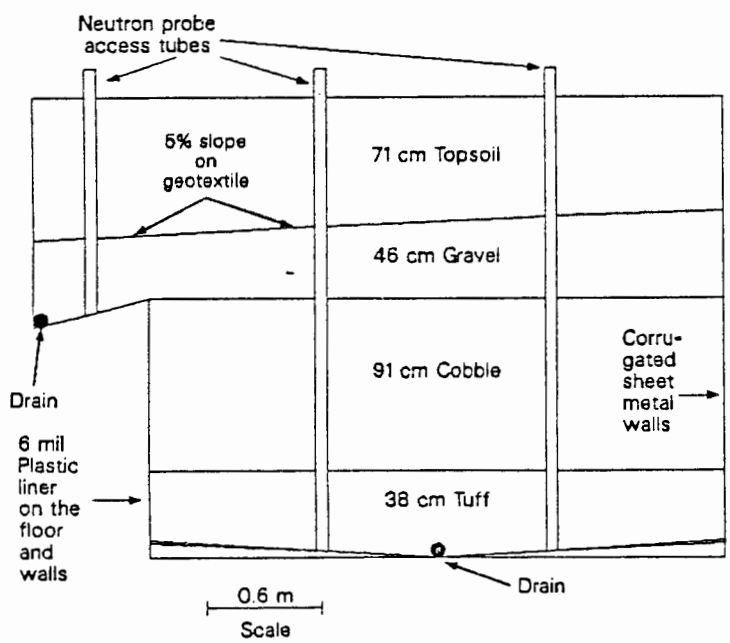


Figure Q-6. Improved landfill cover design in the ITP experiment.

The technology for controlling soil water erosion on both cover designs consisted of applying a 60 to 70% cover of gravel (<0.75-in. diam.) and a plant cover of blue grama and western wheatgrass. A dominant downhill slope of only 0.5% was used on the plot surfaces to ensure that little or no runoff was generated over the course of the experiment (both to maximize the potential for percolation and to simplify the estimation of the other parameters in the water balance equation). Each plot was designed to measure runoff as described previously (Nyhan et al. 1984).

The plots with the conventional landfill cover profile (Fig. Q-5) were 10 by 35 ft and consisted of 8 in. of topsoil (Hackroy sandy loam, a Lithic Aridic Haplustalf belonging to the clayey, mixed, mesic family) emplaced on top of 43 in. of crushed tuff backfill, both of which were described previously (Abeele 1984a, 1984b, 1984c; Nyhan et al. 1984). The crushed tuff backfill beneath a depth of about 39 in. in such a profile would normally contain low-level radioactive wastes in an actual waste disposal site at Los Alamos.

The plots with the improved cover design were 10 by 35 m at the surface and contained provisions for potential subsurface water management and for controlling biological intrusion by plant roots and animals (Fig. Q-6). From the surface downward, 28 in. of topsoil (Hackroy sandy loam) was emplaced over 18 in. of gravel (6.02- to 0.04-in. diam.) to provide for water storage in the topsoil of the profile and to form a capillary barrier to impede the vertical flow of water resulting from precipitation infiltrating the landfill cover. A sharp interface between the soil and gravel layers was maintained with a high conductivity (0.079 ft m/s) geotextile (600X Brand, manufactured by MIRAFI, El Toro, California) with a range in apparent opening size of 300 to 850 fm between the polypropylene yarns of the fabric. A 5% lateral slope (across the 3.05 m width of the plot) on this interface and a large difference in the saturated hydraulic conductivities of these two layers were expected to cause the downward flow of water to have a strong lateral flow component and divert soil water into the overhang (upper) drain system in this plot (Fig. Q-6). The cobble layer made up the biointrusion barrier consisted of a 91-cm-deep layer of cobble with diameters ranging from about 4 to 12 in. (Fig. Q-6). This layer, which represented the bottom of the landfill cover, was expected to minimize plant root and animal intrusion based on previous studies (Hakonson 1986). This cobble layer was underlain by 15 in. of crushed tuff backfill.

3.4 Materials Disposal Area B (SWMU Number 21-015)

MDA B (Fig. Q-7) is located on a narrow eastward trending mesa, with the south side of MDA B being approximately 100 ft from a canyon tributary to Los Alamos Canyon. More specifically MDA B is located on the south side of DP Road, approximately 1600 ft east of the intersection of DP Road and Trinity. This 6-acre area is east of the old trailer court area and west of TA-21. MDA B lies at elevations between 7200 ft (to the west) and 7100 ft (to the east) with native vegetation consisting of mainly piñon pine, one-seed juniper, scattered ponderosa pine, and blue grama.

MDA B is actually a series of pits. Chemical wastes were buried in slit trenches 90 to 35 in. deep, 24 in. wide, and of varying lengths, with other sized trenches also being used (12 ft deep, 15 ft wide, 300 ft long). Unlike the current practice of layering waste in pits, waste filled the depth and width of the pits in MDA B before they were covered by fill material. Shortly after MDA B was closed in 1947, subsidence over the pits was remedied by using the area for disposal of noncontaminated concrete and soil from construction sites. The western

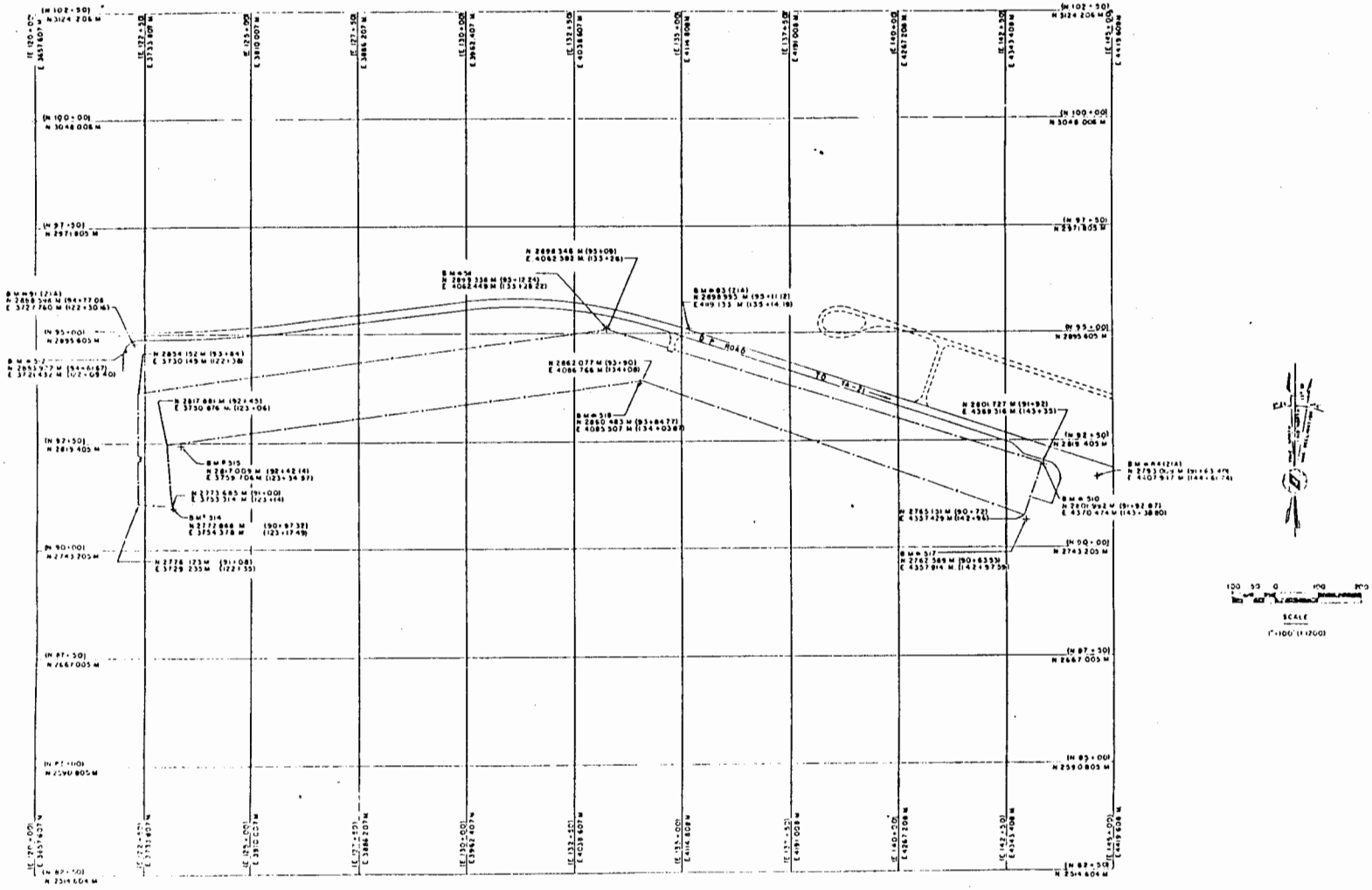


Figure Q-7. Materials Disposal Area B.

two-thirds of MDA B was covered by a layer of asphalt around 1966–1967 and is leased by Los Alamos County for storage of privately owned boats and recreational vehicles.

Approximately 90% of the contaminated wastes consisted of paper, rags, rubber gloves, glassware, and small metal apparatus placed in cardboard boxes by the waste originator and sealed with masking tape with the rest of the material consisting of metal, such as air ducts and large metal apparatus. The latter type of material was placed in wood boxes or wrapped with paper. There is also reference to large quantities of wood from temporary storage cabinets used by the Quantity Control Department, several live storage batteries, and contaminated or toxic chemicals. At least one truck contaminated with fission products from the Trinity test is buried at MDA B. The trenches also contain old bottles of organics, perchlorates, ethers, and other organic materials. The contamination of materials in these pits consists of all types of radioactive materials used at the Laboratory. Some of the known radioactive wastes include plutonium, uranium, americium, cerium, (radioactive Lanthanum), actinium, and other waste products.

Between 1947 and 1982 considerable plant succession occurred on the unpaved portion of MDA B, resulting in plant cover consisting of trees, grasses, and shrubs. The surface of the eastern portion of MDA B was thus extensively renovated in 1982 and replanted in 1984. Preexisting vegetation was removed in 1982 and a new landfill cover emplaced, a portion of which contained a gravel-cobble biointrusion barrier.

In addition to its age, MDA B is distinguished by having been the object of more detailed post-closure studies over the past 35 years than any other site. It is further distinct in that as a result of past and recent remedial actions, it presents the widest range of closure treatments of any of the Laboratory MDA, ranging from an asphalt covering of the western two-thirds of the site applied in 1966 to the recent (1982) resurfacing of the exposed area with crushed tuff and a small section of cobble-gravel biobarrier. Over the past 10 years a continuing series of ecosystem investigations have been conducted at MDA B. Several specific experiments have been emplaced at the site supported by the National Low-Level Waste Management Program and the Environmental Protection Agency Land Pollution Control Division, Contaminant Branch. A common theme in all these studies is the development of a deeper understanding of ecosystem processes affecting the containment of hazardous and radioactive materials disposed in near surface soil horizons and covered by a variety of landfill cover treatments.

In 1987, the surface demonstration studies at MDA B were modified to focus on the tradeoff between erosion control measures and the need to minimize seepage of water below the trench cap. The pilot studies at MDA B were modified to demonstrate the interactive effects of surface mulches, vegetative cover, and soil profile design on site water balance. Twelve plots were installed on the site, four on each of the east, central, and west areas (Fig. Q-8). The plot configuration was consistent with previous studies at the Laboratory in order to utilize existing data bases and models during the analysis and subsequent design phases of the overall demonstration project. Each plot (10 x 36 ft) was oriented with the long axis parallel to the slope of the site and was bordered to prevent overland flow of runoff entering the plot from upslope. A collection system was installed for each plot to monitor total runoff after precipitation events and to allow sampling or collection of transported sediments. Each plot had three access tubes installed for the measurement of soil moisture using a neutron moisture probe. On each soil profile, two plots had a

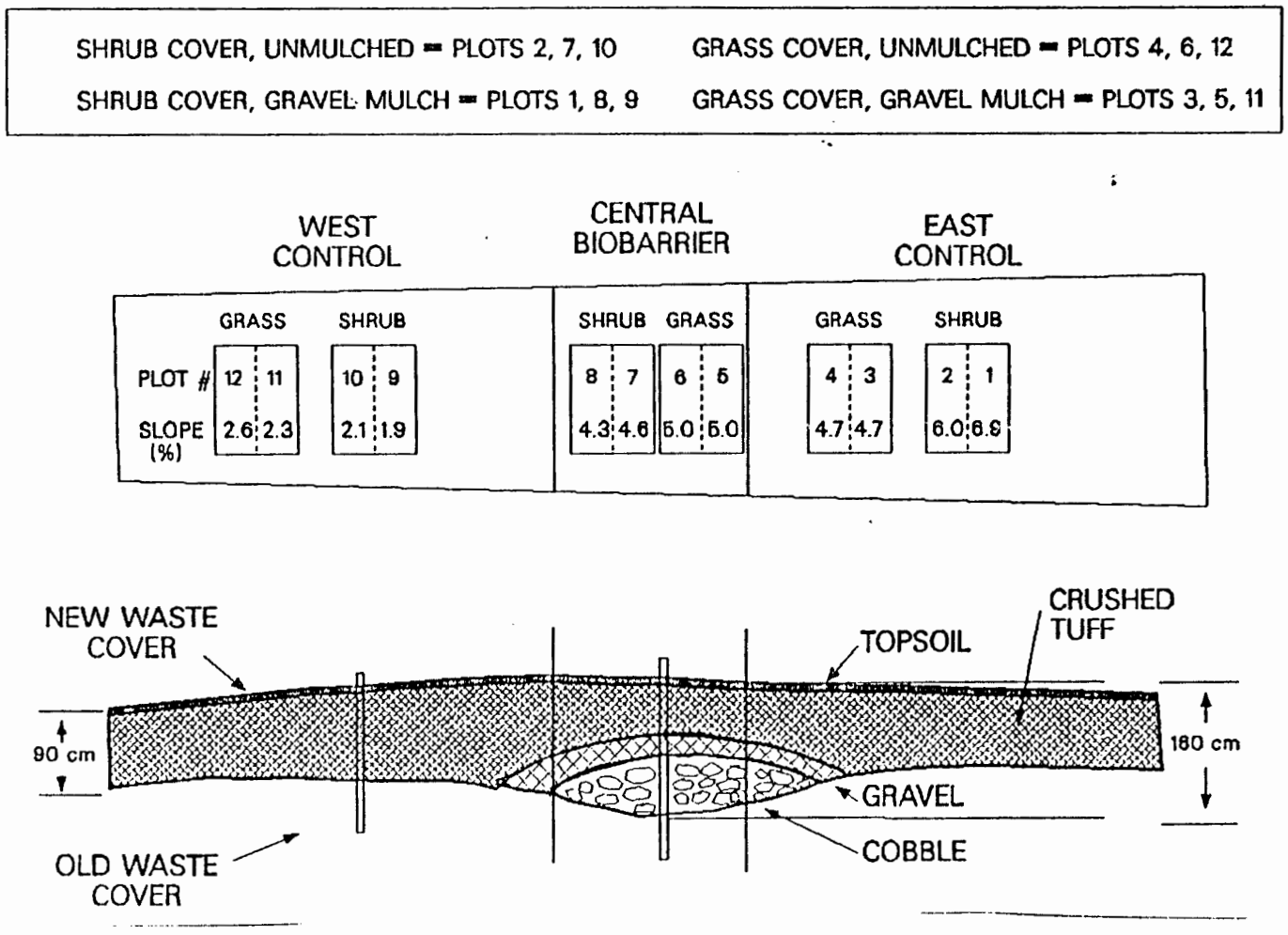


Figure Q-8. Area B plan layout and cross-section.

vegetative cover of shrubs (rubber rabbitbrush, Chrysothamnus nauseosus) and two a cover of mixed grasses and forbs. One plot from each pair with the same plant cover was assigned a surface gravel mulch treatment which was applied at 13 kg/m^2. Vegetative canopy cover and ground cover (gravel, litter, and plant crowns) was measured periodically during the growing season.

By 1990, when the Pilot Studies Project of the ER Program was initiated, the MDA B Cover Demonstration Study was already providing an invaluable data base for modeling and site design.

3.5 Long-Term Woodland Pilot Study

The purpose of the Mesita del Buey Piñon-Juniper Woodland study is to provide a base site for all woodland studies at the Laboratory that address the issue of long-term post-maintenance site integrity. The site was established in November 1987. A 330 x 20 ft transect was laid out in a vigorous stand of piñon-juniper woodland between the office building at TA-51 and the EETF.

The major waste disposal area at Los Alamos (MDA G) is located close by in this woodland community type. Other sites (e.g., MDA B) are also in the same vegetative zone. In the post-maintenance period, natural succession at these MDAs will most likely result in woodland vegetation on closed sites. Ecosystem function of woodland areas must be studied if we are to predict the effects of natural vegetation on site hydrology or surface integrity.

Ongoing projects at the site in the last 2 years have focused on measuring some water balance components (precipitation, soil water storage, canopy interception, and evapotranspiration rates). Access tubes for measuring soil moisture with a neutron moisture probe (down to 10 ft depth) were installed about every 33 m. Soil moisture is measured every 2 weeks. Additional studies of primary productivity and population dynamics are under way by University collaborators.

The vegetative features of the site were mapped (Fig. Q-9). Notice that the piñon seedlings are clustered under the canopies of the mature trees, both piñon and juniper. Piñon dominates the site; shrubs are mountain mahogany and shrub oak; subshrubs include yucca, prickly pear, and sagebrush species. Common grasses include blue grama, mountain muhly, and muttongrass. These plant species are typical of local piñon-juniper communities.

4.0 PILOT STUDIES

The pilot-scale studies performed by the EES-15 will provide data to support the remedial alternative of capping MDAs and leaving the wastes in place. The overall objective is to demonstrate that capping is cost-effective and protection of human health and the environment.

4.1 Approaches for Remediating Contaminated Soils

Because protective barriers currently have such a high probability of success at such a low cost relative to the other candidate technologies, we have chosen to evaluate protective barriers in our pilot-scale field tests.

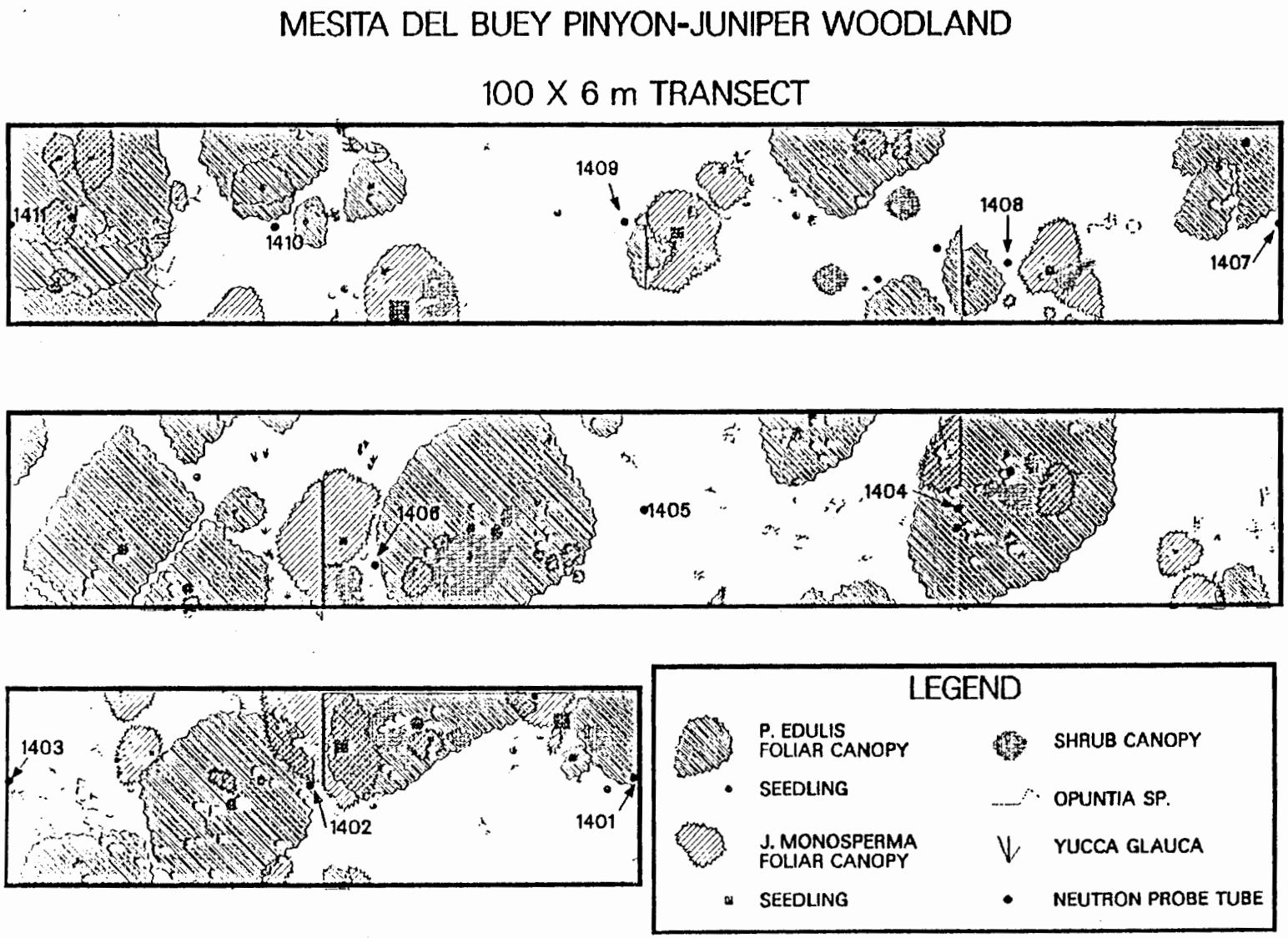


Figure Q-9. Piñon-juniper transect at EETF.

Protective barriers are constructed of naturally occurring material for long-term isolation of waste sites. The movement of contaminants from the unsaturated zone is most often driven by natural precipitation and recharge. Interdiction of recharge by protective barriers can reduce the amount of recharge reaching a waste source and reduce the amount of contamination that is mobilized. Barrier technologies offer a significant economic incentive compared to exhumation and treatment by permitting some types of wastes to remain in place. A considerable portion of the ER budget could potentially be saved by being able to safely dispose of wastes in place. Potential restrictions and uncertainties of the technology include unstable waste sites and underground voids, erosion and removal of barriers by fluvial processes, and long-term barrier performance.

Protective barriers are usually multilayer cover systems used over or around waste units. The protective barrier usually incorporates some form of outer matrix to prevent plant and animal intrusions into the underlying wastes and to reduce erosion of the landfill cover. The barrier usually contains a vegetative cover which functions to reduce soil erosion and to recycle precipitation back into the environment via plant transpiration.

To achieve these objectives, we propose to use both modeling studies and field demonstrations in an integrated program designed to identify key factors that influence site integrity and then to resolve how to manage these factors and implement site-specific designs (see generic flow chart in Fig. Q-10).

These key factors are most likely to be the composition (porosity, unsaturated and saturated hydraulic conductivities) and geometry (depths, slopes, lengths) of soil profile layers, the slope-length and condition of the soil surface (mulched or bare soil), and the characteristics of the vegetation (biomass, seasonality of activity or phenology, structure of the canopy, soil surface covering ability of the plant base). Other factors may emerge as significant during the early part of the program.

If there is insufficient data on these factors or on effects of interactions between them, particularly for local conditions, then specific pilot-scale studies will be initiated. Based on our current understanding of the data needs, fundamentally important studies on site hydrology and long-term system function will be initiated at TA-51, MDA G and MDA F. These studies will be combined with field tests of the EPA cover design and the conventional cover design and will build on our experience at MDA B and the EETF at TA-51. Additional smaller field studies may be incorporated into the long-term study sites as details emerge in the course of the program. For example, two such short-term studies may involve investigating surface stabilization using soil crust organisms and identifying microenvironmental factors that inhibit animal intrusion.

The modeling utilized to identify data needs and prioritize factors will be expanded into a program of evaluating existing hydrologic and ecosystem models and calibrating them to local environmental conditions. A limited program of model development may be initiated as a result of the testing procedure. As already outlined, the modeling program will assist in the design of certain aspects of the field-scale pilot studies as the program progresses. Finally, both the modeling program and the data bases obtained from the field-scale pilot studies will be utilized to develop a generic methodology for site closure at Los Alamos (Fig. Q-10).

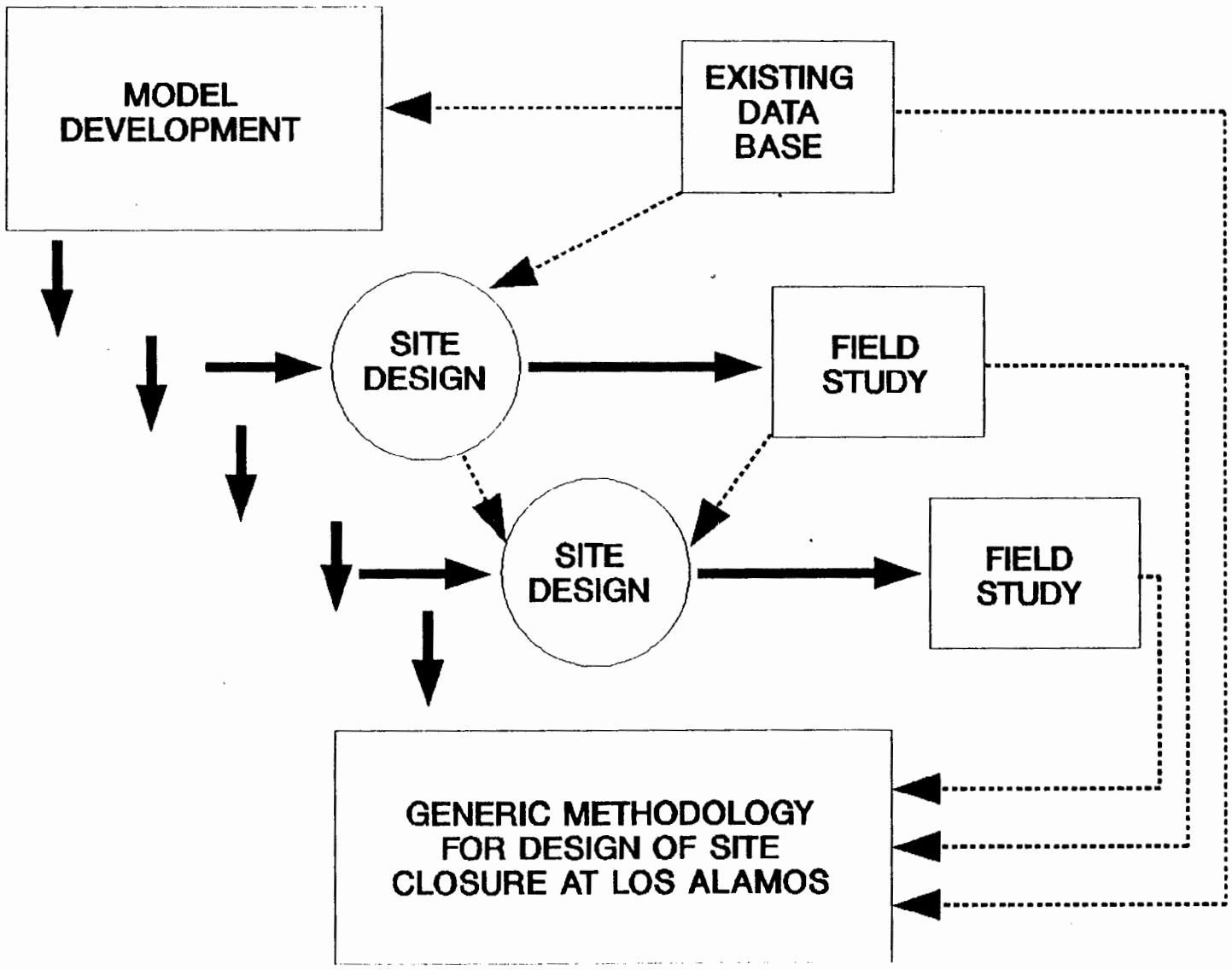


Figure Q-10. Conceptual organization of modeling and field studies for developing a generic site closure methodology.

4.2 Technical Objectives

Water balance components of the various shallow land burial scenarios described above will be determined as a function of time. If we restrict our attention to net rates and amounts and consider one-dimensional movement of water in the soil profile, the following equation can be used to represent a simplified water balance:

$$S = P - Q - ET - I - L \qquad (1)$$

where S = change in soil water storage, P = precipitation, Q = runoff, ET = evapotranspiration, I = interflow, and L = seepage or percolation.

The seepage term (L) is a measure of the total precipitation that makes it through the entire landfill cover and into the underlying wastes. The interflow term (I) involves the subsurface soil water that is diverted horizontally in the protective barrier and is not allowed to penetrate through the landfill cover, as with L.

Thus, the technical objectives of the field testing of SLB designs (left side of Fig. Q-2) and the long-term natural vegetation studies (right side of Fig. Q-2) can be listed as

1. Measure water balance components to spatial and temporal variabilities in the integrity of closure designs.

2. Measure water balance components to evaluate long-term dynamics in natural systems.

3. Measure successional trends in vegetation soils, soil organisms, burrowing fauna at Los Alamos sites.

4. Develop standardized cost-effective field methods for monitoring pilot studies and selecting *in-situ* stabilization.

The results of the field tests will be used to calibrate water balance and other hydrologic models, which in turn will be used in the generic design methodology for site closure (Figs. Q-10 and Q-2). These models will include hydrologic models such as CREAMS, SPUR, WEPP and RUSLE, as well as more sophisticated models currently under development dealing with two-dimensional and three-

dimensional unsaturated soil water transport. Currently, none of these models have been field calibrated (including the EPA HELP model), with the exception of our preliminary CREAMS studies at the ITP Demonstration (Nyhan 1990). Thus, the technical objectives of the modeling studies can be listed as

1. Identification of models for hydrologic simulation of closure designs.
2. Sensitivity analysis to identify key factors contributing to integrity.
3. Calibration of models to the Laboratory environmental conditions at MDAs G, B, and F.

4. Prediction of closure design performance.

The relevance of understanding water balance modeling results to design and remediate waste sites was previously discussed (Hakonson, et al. 1982a, 1987; Lane 1984; Nyhan and Lane 1986a, 1982). Because the various components of the water balance equation are coupled, control of any one component can be obtained by modifying one or more of the other components. For example, if we wish to eliminate seepage, or the L term, then, theoretically, we can increase runoff and/or evapotranspiration to the level where the seepage team is forced to zero. Although the concept appears simple, achieving control of one or more of the water balance components requires a good understanding of the very complex relationships and feedback mechanisms that comprise the water balance. The use of water balance models to design and to remediate landfills (Nyhan et al. 1989) offers the following advantages:

- It accounts for many of the climatological, hydrological, and biological factors that influence waste site integrity;
- Water balance models can be used to screen various designs for effects on erosion and percolation; and
- It can be used to estimate upper boundary conditions for subsurface water flow,important in estimating leachate production and contaminant transport to groundwater.

Our overall technology development objectives can thus be summarized as

1. Evaluation of performance and of prediction of performance at each stage.
2. Development of generic methodology for modeling closure design.
3. Development of generic methodology for incorporating site-specific data into closure design.
4. Development of conceptual models of managing successional trends that can be used to modify designs at Los Alamos.
5. Development of generic methodology for defining long-term maintenance and monitoring needs.

5.0 FIELD INSTALLATIONS AND SAMPLING PLANS

Water balance components of the various shallow-land-burial scenarios and the natural systems transects described above will be determined as a function of time. This section describes the field demonstrations in which this will be accomplished (Sections 5.1 and 5.2) and the specific sampling plans to be used (Section 5.3).

5.1 Protective Barrier Site Installations

In general, field plots (10 x 35 ft) for examining water balance in SLB scenarios will be installed using procedures that have become standardized over many experiments and demonstrations at Los Alamos. The ITP Demonstration serves as a model system for measuring all water balance components except evapotranspiration.

Plots will be constructed with impermeable walls and footing and with drainage and collection systems for both laterally and vertically transported moisture. A surface system of plot borders and gutters will allow collection of surface runoff. Each plot will be instrumented with neutron probe access tubes and/or time domain reflectrometry (TDR) probes for measurement of soil moisture.

Brief descriptions of installations at each site follow.

5.1.1 Material Disposal Area B

The pilot study at MDA B will be documented in detail in the TA-21 Work Plan. Briefly, twelve study plots (10 x 35 ft) were installed in 1987 on an inactive waste site having two different soil profiles in the trench cap. Four surface treatments, grass/gravel mulch, grass/no mulch, shrub/gravel mulch, and shrub/no mulch, were used on plots at each of three locations on the site. Since 1987, soil moisture, runoff, precipitation, and surface conditions have been monitored. Sediment transport was monitored in 1987–1989 on some or all of the plots.

Preliminary results show that the presence of a gravel mulch reduces runoff and sediment transport and enhances evapotranspiration caused by the increased biomass that results from increased infiltration of water. Shrub plots tend to have a drier soil profile than the grass plots, resulting in greater storage capacity for soil moisture during spring snowmelt.

The pilot study at MDA B will be upgraded and extended in FY91-FY95, with specific objectives as outlined in the TA-21 Work Plan. Upgrades at the site definitely include automating measurement of runoff volume and possibly sediment transport if a suitable instrument system exists for small-plot application.

Monitoring of the site will continue to 1995 to provide a long-term data base of responses to local climatic variability.

5.1.1.1 ITP Demonstration

Detailed information on the specific test conditions, soil types, plant cover, and plot designs was given in Section 2.3. Generally, the ITP Demonstration can be used as background information for MDA G, since the soil types, tuff backfill, plant cover, and natural precipitation input are similar to those found at this disposal site. However, in the ITP Demonstration, the surfaces of the field plots are essentially flat, so there is never any runoff generated in these plots. Considering the water balance equation presented in Section 4.3, this means that the seepage term is maximized with added natural precipitation.

5.1.1.2 Pilot-Scale Studies of Protective Barrier Performance in the Experimental Engineered Test Facility

The eight field plots to be emplaced adjacent to the ITP Demonstration in FY91 (at the capillary/hydraulic barrier test site) will be used to evaluate water balance relationships under conditions where artificial precipitation is added to the plots. One set of the field plots will receive a 100-year simulated precipitation event, followed by an addition of water designed to make the capillary or hydraulic barrier (in the protective barrier) fail. The other set of field plots will receive only natural precipitation. The local soils, sand, clay, and local tuff backfill layers, in these plots will be the same as those that will be used in the pilot-scale studies at MDAs G and F. All of these plots will be devoid of vegetation and, thus, will represent a worst possible case: minimal evapotranspiration, maximum interflow, and seepage production.

Under these conditions, these plots will contain profile configurations with protective barrier thickness, slope, and profile components (hydraulic barriers or capillary barriers) as variables. The exact variable values will be determined in FY91 by using literature reviews, evaluating hydrologic models and obtaining field performance data for these scenarios.

In FY92 these same plots will be used to determine the interaction between evapotranspiration and capillary/hydraulic barrier dynamics. The hydraulic field testing performed in FY91 will essentially leave four of the plots very wet (with the additions of artificial precipitation) and four plots considerably drier (with only additions of natural precipitation). In FY92 two "very wet" field plots and two "dry" field plots will receive a plant cover consisting of dominant local plant species (to be determined, but may consist of piñons, rabbitbrush, and a mixture of range grasses). The other four field plots will be maintained without a plant cover. The long-term data from these two types of field plots will allow us to determine

- If evapotranspiration can reduce the stress on the capillary/hydraulic barrier, thus improving protective barrier performance;
- If plant roots have an appreciable effect on capillary/hydraulic barrier integrity; and
- If the initial water content of the landfill has any effect on the interaction between plant cover and capillary/hydraulic barrier performance.

5.1.2 Materials Disposal Areas F and G

The pilot-scale demonstration studies at the four field plots at the control areas in each disposal area will help to evaluate water balance relationships as a function of time (FY93 through the life of the task) with natural precipitation as the input term (remember that the magnitude of this term varies between these two areas). The soil types, slope, and profile components will be the best performing designs tested at the EETF (see subsection on barrier testing above). Plant cover will be a variable in these field studies and will be chosen to match plant species know to be native to each location and contained in the long-term woodland transects at each MDA. This will result in ponderosa pines and native grasses at MDA F and piñons and native grasses at MDA G.

Thus, every variable in the water balance equation will be tested for each of these four landfill cover designs adjacent to each disposal area, with individual component testing and long-term testing being performed in the other portions of the overall pilot-scale study.

5.2 Natural Systems Site Installation

The long-term natural systems pilot studies at the EETF and MDA F will evaluate water balance relationships over time in a natural ecosystem. The piñon-juniper transect at the EETF will be improved in FY91 with the addition of a data acquisition system, which will be used to measure water balance parameters. The natural vegetation transect at MDA F will be emplaced and instrumented in FY91. Modeling studies will incorporate the effects of above-ground processes on site hydrology and site stability. Specific goals for the long-term pilot study over the next 5 years are the following:

1. Complete the water balance studies at the sites by installing means to measure runoff, infiltration, and lateral flow over selected portions of the site. Continue measurement of ET and soil water storage.

2. Complete the integrated ecosystem studies of productivity and evapotranspiration using both field and modeling studies. Apply the models to remediated sites as an estimate of long-term effects.

Measurement of runoff and infiltration will take place in two or more subplots at each site. The subplots will be bordered with gutters to isolate overland flow generated on the subplot, with installation of an endplate and gutter system for collection of runoff on the down slope end. Flexible-membrane impermeable walls will be installed down to bedrock. Suction candles and time domain reflectometry (TDR) probes will be installed horizontally into the exposed soil profiles before wall installation. Characteristics of lateral flow in the system will be evaluated by comparing up- and down-slope soil moisture characteristics over time, both within and outside the subplot. Excess soil moisture buildings (considered to be unlikely) will be removed as necessary using the suction candles.

5.3 Sampling Plan

The sampling plan and analytical methods are presented in this section for each component of the water balance equation and for surface characteristics, since these are the parameters to be determined as a function of time. Several documents are applicable to these demonstration studies in terms of detailed procedures documents (Lopez 1990), quality assurance plans (Essington 1989, Olsen and Dewart 1990), and additional manuals and sampling processing procedures (Lopez 1990); these are addressed in more detail in the following section on site operations and quality assurance.

5.3.1 Precipitation

A continuous record of the precipitation occurring at the EETF (for the ITP Demonstration, the Pilot-Scale Studies, and the natural Piñon-Juniper transect) is measured between the two central

plots using a tipping bucket rain gauge (with a heater and wind-screen to measure precipitation as snowfall) and a long-term event recorder (Weathermeasure Corp., Sacramento, California). The event recorder and battery power source are housed inside a data acquisition trailer.

The Air Quality and Meteorology section of the Laboratory's Environmental Protection Group (HSE-8) maintains a meteorological tower at MDA G (Olsen and Dewart 1990), which is currently used as a backup to the precipitation gauge at the EETF. Besides precipitation data, additional data will be collected at this tower that will be helpful in hydrologic modeling: solar radiation, temperature, wind velocity, relative humidity, and vertical wind velocity. This tower will be decommissioned in early 1991 and another tower emplaced about 2 mi east of the disposal area at that time. This means that precipitation measurements will have to be collected adjacent to our field plots within the disposal area and correlated with the new tower data in 1991.

A meteorological tower (Olsen and Dewart 1990) was removed from TA-50 in April 1989 and emplaced at TA-6, only about 2000 ft east of MDA F. Besides precipitation, several other parameters will be measured: wind speed, temperature, solar radiation, relative humidity, vertical wind speed, soil temperature, soil heat flux, dew point, and sensible and latent heat flux.

5.3.2 Seepage/Interflow Production

When seepage production occurs in the ITP Demonstration, the flow rate is determined using a graduate cylinder and a stopwatch several times a day. The total volume of leachate produced is collected to crosscheck the estimates based on flow rate extrapolated over time. This system will be upgraded to include a tipping bucket event recorder (for each of the four field plots) attached to a data acquisition system.

The pilot-scale studies of protective barrier performance done at the EETF and the pilot-scale demonstration tests at MDAs G and F will all involve collecting interflow and leachate from several subsurface locations along the barrier length within each plot. This seepage production will be collected in a series of large metal pans located at the bottom of the landfill profile being tested and will then flow through below ground plumbing and a tipping bucket gauge, which will interface with a data acquisition system. Interflow will be measured using the same technique, and total flow per sampling period will also be determined by collecting and measuring all of the water after it flows through the tipping bucket.

5.3.3 Runoff

Runoff will be determined on the pilot-scale studies of protective barrier performance (performed at the EETF and on the pilot-scale demonstrations at MDAs G and F. Runoff from each field-plot surface area will be collected and measured with techniques similar to those used for determining seepage/interflow production.

The concentration of soil in each runoff event will be determined, if the funding levels for this program are adequate, by mixing a representative fraction of each runoff event and determining the sediment concentration gravimetrically. The soil loss rate can then be determined for each runoff event.

5.3.4 Change in Soil Water Storage

Soil water storage will be determined using neutron moisture gauges and TDR. The neutron moisture gauge readings will be collected once a week at sampling locations throughout each profile at 8-in. depth increments. Neutron moisture gauge access tubes will be emplaced at a sampling density of about one per 55 ft^2 of field plot area.

The TDF readings will be collected where more of a point estimate of soil water content is required than can be obtained from the neutron moisture gauge. In this procedure, 6- and 12-in. probes will be used to determine soil water status, normally determined weekly. With this technique both the pilot-scale studies of protective barrier performance and the studies in the natural piñon-juniper transect at the EETF will require measurements collected several times a day at a sampling density of up to 1 assay per square meter.

5.3.5 Evapotranspiration

On field plots instrumented for leachate collection, all of the other parameters in the water balance equation will have been directly determined, and evapotranspiration will be determined by difference. Thus, the sampling frequency and density are similar to those for the change in soil water storage.

Evapotranspiration will also be measured on vegetated sites using sap-flow gauges on selected individual trees or bushes that are representative of the entire community (as shown by characterization studies in section F). This technology, recently developed, is currently being tested at the woodland study site by an off-site collaborator. The technique shows great promise for reliable, automatic data collection. It will be calibrated to other accepted (more labor-intensive) methods such as leaf porometry or mini-lysimter studies at each site on each species as appropriate.

5.3.6 Surface Characterization

Quantification of vegetative and soil surface properties on vegetated test plots and natural area plots is critically important to evaluate both short- and long-term site stability. Current studies at MDA B have shown the importance of vegetation and soil mulches in preventing erosion and maximizing evapotranspiration. Significant changes in surface characteristics at MDA B have been noted from year to year and are correlated with changes in water balance components. Documenting surface dynamics, particularly over time closure, is thus an important task. Variables to be measured or estimated will include (1) soil coverage by class of material (rock, litter, crytogams, grass/forb crowns, perennial stem bases); (2) soil coverage by plant canopy at different height classes (grass, shrub, tree),;(3) vegetative leaf area index by growth form (grass, forb, shrub, tree) and/or species (shrubs and trees); (4) vegetative biomass by growth form and as species; and (5) microtopography of soil surface.

These variables will be measured frequently (every 2 months) at selected sites until the seasonal dynamics are established. After that, annual or biannual measurements will suffice.

Photographic or high-resolution still-video documentation will primarily be used, with computer-assisted quantitive analysis. We sponsored a post-doctoral fellow (Dr. Paul Rich) in 1987 and 1988 to develop this area of measurement technology for us. We also have collaborators at UNM who are experts in this field. This methodology, backed up by periodic calibration exercises using harvesting or point measurement techniques, is the most reliable and has the best documentation possibilities for quality assurance/quality control (QA/QC) purposes.

6.0 SITE OPERATIONS AND QUALITY ASSURANCE

During FY91, a detailed procedure (DP) manual of site operations and data QA will be prepared. This manual will consist of detailed standardized procedures generic to all the pilot study field sites, followed by procedures specific to each site. A detailed manual for the MDA B pilot study is currently being developed as part of the TA-21 Work Plan. This document will serve as the model for the overall Pilot Studies DP/QA manual. All QA procedures will be consistent with the ER Quality Program (Annex II).

A preliminary draft of the contents of the manual is given in Table Q-1. The manual is intended to be an ongoing record of DP and QA guidelines that is kept current and used by project personnel. As such, it will include health and safety guidelines, support services, narrative descriptions of field and data management procedures, as well as extensive appendices of checklists that can be copied and taken to the field to guide operations.

7.0 DATA REDUCTION AND MANAGEMENT

Most of the testing procedures discussed in the previous section have already been well documented; EES-15 has been performing similar field testing since 1979. Many photographs were taken during the field test's installation to help answer questions which come up long after the field test is installed. Most of these photographs should be taken with a camera equipped with a data back, which has the capability of immediately entering the date on the photograph.

Field notes on parameters such as runoff will be collected in waterproof field notebooks, which can withstand being rained on, snowed on, and dropped into a runoff collection tank. After each precipitation event the total runoff is determined and recorded (Lopez 1990). The runoff gutters, pipes, and flumes are then rinsed with clean water or runoff sample to get residual sediment into the tank. If clean water is used, the amount of rinse water used will be recorded. Samples of runoff will be collected for determination of sediment transport. Standardized procedures are well established and will be documented in a detailed descriptive procedures manual for each site.

Multislot divisors are installed on all plots that are the most likely to exceed the volume of the first tank. These divisors direct only a fraction of the overflow volume into the second holding tank and discard the remaining volume. Other plots have a single holding tank with no divisors.

The runoff samples are taken back to the lab, where they are first weighed and recorded into a Lotus spreadsheet file. The samples are then placed in a forced-air oven at approximately 105 degrees centigrade. It usually takes 2 to 4 days for all the water to evaporate. The samples are determined to be dry when their dry weight stabilizes. When the samples are dry, they are removed

from the oven and then allowed to cool to room temperature. The samples are reweighed and recorded into a spreadsheet file using the same procedures as described above. The sample containers are not reused, instead they are stored for future reference as a backup to the data base.

A summary of each event where runoff is collected is compiled and incorporated into a spreadsheet file. This file contains the volumes (L) collected from the stock tanks and the overflow tanks, the identification number of sample containers and types of samples, and the total runoff.

All three files are used in the statistical program, SAS, to compile data on erosion rates, sediment concentration, and soil loss. The SAS program uses print files instead of the worksheet files, so these files must be produced in addition to the worksheet files. This is done using LOTUS 1-2-3 after the worksheet files are finished. Hard copies of all files are also produced to keep a record of the files. In addition, back-up disk files are made of all files.

Soil moisture measurements are collected at each sampling location using a Campbell Pacific neutron probe, which has the capability of storing the raw count data collected in the field (Lopez 1990). Part of this raw data includes the sampling location and date. This raw data is then imported to an IBM-PC and SAS is used to convert the raw data to volumetric water content data and to calculate average soil water content values for several similar data files across several weekly sampling periods.

Precipitation, interflow, and seepage raw data will be stored in a data acquisition system in the field. The raw data in this case will be the number of tips per time interval, as well as the time and sampling location. The raw data will be imported to a laptop computer which will export this data on a hard disk. The raw data on the hard disk is then brought back to the laboratory and imported to LOTUS on an IBM PC. LOTUS is used to calculate the final data in terms of centimeters of water produced per unit time over the drainage area.

The final estimates of all the parameters in the water balance equation are determined using SAS and several other FORTRAN programs. This information is then usually plotted in more detail using other graphic software programs, which generate publication-quality graphs of the final data.

All records, including data, will be incorporated into the Records Management data base (Annex IV).

8.0 FINAL DATA ANALYSIS AND INTERPRETATION WITH AN EVALUATION OF TECHNOLOGY

The neutron moisture gauge data will be used along with measurements of runoff, leachate and interflow production, and precipitation to estimate evapotranspiration by difference and to calculate water budgets for each plot.

The most practical comparisons between the two ITP types of landfill cover designs for a semiarid region, in terms of their usefulness to the burial site operator, should be the overall performance comparison of the hydrologic parameters of the water balance estimates over the 3-year duration of the experiment. There was enhanced evapotranspiration on the improved plots over that observed

on the control plots, due to both capillary barrier dynamics in retarding vertical water movement in the profile, and to enhanced biomass on the improved plots (Nyhan 1990). About 88% of the precipitation received was lost to evapotranspiration on the control plots, whereas about 96% of the precipitation received by the improved plots was removed from the landfill cover via evapotranspiration. These types of information are typical of what will be determined for the field demonstrations adjacent to the disposal areas and the natural vegetation plots.

In hydraulic barrier plots to be installed at the EETF, various slopes, slope lengths, and soil hydraulic properties will be varied to quantify their influence on reducing seepage and enhancing interflow. Thus, one measure of the overall efficiency of the two landfill cover designs is simply differences in the amount of leachate that penetrates the cover. Since more of this difference in leachate production occurred in a record snowmelt season, it is our opinion that an even greater difference in leachate production would have occurred between the two designs given a more average annual precipitation input. The capillary barrier in the improved design can potentially greatly reduce leachate production in the typical year and can reduce the time period during which leachate is produced in the extremely wet year by over half. This would especially be true if the surface of the improved design had a surface slope of 5 to 10% as will occur in the new field plots to be installed in FY91 (compared with the 0.5% slope at the surface of the improved plot design), which would therefore result in increased runoff and decreased infiltration of precipitation into the landfill cover (see Eq. [1]).

The data to be collected in the pilot study field tests will be used to field calibrate a simple, one-dimensional model (CREAMS) without extensive input parameters (Nyhan 1990). For the first time (with the exception of the preliminary calibration on the ITP plots, performed with only 3 years of field data), direct measures of all of the water balance components will exist from this study and can be compared with model-simulated values, instead of just comparing observed and predicted soil water content values to evaluate the success of the hydrologic simulation. Ultimately, we will validate a multidimensional finite element model that takes into account soil, plant, and climatic variability from data collected in the field tests in addition to the ITP Demonstration. Such models can be used to optimize configurations of specific landfill cover materials, such as the thickness of the cover. Using this approach, landfill closure designs can be further evaluated for 20 to 50 years of meteorological conditions to encompass the average and to record wet years, so that the effectiveness of the landfill covers can be assessed. The cost effectiveness and practicality of various designs will be evaluated with the help of our site operator, who will have a major input into the selection of a final closure design for low-level radioactive and hazardous waste sites.

9.0 HEALTH AND SAFETY

Each employee is required to obtain the New Employee Safety Orientation and Hazardous Communication Training which is offered by the Laboratory. In addition, all employees must adhere to our Group's requirements on safety. These requirements include reading and demonstrating that they understand all SOPs, Emergency Plans, and Field Safety Plans. All activities will comply with requirements of the ER Health and Safety Program (Annex III).

10.0 MANAGEMENT OF RESIDUALS

No waste materials will be generated as a result of pilot-scale demonstrations and testings. Basically, no simulated wastes or chemicals will be used (all the tests and demonstrations deal with the status of soil and plant water as a function of time). The new field testing will be carried out in field locations adjacent to Laboratory disposal areas (not within MDAs) so that influencing previously buried wastes is also not a concern.

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Introduction

Numerical simulation of the transport of contaminants will play a vital role in evaluating different remediation strategies and in the design of specific features of a given disposal site. Also, the collection of field data and the execution of laboratory tests can be optimized by calculations which identify the sensitivity of material properties and the impact of the geology on overall performance. The purpose of this report is to illustrate the kinds of calculations that can be performed to help evaluate the effectiveness of a particular stabilization technique in a given geologic setting. Spatial distributions of contaminants are determined for a generic remdiated site after many years of service. The utility of these calculations is in identifying possible monitoring station locations and to study the influence of natural and engineered barriers. Calculations can also help identify the potential for failure and provide insight into corrective action.

We have used realistic parameters whenever possible, however the emphasis of this report is in demonstrating the kinds of numerical solutions that can be brought to bear on this complex problem. We have resisted the temptation to relate the calculations to a specific site. The reader should understand that the capabilities of the computer codes often exceed our knowledge of the site. Boundary conditions were selected, within reasonable limits, to show the wide range of possible simulated response, and thereby emphasize the importance of defining the most realistic material properties and geologic stratigraphy. Similarly, a "real world" numerical solution would almost certainly require a three-dimensional solution. The codes utilized here are both fully operational in 3-D, but the 2-D results presented here are sufficient to illustrate their capabilities and potential usefulness.

Two scales were modeled: the near field, to a depth of a few meters in order to study the detailed flow field in the vicinity of the generic trench, and the far field, to a depth of 350 meters to study the migration of contaminants toward the groundwater table. The results of these calculations are presented and a list of specific requirements is provided so that realistic simulation of all the relevant processes can be performed.

TRACR3D is a general purpose flow and transport code (Travis and Birdsell, 1988). It simulates transient, saturated and unsaturated flow, single or two phase (air and water), in non-homogeneous isotropic or anisotropic porous media. It can also simulate the movement of solutes. A variety of transport mechanisms are utilized, including advection, diffusion, soprtion (equilibrium and reversible to irreversible, saturable and non-equilibrium), radioactive decay and decay chains. In addition, the transport of dilute, volatile organics is treated through the use of Henry's Law for the partitioning of organics between liquid and air/vapor phases. A biodegradation package is available which simulates biological (microbial) action and one or two mobile substrates under aerobic and anaerobic conditions. It solves five equations for the two substrates, oxygen, nutrient and bacteria.

The FEHMN code calculates transient, multiple-phase, non-isothermal flow of air and water (Zyvoloski et al., 1990). It is a finite-element code, thereby allowing for non-regular meshes and mixing of elements. It allows for reactive multi-component tracers in the gas and liquid phases. Several models of deformable, porous media are

available. Fully coupled stress solutions are also available. The code utilizes an adaptive solution strategy for highly efficient solutions.

Background

The first decision in a stabilization strategy is to decide if a given technique, or any technique, is appropriate for a particular site. Modeling can play an important role by establishing a systematic approach in characterizing the problem.

Decision for a Given Stabilization Strategy

There are four categories of information that must be identified before the first calculation can be performed: 1) complete time-dependent description of the contaminant source, 2) identification of all the relevant different materials, both natural and engineered, and the properties of each material, 3) the spatial distribution of each of these materials, and 4) establishment of the boundary conditions which drive the problem. All of these aspects must be addressed before the appropriateness of a given technique can be evaluated. Precise geologic data is of little value if nothing is known about precipitation rates or how the contaminant was introduced into the environment. Generally, none of the four areas can be perfectly described and often very little information can be obtained. Still, data can be compiled and qualitative judgement can be introduced to identify uncertainties.

If this approach is followed, even before the first calculation is performed, enough site-specific data (and the associated "error bars") will be available to make a reasonable estimate as to the effectiveness of a given approach. The purpose of the calculations, then, is to compare different candidate stabilization strategies to each other and to the unstabilized scenario to determine the most favorable outcome with respect to some criteria, namely the regulatory environment. If the data compilation was performed as described above, then the effect of the uncertainties can be quantitatively evaluated by a series of parameter sensitivity calculations. The numerical results can then be used directly in a formal risk analysis to identify the overall impact of the proposed strategy.

Review of Existing Cap Design Technology
(portions extracted from Nyhan et al., 1990)

The primary objective of postclosure requirements for waste repositories is to limit the exposure of the general public to radioactive and hazardous wastes for time periods ranging from 100 to 10000 years (USNRC, 1982; USEPA, 1980, 1985). Hydrologic processes historically account for most of the performance related problems (Jacobs et al., 1982b; USDOE, 1980). For example, the erosion of the landfill cover can breach the cap and expose waste to the biosphere. Water that infiltrates into the cover can accumulate within the landfill, leach wastes into the groundwater, and enhance subsidence with the landfill.

As Fig. 1 implies, the successful performance of an entire landfill is very much a function of interactive processes operating to control water balance within the landfill covers. Considering only net rates and amounts, the following equation represents a simplified one-dimensional water balance

$$\Delta S = P - Q - ET - L$$

where ΔS is the change in soil storage, P is the precipitation, Q is runoff, ET is evapotransporation and L is the seepage or percolation.

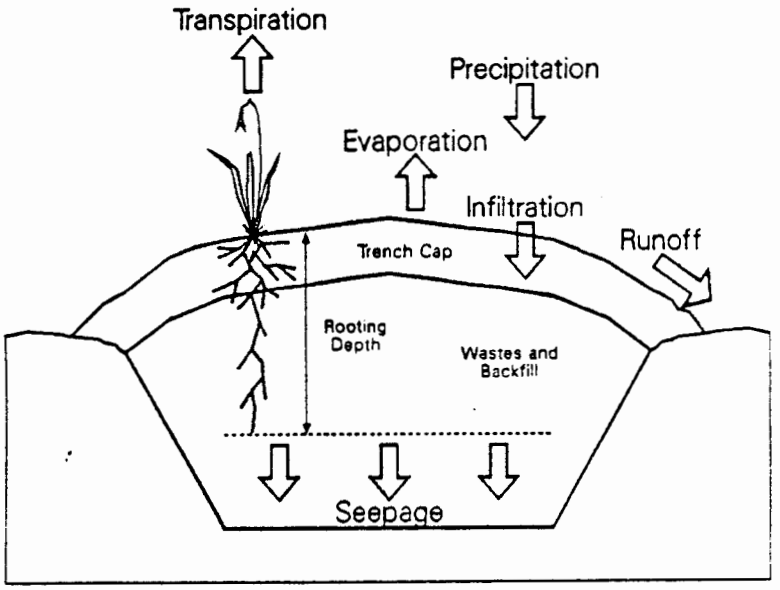

Figure 1. Hydrology of shallow land burial of waste materials (Nyhan et al., 1990)

Traditional remedial engineering solutions, which do not include analyses of these interactive landfill factors, have already led to numerous landfill failures (Hankonson, et al., 1982b). Future designs that ignore these interactive factors will certainly reproduce many of the failures of the past (Hankonson et al., 1982b, 1987; Nyhan and Lane, 1986a), and at a very high cost: landfill cover installation costs range from $400,000 up to $4,000,000 per hectare of landfill (Brandt, 1988; Cook, 1988).

Currently, adequate field data does not exist from carefully instrumented large-scale experiments on the movement of water and contaminants under unsaturated conditions to enable a site operator to define and engineer suitable barriers to prevent the migration of waste materials out of a landfill. Our approach to developing an effective landfill cover technology combined the results from individual studies at Los Alamos, NM on soil erosion (Hankonson et al., 1982; Nyahn et al., 1983a, 1984a,b; Nyhan and Lane, 1986a,b; on subsidence (Abeele, 1984a,b,c; 1985, 1986; Abeele et al., 1986; Nyhan et al., 1984a), on biointrusion barriers (Pertusa, 1980; Felthauser and McInroy, 1983, Hankonson et al., 1982a,c, 1983; Hankonson, 1986; Nyhan et al. 1984a, 1986) to design and emplace a landfill cover demonstration called the Integrated Test Plot (ITP) experiment.

In the ITP field experiments (Nyhan et al., 1990), the performance of the improved cover design in managing water and biota at the disposal site was compared for 3 years with that obtained from a more conventional design that has been widely used in

the industry. The conventional cover consisted of 20 cm of sandy loam topsoil over 108 cm of a sandy silt backfill. The improved design consists of 71 cm of topsoil over a minimum of 46 cm gravel, 91 cm of river cobble, and 38 cm of sandy silt backfill. Each plot was lined with an impermeable liner to allow for mass circulation of water dynamics. Results over a three year period, including two wet years, demonstrated that the improved design reduced percolation of water through the landfill by a factor greater than four over the conventional design. This decrease in percolation was attributed to a combination of increased evapotransporation from the plant cover and the effect of a capillary barrier embedded within the enhanced cover profile in diverting water laterally in the cover. The field data has allowed calibration of a simple water balance model at Los Alamos which has been used to improve the design of landfill covers (Nyhan, 1990).

Near Field Simulation

Figure 2a shows a low resolution finite element grid from the FEHMN code of a generic trench design, after Nyhan et al., 1989. These calculations do not rely heavily on site-specific data, which are currently sparse. Table 1 gives the assumed properties. Different material regions are illustrated in Fig. 2b.

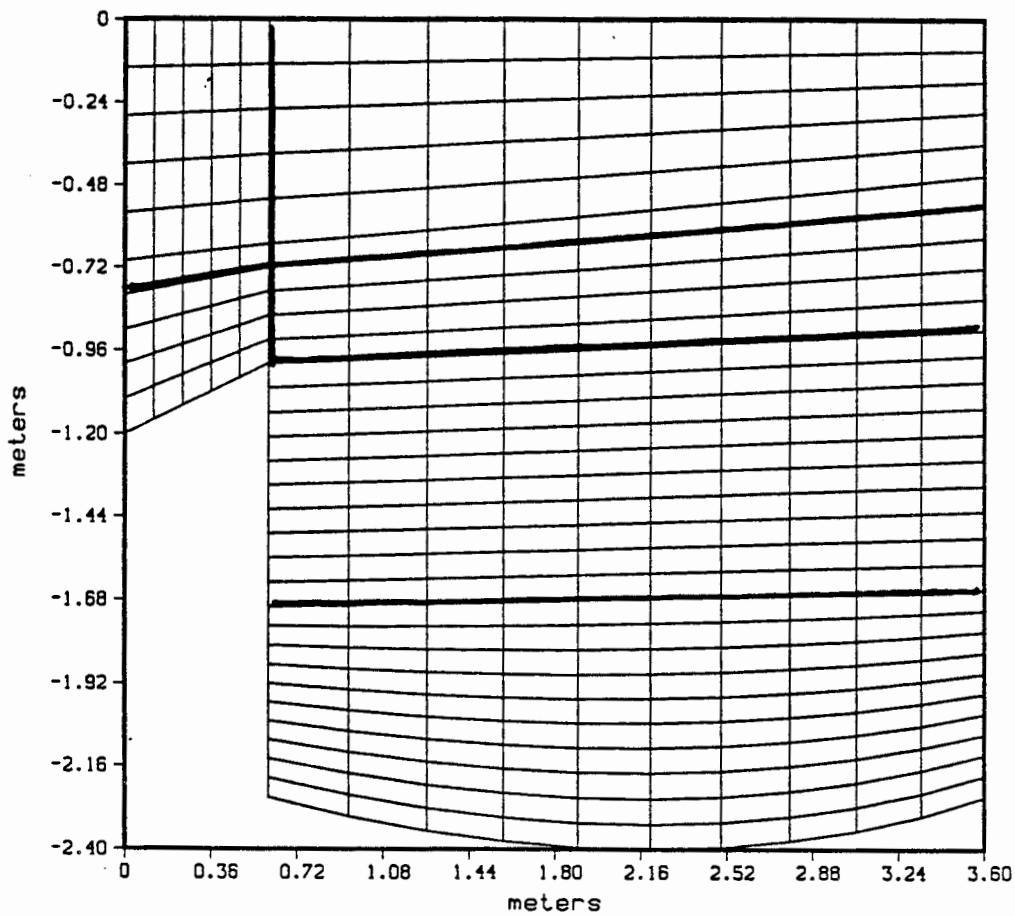

Figure 2a. Computational FEHMN mesh for the near-field trench model.

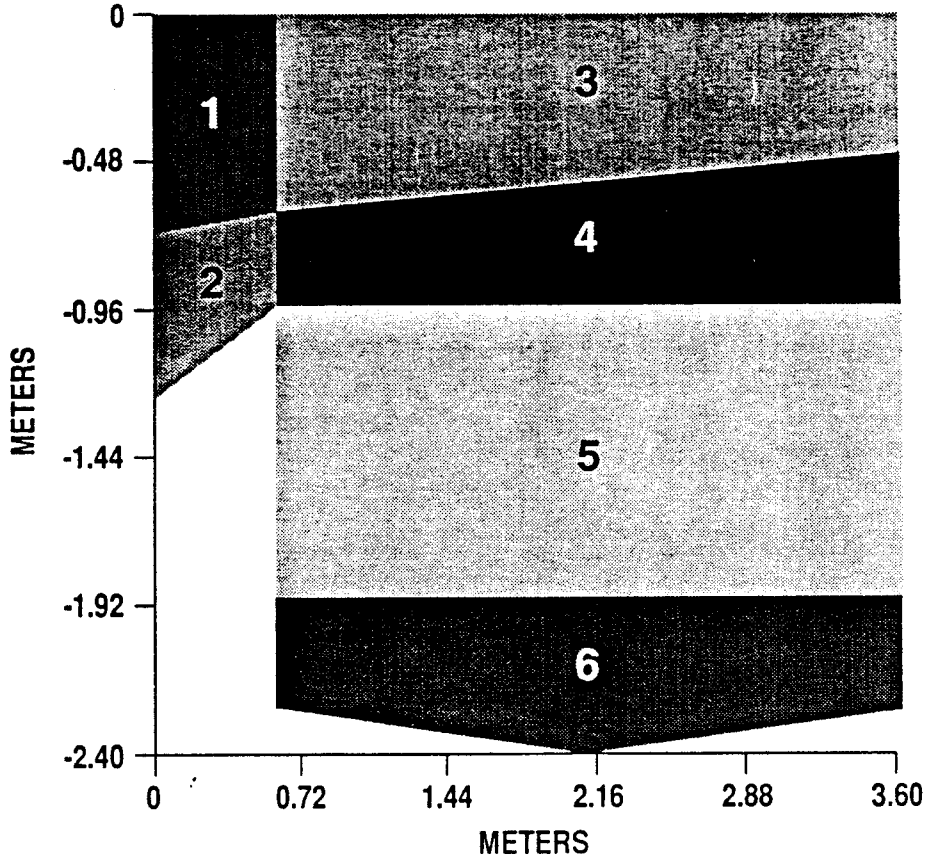

Figure 2b. Different material regions for the grid in Fig. 2a. Regions 1 and 3 are soil; 2 and 4 are gravel, 5 is cobble and region 6 is tuff.

Table 1. Material Properties for FEHMN Near-Field Trench Calculation

Material	k	R_1	Pc	ϕ
soil	10^{-14}	2	1, 1.0	0.1
gravel	10^{-11}	1	1, 0.2	0.3
cobble	10^{-10}	1	1, 0.1	0.5
tuff	10^{-11}	3	2, 1000	0.3

where
k is saturated permeability in m^2

R_1 is relative permeability:
1 - proportional to saturation
2 - Corey type
3 - van Genutchen

Pc is the capillary model, maximum suction (MPa)
1 - linear
2 - van Genutchen

ϕ is the porosity (voids volume / total volume).

Different capillary pressure and relative permeability models are used for each material. The calculation of water influx was chosen to be 1 mm per year and was distributed evenly along the top boundary. The code was first run to obtain a steady state flow field. Two years of simulated inflow were sufficient for this purpose. The steady state water saturations are shown in Fig. 3.

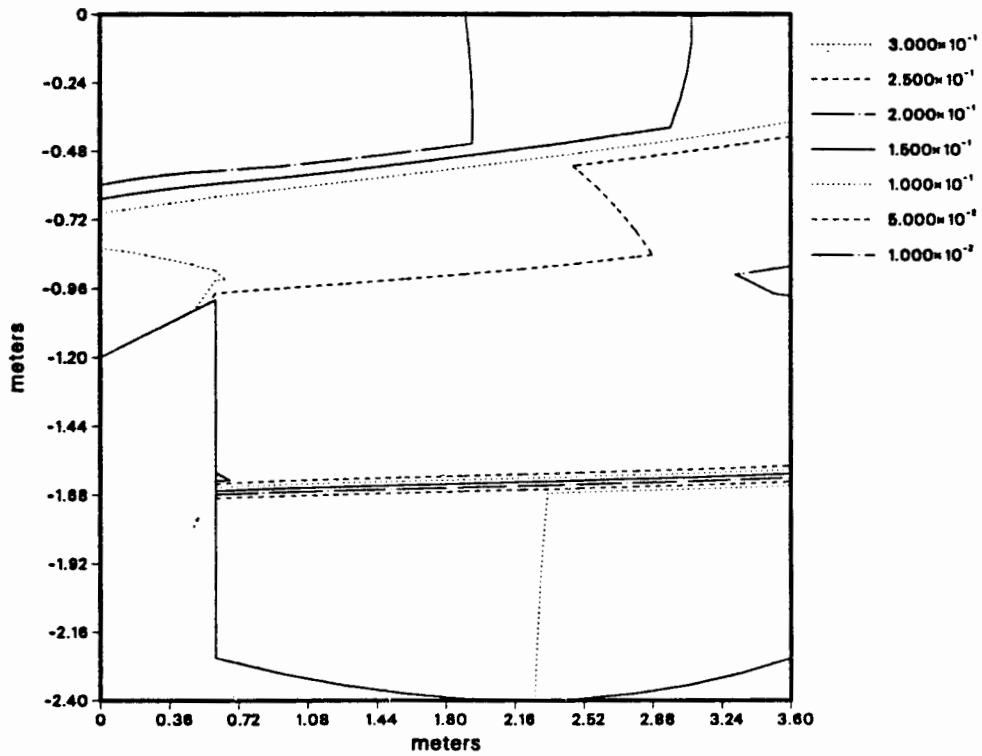

Figure 3. Steady state liquid saturation profiles for the near-field simulations.

Notice that the saturations are highest in the high capillary pressure materials, i.e. the soil and tuff. The steady state liquid and vapor velocity fields are shown in Figs. 4 and 5, respectively.

After the steady state infiltration rate had been achieved, two tracers were injected with the recharge. This was done in order to show possible contaminant transport paths. First a conservative liquid tracer was injected and then a reactive liquid tracer was modeled. The reactive tracer was simulated by assuming a Langmuir isotherm model. The conservative (non-reactive) results are shown in Figs. 6 and 7 after one hundred days and one year, respectively. The tracer was originally injected along the top edge of the simulation region. From Fig. 7 it can be seen that the 0.1 concentration contour progressed 0.5 meters in one year. Since the code does not assume any specific concentration at the source, this contour represents four orders of magnitude lower concentration than the injected value.

The reactive tracer results are given in Figs. 8 and 9. Here the Langmuir parameters of $a_1 = 1.0$ and $a_2 = 0.7$ were used (see Zyvoloski et al., 1990). Comparing Fig. 9 to Fig. 7, it is clear from noting the positions of the 0.1 contours, that the reactive tracer movement is severely retarded relative to the conservative tracer.

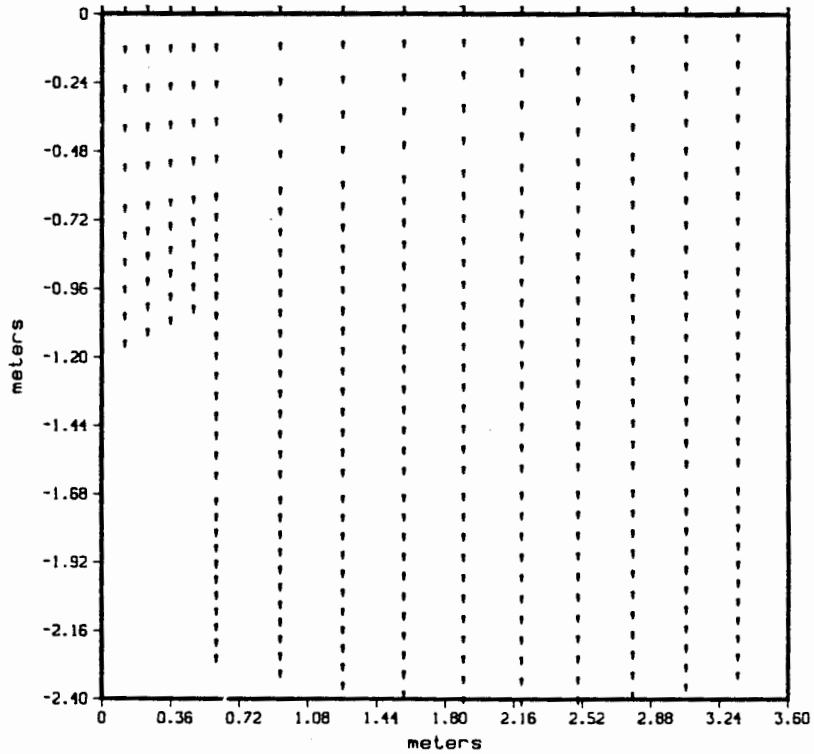

Figure 4. Liquid phase velocity vectors for the near field case after one year. Maximum velocity is 5 x 10^{-8} meters per second.

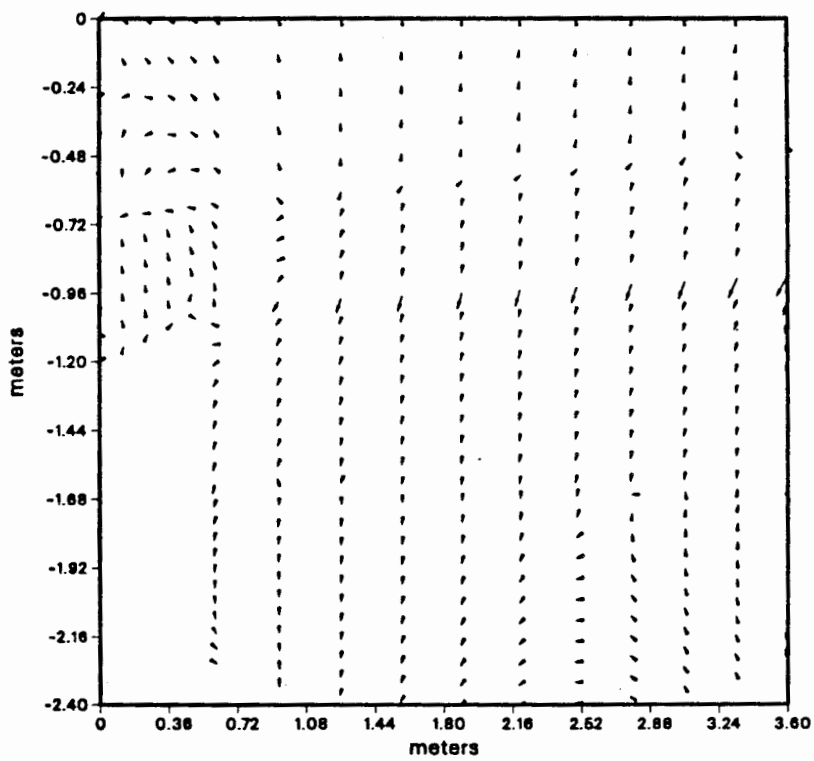

Figure 5. Vapor phase velocity vectors for the near field case after one year. 1.0 m relative length represents 10^{-5} meters per second velocity.

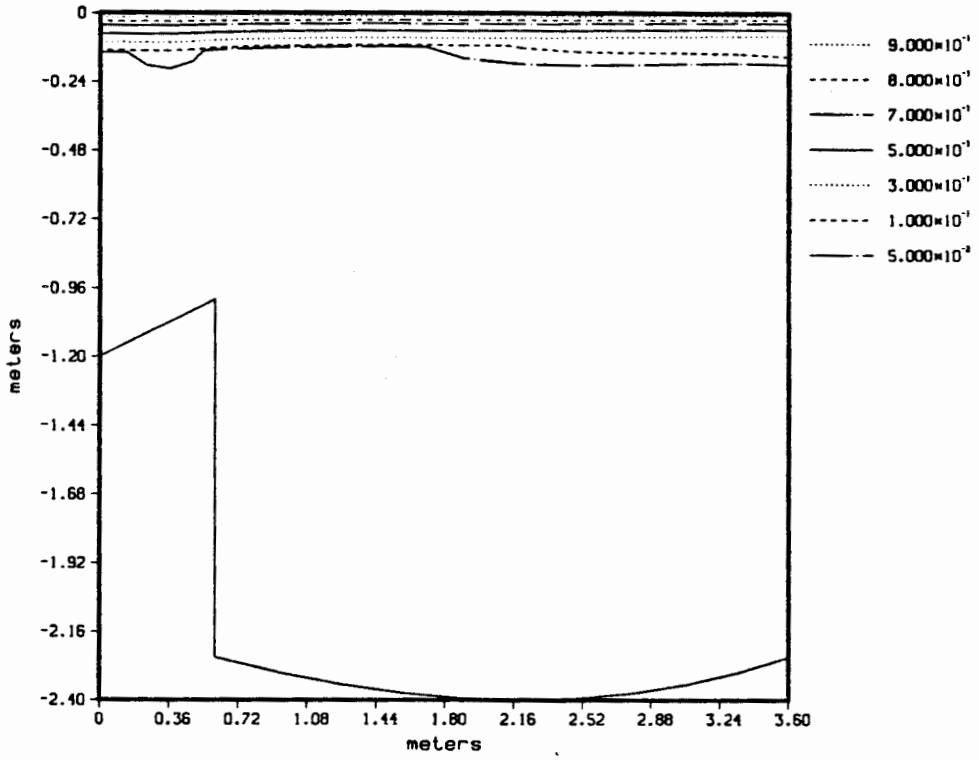

Figure 6. Conservative (non-reactive) tracer concentrations after 100 days.

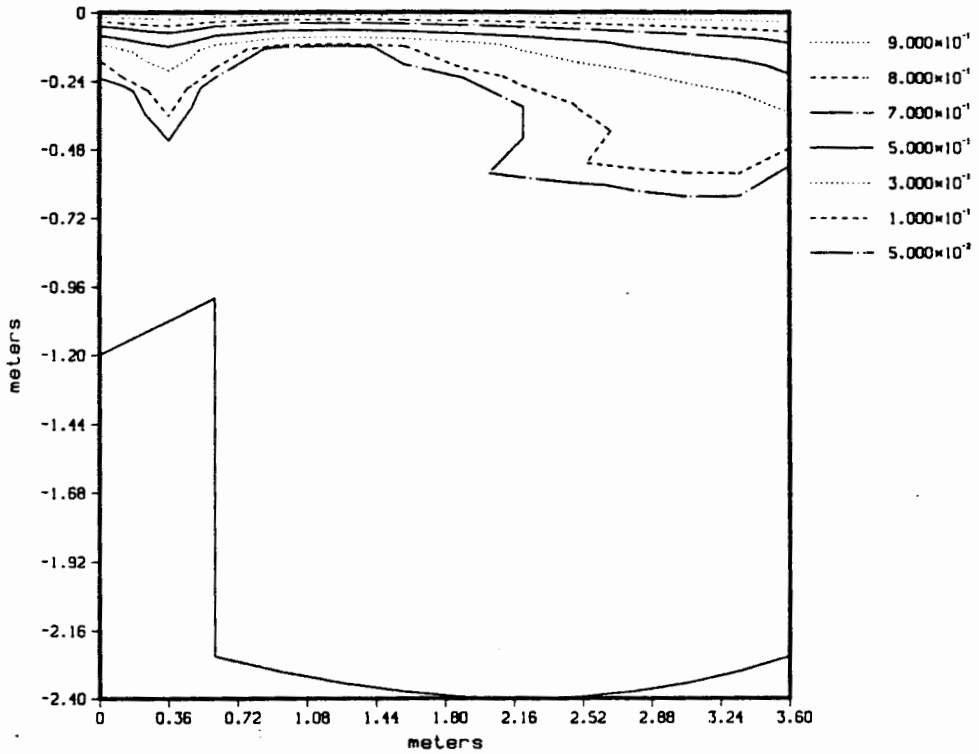

Figure 7. Conservative (non-reactive) tracer concentrations after one year.

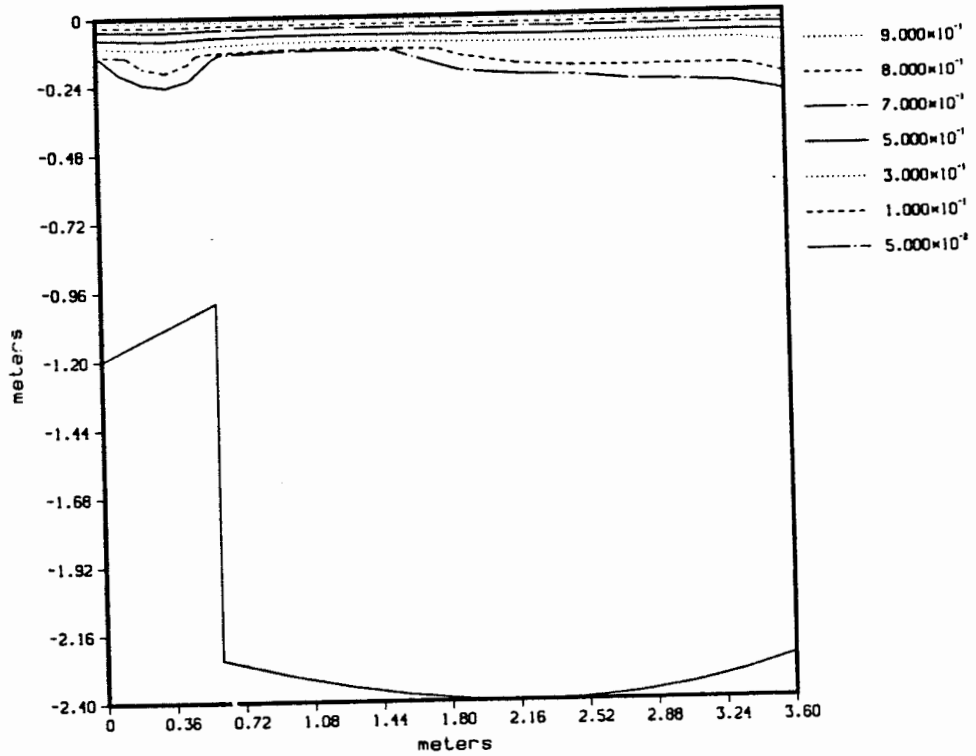

Figure 8. Reactive (Langmuir) tracer concentrations after 100 days.

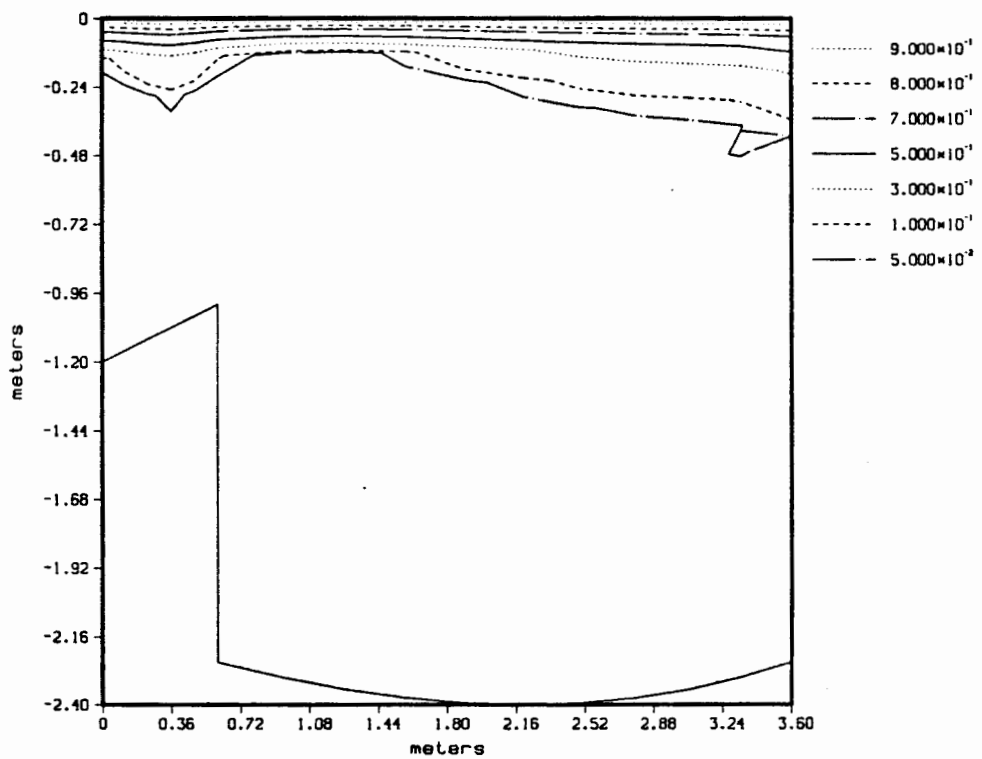

Figure 9. Reactive (Langmuir) tracer concentrations after one year.

These trench calculations show the FEHMN code is well suited to study contaminant transport problems where the geometry is complex. Finer zoning is required to realistically model the details of tracer migration, but the present calculations illustrate the nature of the problem. Moreover, an accurate description of the material properties involved is essential, particularly the sorbing characteristics which, for the present analysis, were estimated from previous investigations. Transport of organic contaminants in the vapor phase could also be modeled with FEHMN.

Far Field Simulation

A longer term and more important consideration, with respect to state and federal regulations, is the migration of contaminants toward the water table. Two calculations were performed to demonstrate techniques and capabilities in order to study, for example, the influence of aquifer recharge on the movement of a contaminant through unsaturated materials. It was assumed to be non-reactive and the water table was assumed to be at a depth of 360 meters, which is appropriate for most waste sites on the Pajarito Plateau. Figure 10 shows a generalized geologic cross-section, illustrating thick welded tuffs bounded by two pumice layers.

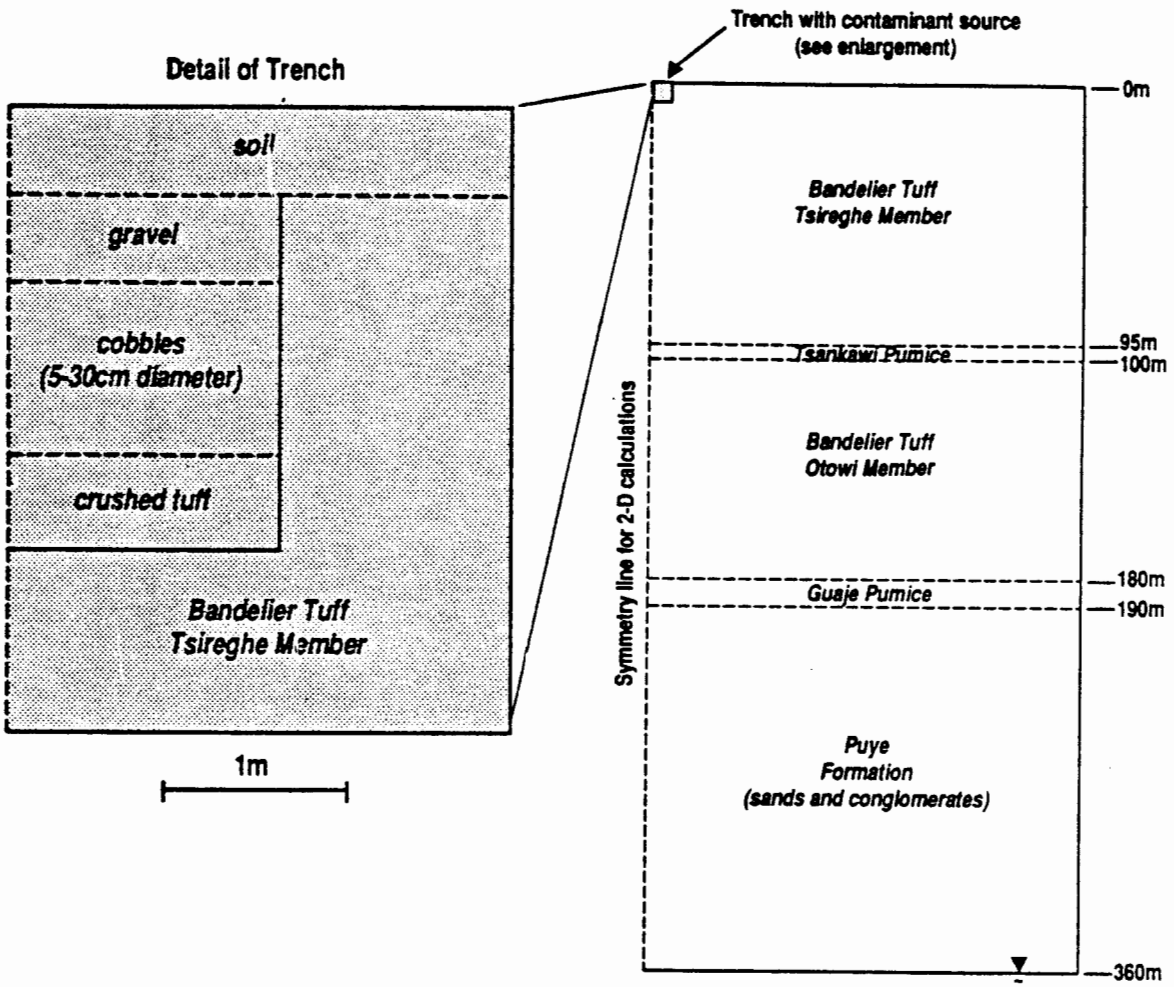

Figure 10. Idealized stratigraphic section for Pajarito Plateau used for the far-field simulations (not to scale).

A simplified version of the near field trench design described in the previous section was used for the contaminant source region. Table 2 gives the assumed material properties for the TRACR3D calculations described in this section. It is worth noting that for detailed trench models, Darcy's Law is not valid in the biointrusion layers (30 cm cobbles) since they are too coarse. It is likely, however, that effective constitutive laws for such materials will be obtained through modeling and experimental research. For these preliminary calculations, the present analysis is sufficient.

Table 2. Material Properties for TRACR3D Far Field Calculations

Material	Saturated Permeability[a] (darcys)	Porosity (vol/vol)	Irreducible Saturation (vol/vol)	Average Particle Size (cm)	Matric Potential and Relative Perm. Model
Intact Tuff	0.24	0.505	0.02	0.1	Table V, Abeele et al. (1981)
Pumice Beds [1]	0.094	0.40	0.02	0.1	Table IV, Abeele et al. (1981)
Puye Conglomerate	10.0	0.35	0.0	0.25	Brooks-Corey
Cobble Layer [2]	1000.0	0.45	0.005	15.0	Brooks-Corey
Gravel Layer [2]	30.0	0.45	0.005	1.0	Brooks-Corey
Soil [2]	4.8	0.30	0.005	0.03	Brooks-Corey

[a] All permeabilities assumed to be isotropic
[1] Properties of crushed tuff were used for pumice beds
[2] Layers in trench cap

The TRACR3D mesh consists of 19 horizontal and 67 vertical zones and is shown in Fig. 11. Regions where material properties change, e.g., near the pumice beds, are more finely resolved. Detail of the trench region is given in Fig. 12. In both calculations the contaminant source was distributed evenly in the gravel, cobble, and crushed tuff layers of the trench. Constant water infiltration rates were specified across the top of the entire domain. The concentration of contaminant in the trench was held constant at a value of 1.0. The contours, therefore, represent the relative concentration with respect to this value, e.g. the 10^{-6} contour is actually 10^{-6} times the source term.

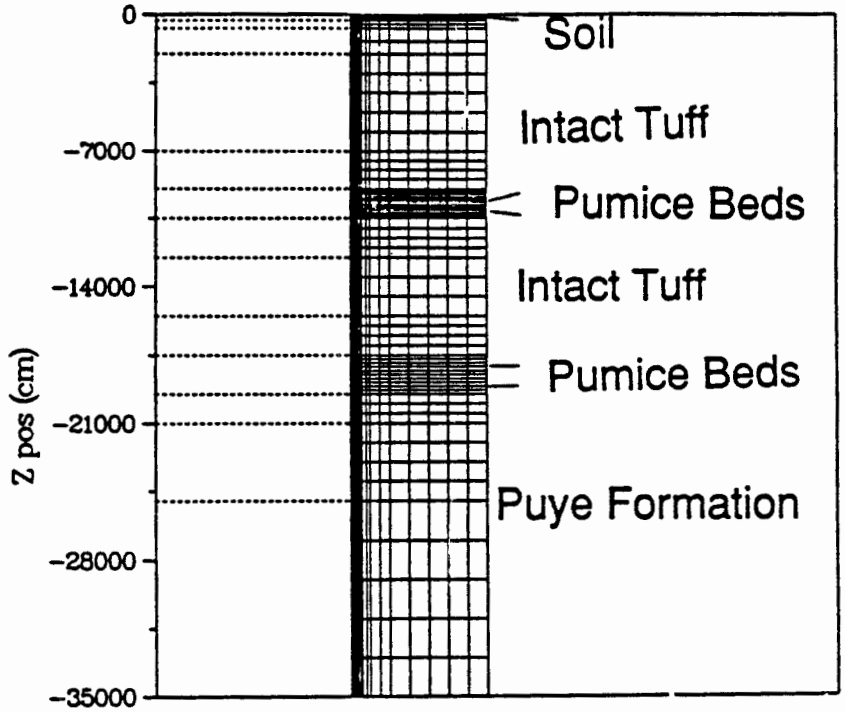

Figure 11. Calculational mesh used for the TRACR3D far-field simulations. The grid is 19 cells by 67 cells. It is more finely resolved in the pumice beds.

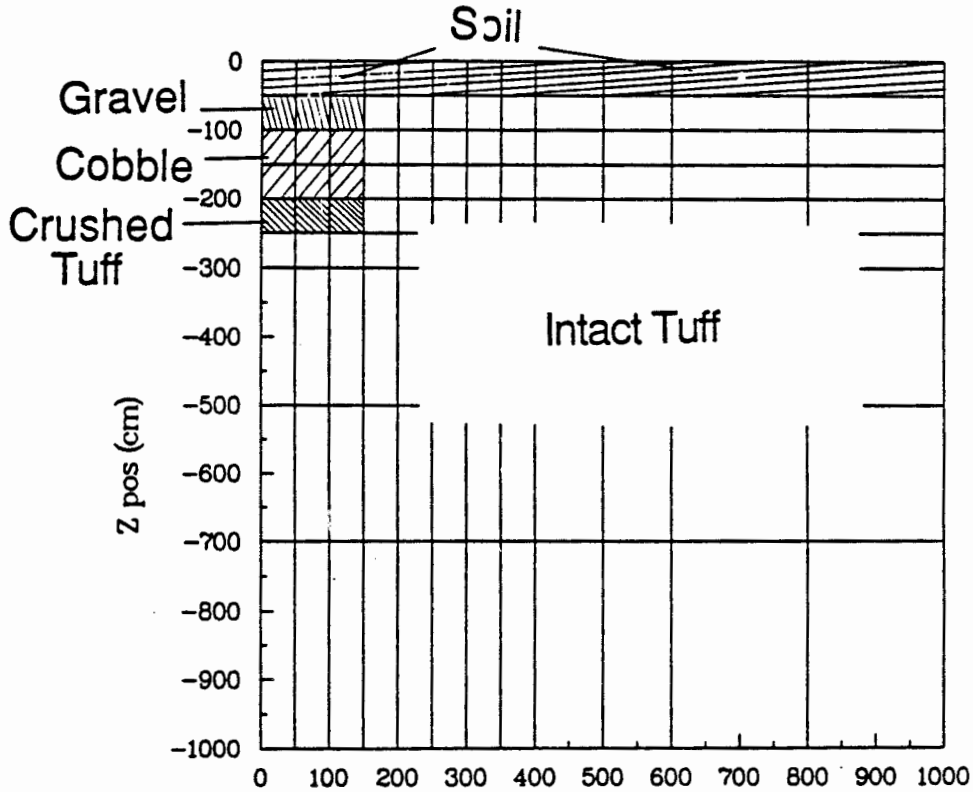

Figure 12. Detail of the TRACR3D mesh showing the location of the different trench materials. Notice the lack of detail and zoning compared to Fig. 2a.

Many calculations would be required to fully characterize a potential design at a specific site. They are not particularly computer intensive and many variations could easily be performed once the initial problem is set up. The far field calculations in the previous section varied the tracer reactivity. Here we varied the infiltration (rainfall less evaporation) rate, assuming a non-reactive species, the most conservative scenario. A matrix of appropriate calculations could easily be developed and executed. Detailed site specific data would have to be available in order to perform credible calculations. This is discussed in the next section.

The first calculation assumed an infiltration rate of 0.3 mm per year, a value suggested by Abeele et al. (1981). Figure 13 shows contours of steady state water saturation. The low permeability pumice layers are clearly visible. Figures 14a to 14f are contours of the log of tracer concentration from 127 years to 10000 years. Notice that the axes have different scales. The concentration represents a fraction of the initial value.

Generally, the contaminated plume moves downward but there is also horizontal spreading. Flow is only moderately impeded after 900 years when the 5m thick pumice layer is encountered at depth of 95m. Notice, however, that nearly 4000 additional years are required for the tracer to travel an additional 100m to the second pumice layer, this time 10m thick. This barrier is sufficient to keep the contaminant well away from the water table.

The next calculation was identical in every way, except that the infiltration rate was increased to 1.0 mm per year. Figure 15 shows that the water saturation in the lower (thicker) pumice layer has increased to over forty percent. Figures 16a to 16f illustrate the much faster migration of the plume. After only 317 years, significant amounts of the tracer have reached the Otowi member of the Bandelier Tuff. The lower pumice layer is effective in slowing the downward progress, but it is eventually breached and by 4120 years trace amounts have reached the water table. By 10000 years, significant contamination of the water table has taken place, notwithstanding radioactive decay.

Discussion

These calculations do not necessarily represent any perceived threat to the aquifer, since no site specific properties were used. The far field simulations are conservative in the sense that no sorption was allowed. The presence of certain minerals in the soil and rock can drastically retard the movement of a given species. On the other hand, it would be unreasonable to rely on those characteristics based on information obtained at a distant site, although sorption characteristics of tuffs in Nevada have been applied to the Parajito Plateau in previous studies. The calculations presented above simply show the wide range possible response, based on a single (reasonable) variation of two parameters, reactivity and aquifer recharge.

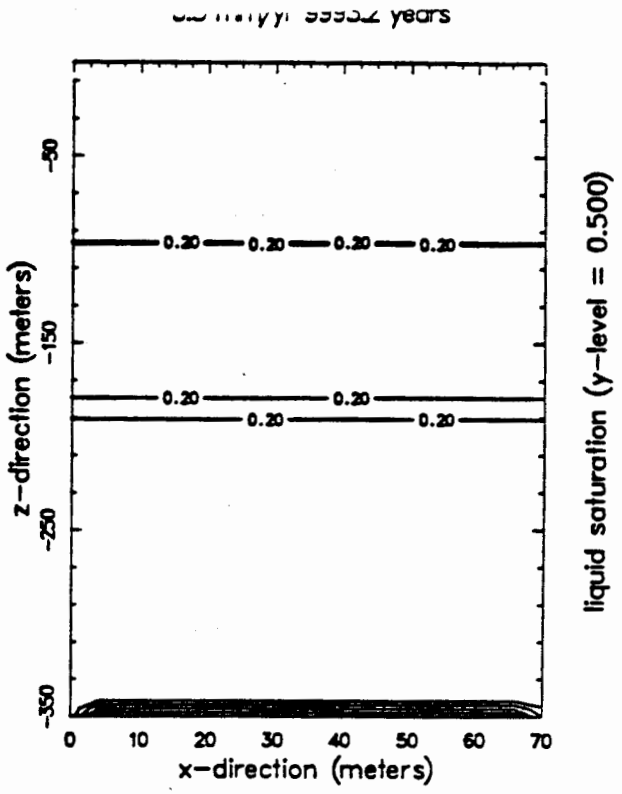

Figure 13. Steady-state liquid saturations in the vertical section of the far-field simulation for an infiltration rate of 0.3 mm per year.

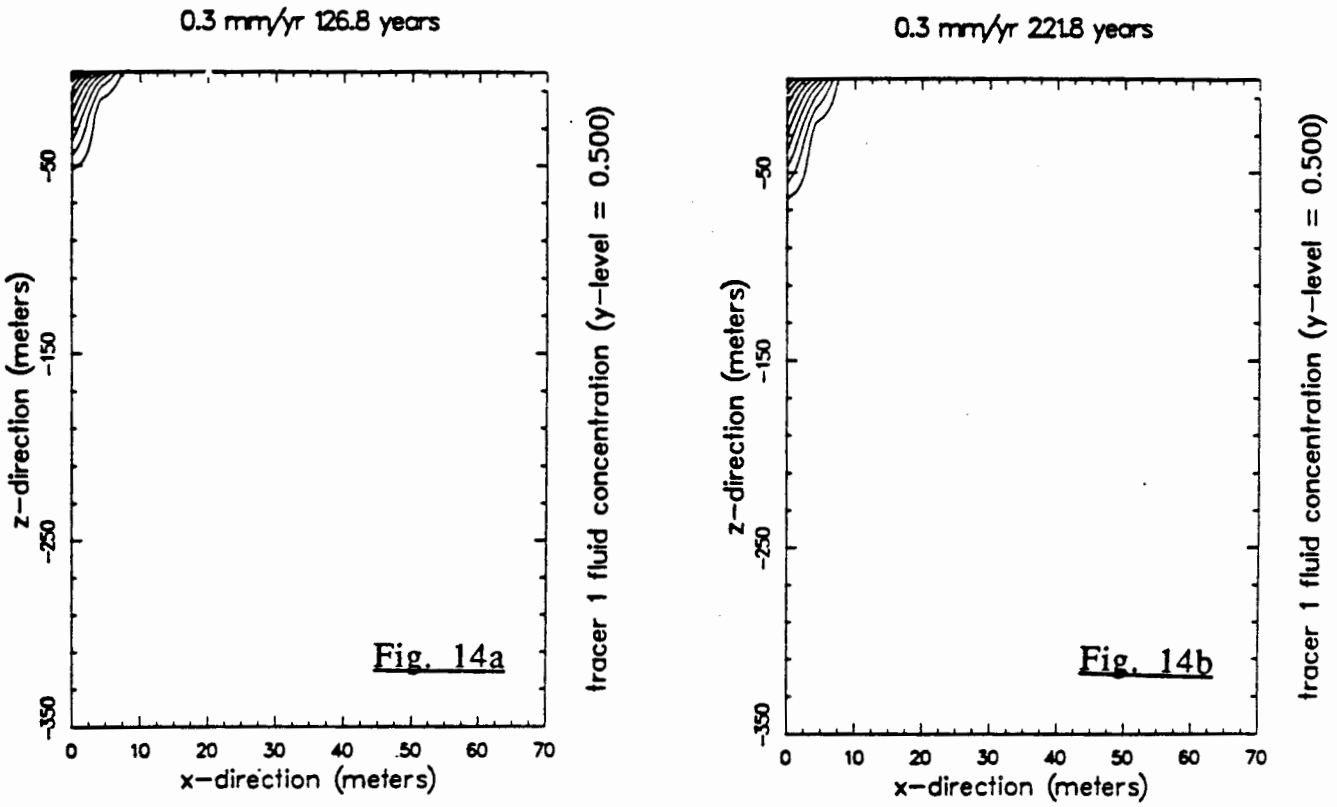

Figure 14. Contour plots of the log of concentration of the contaminant. Notice the retardation caused by the pumice beds at 900 and 10000 years.

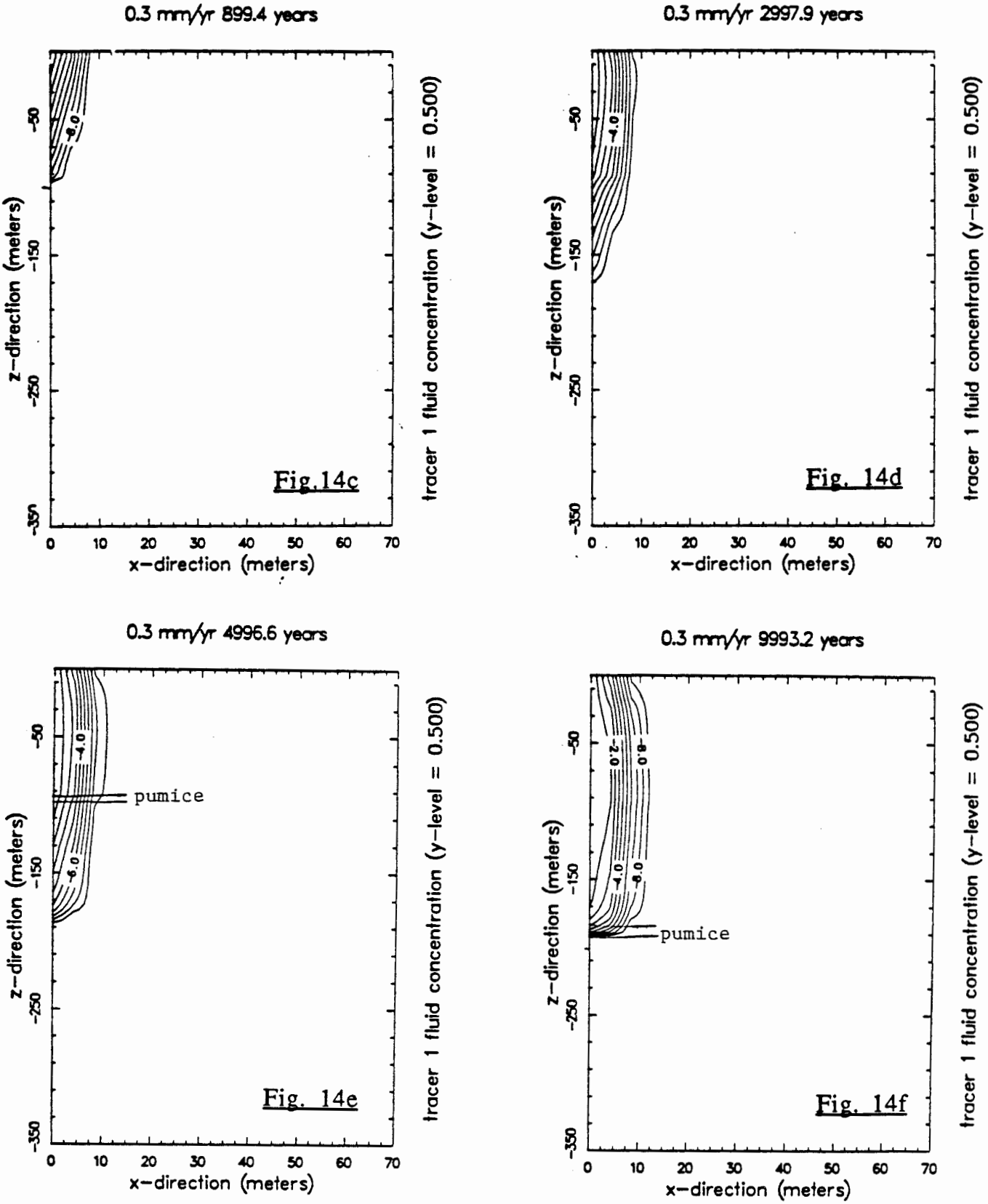

Figure 14. (continued) Concentration of the contaminant for 0.3 mm per year recharge rate.

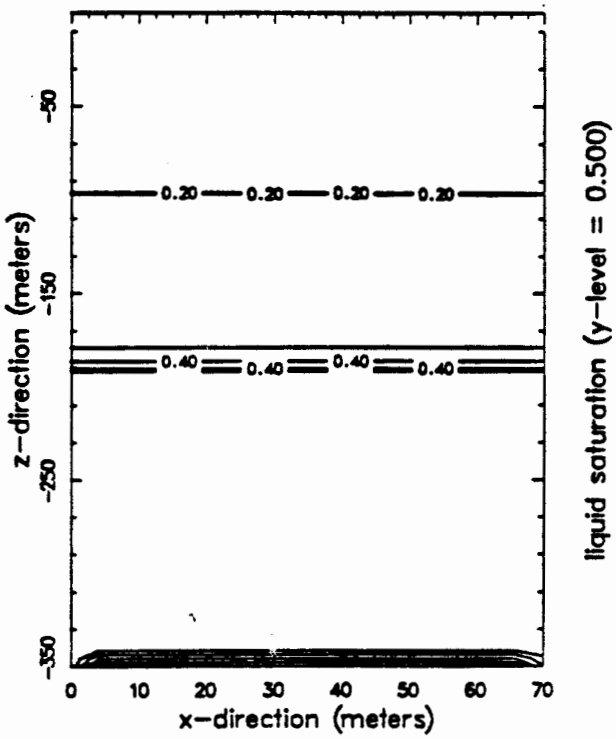

Figure 15. Steady-state liquid saturations in the vertical section of the far-field simulation for an infiltration rate of 1.0 mm per year. Notice the higher water content in the lower pumice bed compared to Fig. 13.

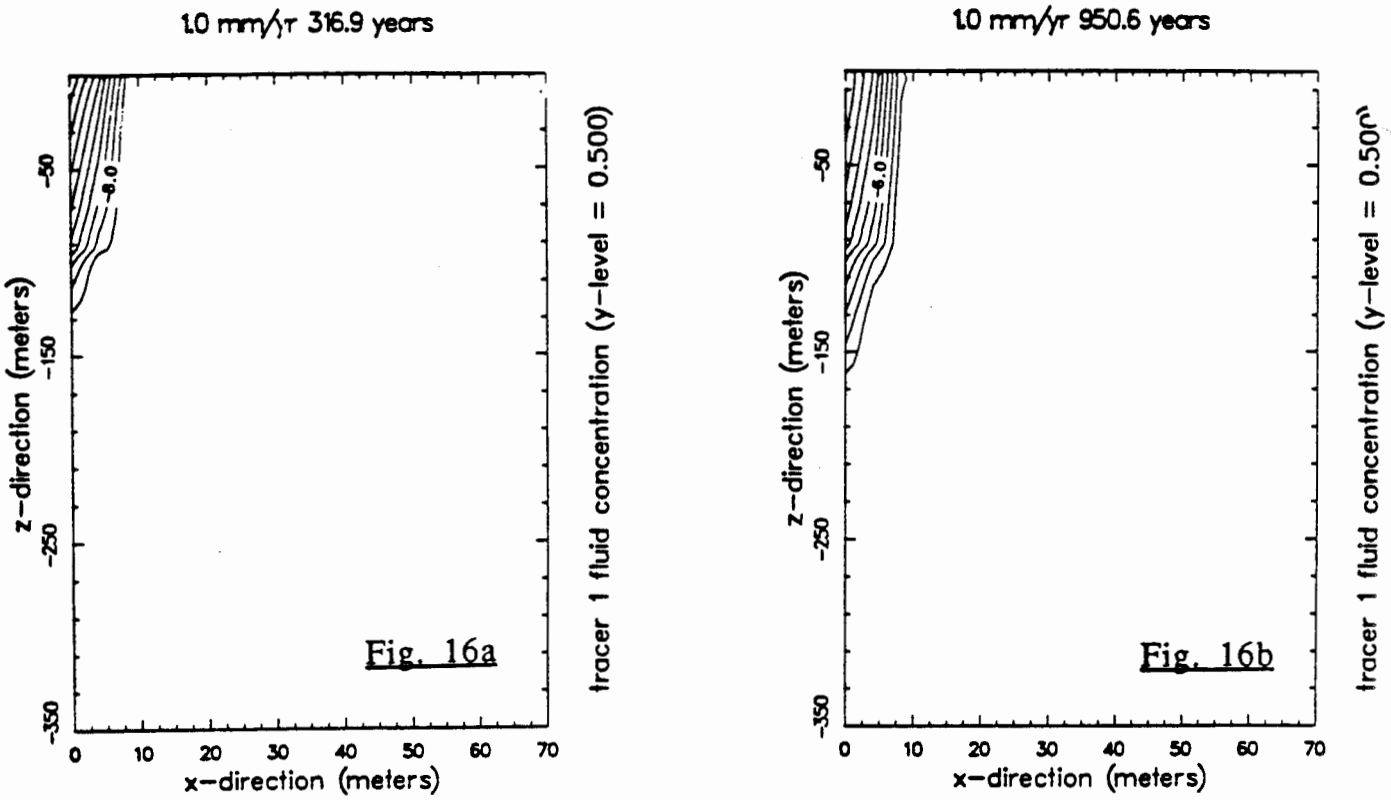

Figure 16. Contour plots of the log of concentration of the contaminant. Notice the breach of the upper pumice layer at 317 years and the eventual contact with the water table at 4120 years.

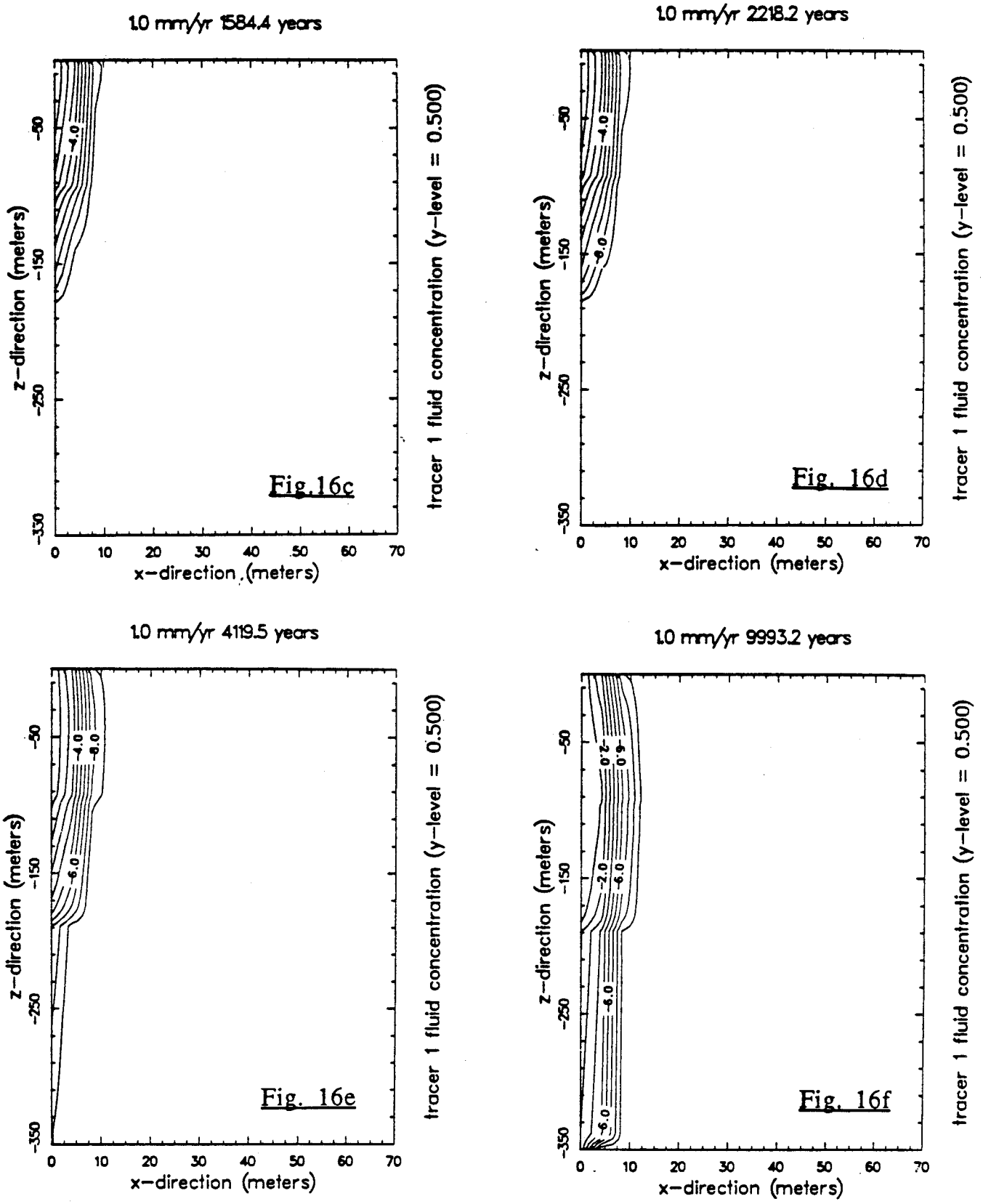

Figure 16. (continued) Concentration of the contaminant for 1.0 mm per year recharge rate.

Optimization of a Monitoring System

These kinds of calculations can be used effectively to determine the locations of subsurface sampling locations. Using the best known geology and subsurface conditions, a few simulations will indicate how concentrations can be expected to change, before and after treatment. Once the monitoring instrumentation is in place, the data can be used to refine the codes and material properties.

Evaluation of Failure Modes

In order to determine the risk of failure of a given remediation strategy, a realistic assessment of the environmental impact of the proposed work must be performed. The greatest uncertainties will probably concern the material properties and the spatial distribution of the different geologic media. Most sites will have complex three-dimensional subsurface features that will govern response. Presumably, the definition of the failure of a given stabilization strategy will be provided, e.g. failure to comply with a particular regulation. By running a matrix of simulations, numerical modeling can play a crucial role in identifying potential failure scenarios, the likelihood of such a failure, the consequences of the failure and potential methods to remedy the failure. The risk of failure, therefore, can be quantified by running enough scenarios so that the influence of each critical parameter is well understood. For example, if there is a ten percent uncertainty in the permeability of a given material, a twenty percent uncertainty in the thickness of an important layer and a thirty percent uncertainty in the mineralogy relevant to sorption, several calculations can be performed to determine which combinations of the uncertain parameters result in the worst case, e.g. is there a combination that results in a contaminated plume reaching a critical boundary.

Recommendations

We recommend that the following areas be addressed specifically for the purpose of improving the numerical simulations:

Recharge Rates (for each geographical area)

Incorporate more detailed time-dependent recharge, for example the seasonal variation in precipitation must reflect realistic conditions (most precipitation occurs in the winter and recharge occurs during spring runoff).

Climatological variations such as 50, 100 and 1000 year precipitation events must be incorporated.

Spatial variations in recharge should be accommodated when appropriate. This is especially relevant for three-dimensional simulations.

Rock Properties (for each site)

Detailed stratigraphy and faulting, especially any 3-D implications;

Rock matrix (bulk) properties:
permeability
porosity
mineral content (for sorption);

Fracture distribution and characteristics: studies at Yucca Mountain in Nevada are indicating that water can migrate at speeds of order 1.0 meters per year through fractures even at very low precipitation rates - this is much faster than the matrix flow, simulated in this study;

Sorption characteristics and colloid transport.

Site Histories

Contaminant inventories;

Material properties for buried waste (e.g. trucks, containers, etc.)

Histories of ponding and/or water flooding.

The utility of the calculations will always be limited not only by the quality of the algorithms that model the physical process but also by the boundary conditions and the properties and distributions of all the appropriate materials. This report has demonstrated that the models presently exist to perform credible simulations. It now remains to support these models with equally high-quality descriptions of the actual *in situ* conditions.

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APPENDIX R

Education and Relevant Experience of Environmental Restoration Program Staff

ER PROGRAM STAFF EDUCATION AND RELEVANT EXPERIENCE

NAME AND AFFILIATION	EDUCATION/EXPERTISE	ER PROGRAM ASSIGNMENT
Paul Schumann, DOE-LAOO	Ph.D. Environmental Science and Engineering 10 years experience in environmental engineering and hazardous waste management including 4.5 years on RCRA and CERCLA programs, and program management	DOE Project Manager
Tom Gunderson, HSE-DO	Ph.D. Environmental Engineering 15 years experience in environmental surveillance and assessment, and regulatory compliance, including management	Deputy Division Leader
Bob Vocke, HSE-13	Ph.D. Water Resources 15 years experience in environmental and hazardous waste site assessment, including waste management, regulatory compliance, and program management	Program Manager; HSE-13 Group Leader
ars Soholt, HSE-13	Ph.D. Biology 20 years experience in assessment of energy and waste management systems, including project management experience	Programmatic Project Leader
Paul Aamodt, HSE-13	B.S. Geology 20 years experience in geosciences, including site characterization, radioactive and hazardous waste management and disposal, and project management	Operable Unit Project Leader
Jim Aldrich, EES-1	Ph.D. Geology 16 years experience in geosciences research and environmental sciences, including project management planning and scheduling	Operable Unit Project Leader

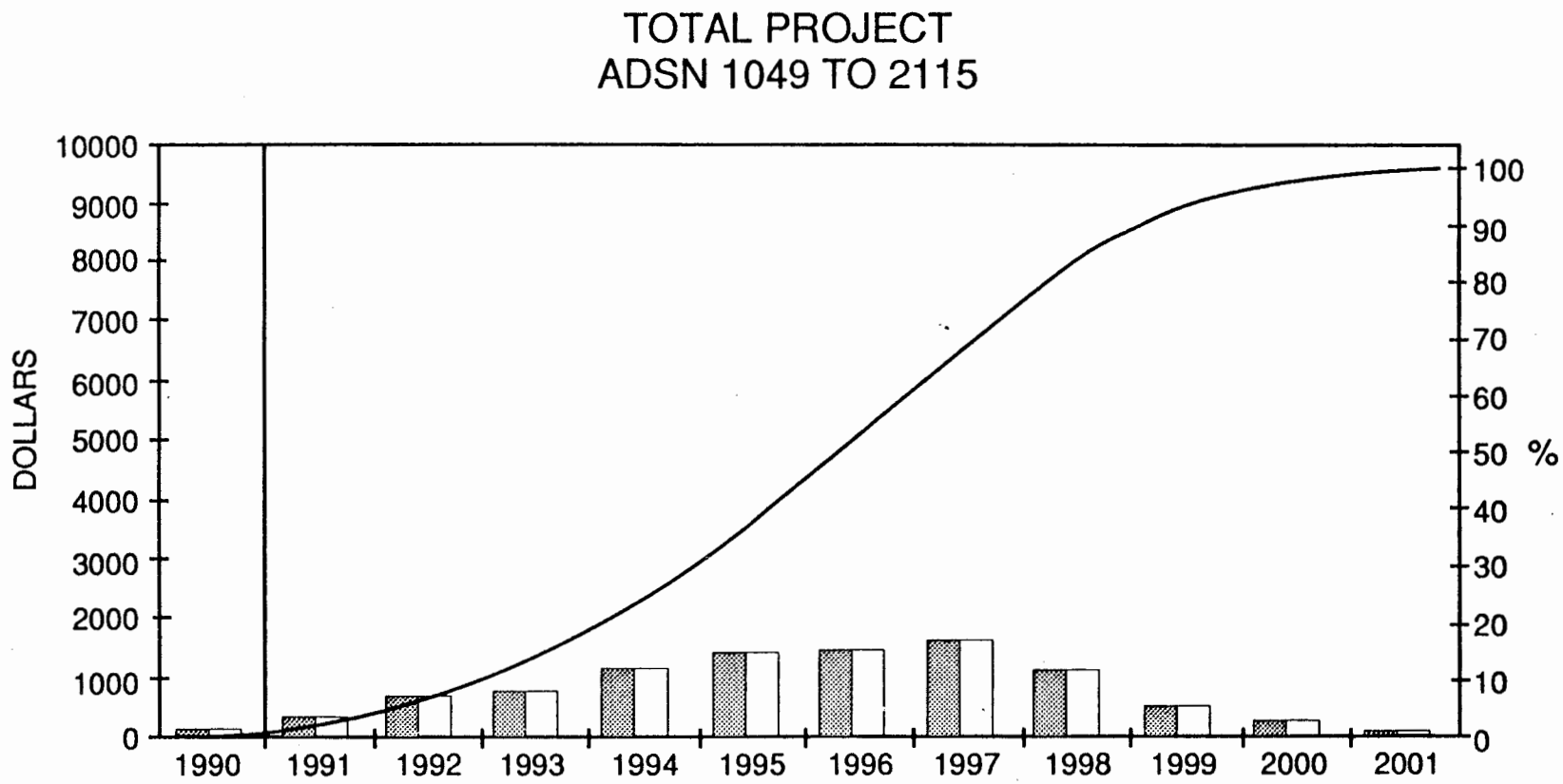
Kathy Campbell	Ph.D. 15 years experience with statistical sampling/presentation/evaluation of geochemical and hazardous waste/ chemistry data	Technical Team Leader
Greg Cole, EES-1	Ph.D. Geosciences 13 years experience with computerized integration and analysis of field and technical data from earth sciences, project management experience	Facility for Information Management, Analysis, and Display Project Leader
Dave Curtis	Ph.D. Geochemistry/Chemistry 30 years experience in application of radioisotopes to scientific and technical problems, analytical and cosmo-chemistry, and management	Technical Team Leader
Micheline Devaurs, HSE-13	M.S. Hydrology 8 years experience environmental contamination evaluation, hydrologic modeling and field sampling and project management	Operable Unit Project Leader
Keith Dowler, CLS-1	B.S. Metallurgical Engineering 15 years experience in irradiated material examination and handling, and management experience	Operable Unit Project Leader
Barry Drennon, EES-15	14 years analytical chemisty, 3 years records management and archive investigations	Technical Team Leader
Craig Eberhart	B.S. Forestry/Biology, M.S. Environmental Science, M.S. Biology/Ecology 13 years experience in air quality/meteorology and project management (QA)	Technical Team Leader
Gary Eller, INC-7	Ph.D. Chemistry 16 years experience in transuranic chemistry, process chemistry, co-contaminant environ-mental chemistry, and project management	Operable Unit Project Leader
Harry Ettinger, HSE-DO	M.S. Civil Engineering 30 years experience in occupational and environmental health management	Technical Team Leader
Roger Ferenbaugh, HSE-8	M.S. Chemical Engineering, Ph.D. Ecology/Environmental Science 5 years experience with chemical pilot plant operations; 20 years experience with environmental impact analysis, ecological studies, and environmental regulatory compliance including 6 years involvement with hazardous waste site management experience	Operable Unit Project Leader

Doris Garvey,	M.S. Economics 6 years experience in NEPA activities for ER program, and management experience in compliance program and CEARP	Technical Team Leader
Robert Gonzales, HSE-13	B.M.S. Environmental Science 14 years experience in regulatory compliance and environmental assessments, including hazardous waste site characterization	Technical Liaison
Tom Hakonson, EES-15	Ph.D. Radiation Ecology 18 years experience in radioecological work on environmental processes leading to transport of radioactive and hazardous materials, and management experience	Operable Unit Project Leader
Martin Janowski, PA-3	B.A. Journalism 10 years experience in public relations with 4 years in hazardous/radioactive waste communications and community relations	Community Relations Project Leader
Elizabeth J. Kelly, A-1	Ph.D. Biostatistics 3 years experience in devising sampling plans and data analysis techniques for environmental studies including surface covers, site integrity and decision analysis for ER programs	Technical Team Leader
John Krueger, HSE-13	B.S. Chemical Engineering 4 years experience in implementing and managing assessment and remediation activities for hazardous waste sites	Operable Unit Project Leader
Bill Laughlin,	Ph.D. 21 years experience geology, geochemistry and project management	Technical Team Leader
Craig Leasure,	Ph.D. Analytical Chemistry manager of chemistry lab performing analysis for ER program	Technical Team Leader; HSE-9 Group Leader
Chris Loggains	16 years Engineering Project Management, including 7 years in Environmental Programs	Technical Team Leader
Larry Maassen, HSE-13	M.S. Exploration Geology 12 years experience in exploration geology and 5 years in radioactive waste programs quality assurance and management	Quality Project Leader

Dave McInroy, HSE-8	B.S. Biology 8 years experience in waste management activities, including project management	Technical Team Leader
Ted Norris, HSE-13	Ph.D. Chemistry 12 years experience in radionuclide migration; 3 years experience in atmospheric pollutant transport; and 3 years experience as health and safety officer	Health and Safety Project Leader
Mike Ray, EES-1	B.S. Geology 7 years experience in waste related site assessment drilling and sampling plan development, and database maintenance for technical baseline design documents	Records Management Project Leader
Chuck Rzeszutko, HSE-9	M.S. Chemistry 14 years experience in organic analysis using various GC/MS HPLC and various related instruments. Involved with EPA for 7 years; support of criminal and civil cases	Technical Team Leader
Linda Trocki	Ph.D. Mineral Economics 4 years experience in environmental restoration; experience in site characterization	Technical Team Leader
Sandra Wagner, HSE-13	M.S. Organic/Analytical Chemistry 9 years experience in implementing and managing assessment and remediation activities for hazardous waste sites	Operable Unit Project Leader
Don York,	B.S. Mechanical Engineering 8 1/2 years on radioactive waste management; 20 years project management planning/scheduling experience	Resource Planning Project Leader

APPENDIX S

Projected Schedule and Cost for the Corrective Action Process at Los Alamos National Laboratory



	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
ACWP+ETC	115	153	677	793	1180	1435	1512	1627	1123	564	285	111
BCWS	115	153	677	793	1180	1435	1512	1627	1122	564	284	111
BCWP	0	0	0	0	0	0	0	0	0	0	0	0
CUM LRE	115	268	945	1737	2917	4352	5864	7491	8613	9177	9462	9573
CUM BCWS	115	268	945	1738	2918	4353	5865	7492	8614	9178	9462	9573
CUM BCWP	0	0	0	0	0	0	0	0	0	0	0	0

Scale 1: 100000

ACWP = ACTUAL COST OF WORK PERFORMED
BCWS = BUGETED COST OF WORK SCHEDULED
BCWP = BUDGETED COST OF WORK PERFORMED

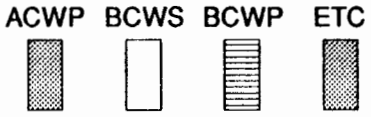


Fig. S-1. Projected total costs for the corrective action process through the corrective measures studies at Los Alamos National Laboratory.

ACTIVITY DESCRIPTION	EARLY START	EARLY FINISH
PROGRAM & INFORMATION REMEDIATION MGT (2106)		
START REMEDIATION MANAGEMENT ACTIVITIES	20CT89	
FINISH REMEDIATION MANAGEMENT ACTIVITIES	1JUN05	
PROGRAM & INFORMATION ASSESSMENT MGT (2107)		
START ASSESSMENT MANAGEMENT ACTIVITIES	20CT89	
FINISH ASSESSMENT MANAGEMENT ACTIVITIES	31MAY01	
CANYONS ASSESSMENT (1049)		
START OU-1049 DRAFT RFI WORK PLAN	10CT92	
FINISH OU-1049 DRAFT RFI WORK PLAN	23MAY94	
FINISH OU-1049 FINAL RFI WORKPLAN	28OCT94	
START OU-1049 RFI	28OCT94	
START OU-1049 DRAFT RFI REPORT	18MAY98	
FINISH OU-1049 RFI	28OCT99	
FINISH OU-1049 DRAFT RFI REPORT	28OCT99	
FINISH OU-1049 FINAL RFI REPORT	14APR00	
START OU-1049 DRAFT CMS WORK PLAN	14APR00	
FINISH OU-1049 DRAFT CMS WORK PLAN	11JUL00	
START OU-1049 CMS	11JUL00	
START OU-1049 DRAFT CMS REPORT	17NOV00	
FINISH OU-1049 FINAL CMS PLAN	19DEC00	
FINISH OU-1049 CMS	20DEC01	
FINISH OU-1049 DRAFT CMS REPORT	20DEC01	
FINISH OU-1049 FINAL CMS REPORT	6JUN02	
INTERIM REMEDIAL MEASURES ASSESSMENT (1062)		
START INTERIM REMEDIAL MEASURES ASSESSMENT	10CT90	
FINISH INTERIM REMEDIAL MEASURES ASSESSMENT	10CT97	
TA-0, 19, 26, 73, 74 ASSESSMENT (1071)		
START OU-1071 DRAFT RFI WORKPLAN	10CT90	
FINISH OU-1071 DRAFT RFI WORKPLAN	22MAY92	
FINISH OU-1071 FINAL RFI WORKPLAN	29OCT92	
START OU-1071 RFI	29OCT92	
START OU-1071 DRAFT RFI REPORT	16MAY96	
FINISH OU-1071 RFI	28OCT97	
FINISH OU-1071 DRAFT RFI REPORT	28OCT97	
FINISH OU-1071 FINAL RFI REPORT	16APR98	
START OU-1071 DRAFT CMS WORK PLAN	16APR98	
FINISH OU-1071 DRAFT CMS PLAN	13JUL98	
START OU-1071 CMS	13JUL98	
START OU-1071 DRAFT CMS REPORT	19NOV98	
FINISH OU-1071 FINAL CMS PLAN	21DEC98	
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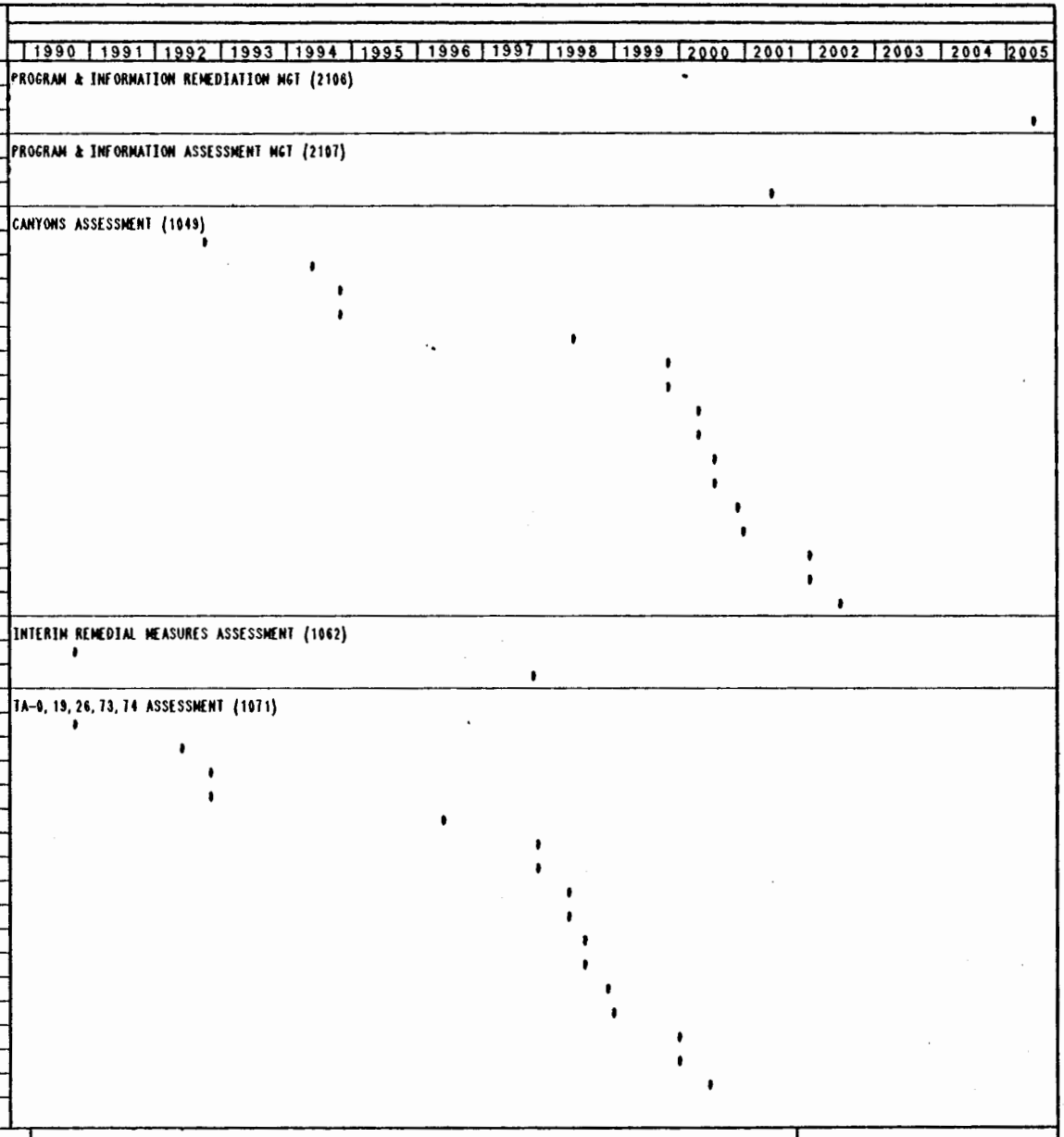
FINISH OU-1071 CMS REPORT	7JUN00	



Activity Bar/Early Dates
Critical Activity
Progress Bar

TYPE OF ACTIVITY
START OF ACTIVITIES THAT PRODUCE MILESTONE
ASM LEVEL MILESTONE

Primavera Systems, Inc. 1986-1996

LOS ALAMOS NATIONAL LABORATORY
ENVIRONMENTAL RESTORATION
ENVIRONMENTAL RESTORATION MILESTONES

Planning Unit Day

Sheet 1 of 9

Project Start : 20CT89
Project Finish: 1JUN05

Data Date: 20CT89
Plot Date: [illegible]

ENVIRONMENTAL RESTORATION PROGRAM

Date	Revision	Checked	Approved

Fig. [illegible] Major milestones of the corrective action process through the corrective measures studies at Los Alamos National Laboratory.

ACTIVITY DESCRIPTION	EARLY START	EARLY FINISH
TA-1 ASSESSMENT (1078)		
START OU-1078 DRAFT RFI WORKPLAN	1FEB90	
FINISH OU-1078 DRAFT RFI WORKPLAN	22MAY92	
FINISH OU-1078 FINAL RFI WORKPLAN	29OCT92	
START OU-1078 RFI	29OCT92	
START OU-1078 DRAFT RFI REPORT	16MAY96	
FINISH OU-1078 RFI	28OCT97	
FINISH OU-1078 DRAFT RFI REPORT	28OCT97	
FINISH OU-1078 FINAL RFI REPORT	16APR98	
START OU-1078 DRAFT CMS PLAN	16APR98	
FINISH OU-1078 DRAFT CMS PLAN	13JUL98	
START OU-1078 CMS	13JUL98	
START OU-1078 DRAFT CMS REPORT	19NOV98	
FINISH OU-1078 FINAL CMS PLAN	21DEC98	
FINISH OU-1078 CMS	23DEC99	
FINISH OU-1078 DRAFT CMS REPORT	23DEC99	
FINISH OU-1078 FINAL CMS REPORT	7JUN00	
TA-10, 31, 32, 45 ASSESSMENT (1079)		
START OU-1079 DRAFT RFI WORKPLAN	2APR90	
FINISH OU-1079 DRAFT RFI WORKPLAN	22MAY92	
FINISH OU-1079 FINAL RFI WORKPLAN	29OCT92	
START OU-1079 RFI	29OCT92	
START OU-1079 DRAFT RFI REPORT	16MAY96	
FINISH OU-1079 RFI	28OCT97	
FINISH OU-1079 DRAFT RFI REPORT	28OCT97	
FINISH OU-1079 FINAL RFI REPORT	16APR98	
START OU-1079 CMS DRAFT PLAN	16APR98	
FINISH OU-1079 CMS DRAFT PLAN	13JUL98	
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START OU-1079 DRAFT CMS REPORT	19NOV98	
FINISH OU-1079 CMS	23DEC99	
FINISH OU-1079 DRAFT CMS REPORT	23DEC99	
FINISH OU-1079 FINAL CMS REPORT	7JUN00	
TA-11, 13, 16, 24, 25, 28, 37 ASSESSMENT (1082)		
START OU-1082 DRAFT RFI WORKPLAN	10CT91	
FINISH OU-1082 DRAFT RFI WORKPLAN	24MAY93	
FINISH OU-1082 FINAL RFI WORKPLAN	29OCT93	
START OU-1082 RFI	29OCT93	
START OU-1082 DRAFT RFI REPORT	16MAY97	
FINISH OU-1082 RFI	28OCT98	
FINISH OU-1082 DRAFT RFI REPORT	28OCT98	
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START OU-1082 DRAFT CMS REPORT	19NOV99	
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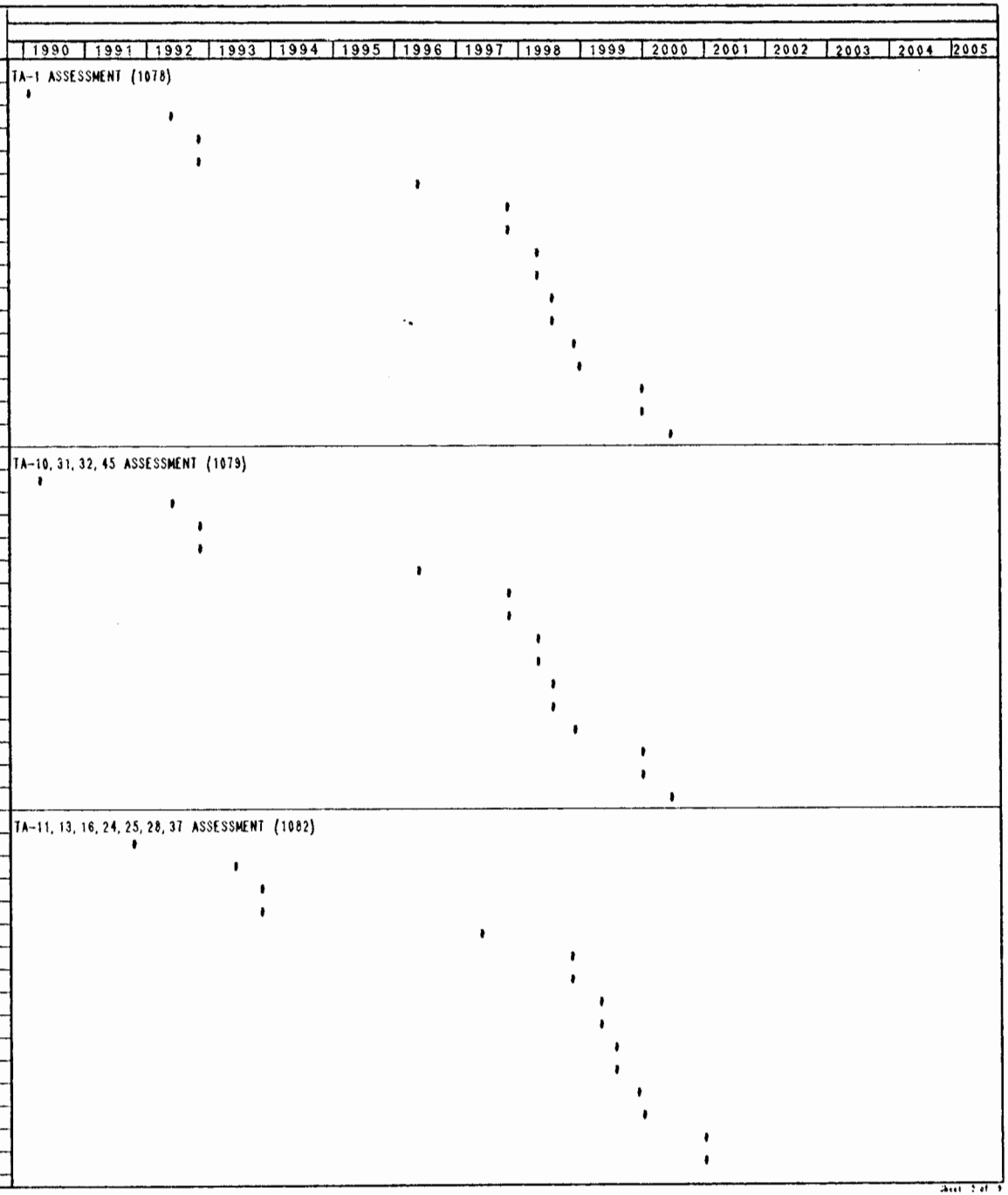

ACTIVITY DESCRIPTION	EARLY START	EARLY FINISH
FINISH OU-1082 FINAL CMS REPORT	6JUN01	
START OU-1085 DRAFT RFI WORKPLAN	10CT92	
FINISH OU-1085 DRAFT RFI WORKPLAN	24MAY94	
FINISH OU-1085 FINAL RFI WORKPLAN	31OCT94	
START OU-1085 RFI	31OCT94	
START OU-1085 DRAFT RFI REPORT	19MAY98	
FINISH OU-1085 RFI	29OCT99	
FINISH OU-1085 DRAFT RFI REPORT	29OCT99	
FINISH OU-1085 FINAL RFI REPORT	17APR00	
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FINISH OU-1085 DRAFT CMS PLAN	12JUL00	
START OU-1085 CMS	12JUL00	
START OU-1085 DRAFT CMS REPORT	20NOV00	
FINISH OU-1085 FINAL CMS PLAN	20DEC00	
FINISH OU-1085 CMS	21DEC01	
FINISH OU-1085 DRAFT CMS REPORT	21DEC01	
FINISH OU-1085 FINAL CMS REPORT	7JUN02	
START OU-1086 DRAFT RFI WORKPLAN	10CT91	
FINISH OU-1086 DRAFT RFI WORKPLAN	24MAY93	
FINISH OU-1086 FINAL RFI WORKPLAN	29OCT93	
START OU-1086 RFI	29OCT93	
START OU-1086 DRAFT RFI REPORT	16MAY97	
FINISH OU-1086 RFI	28OCT98	
FINISH OU-1086 DRAFT RFI REPORT	28OCT98	
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START OU-1086 CMS	13JUL99	
START OU-1086 CMS REPORT	19NOV99	
FINISH OU-1086 FINAL CMS PLAN	21DEC99	
FINISH OU-1086 CMS	21DEC00	
FINISH OU-1086 CMS REPORT	21DEC00	
FINISH OU-1086 FINAL CMS REPORT	6JUN01	
START OU-1093 DRAFT RFI WORKPLAN	10CT91	
FINISH OU-1093 DRAFT RFI WORKPLAN	24MAY93	
START OU-1093 RFI	29OCT93	
START OU-1093 DRAFT RFI REPORT	16MAY97	
FINISH OU-1093 RFI	28OCT98	
FINISH OU-1093 DRAFT RFI REPORT	28OCT98	
FINISH OU-1093 FINAL RFI REPORT	16APR99	
START OU-1093 CMS PLAN	16APR99	
FINISH OU-1093 CMS PLAN	13JUL99	
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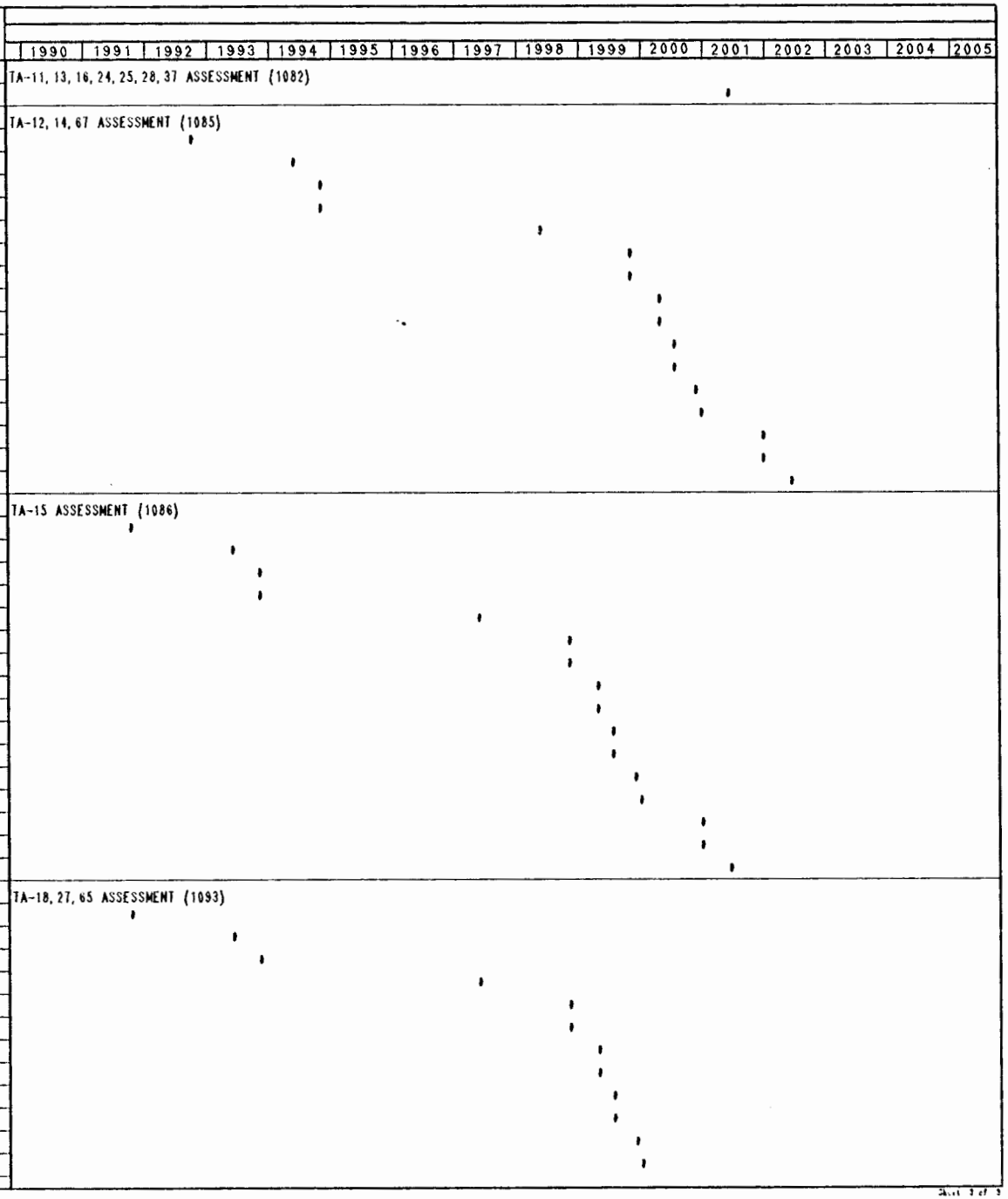

ACTIVITY DESCRIPTION	EARLY START	EARLY FINISH
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FINISH OU-1093 DRAFT CMS REPORT	21DEC00	
FINISH OU-1093 FINAL CMS REPORT	6JUN01	
START OU-1098 DRAFT RFI WORKPLAN	10CT91	
FINISH OU-1098 DRAFT RFI WORKPLAN	24MAY93	
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FINISH OU-1100 DRAFT RFI WORKPLAN	24MAY94	
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START OU-1100 RFI	31OCT94	
START OU-1100 DRAFT RFI REPORT	19MAY98	
FINISH OU-1100 RFI	29OCT99	
FINISH OU-1100 DRAFT RFI REPORT	29OCT99	
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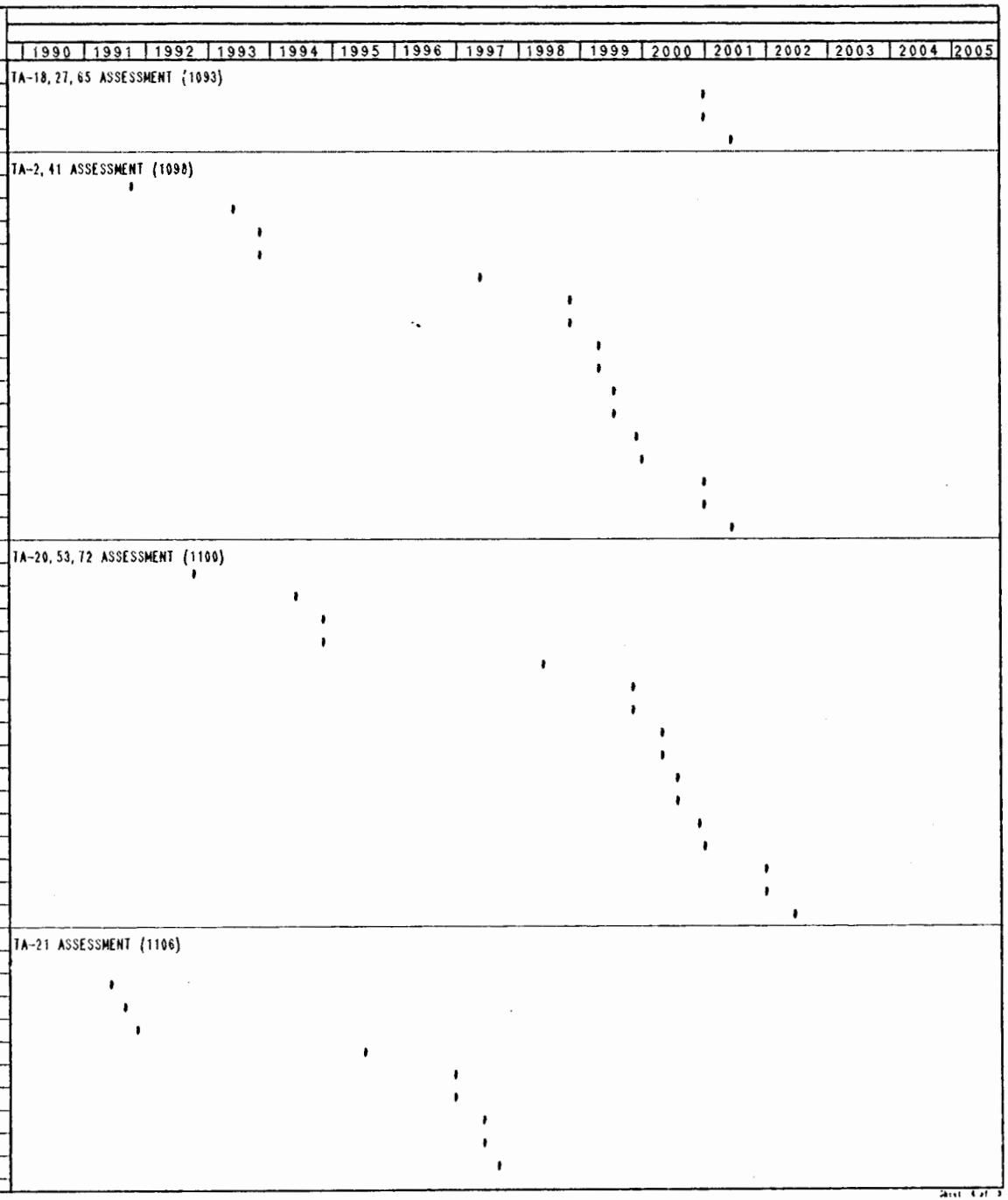
FINISH OU-1100 DRAFT CMS REPORT	21DEC01	
FINISH OU-1100 FINAL CMS REPORT	7JUN02	
START OU-1106 DRAFT RFI WORKPLAN	20CT89	
FINISH OU-1106 DRAFT RFI WORKPLAN	22MAY91	
FINISH OU-1106 FINAL RFI WORKPLAN	16AUG91	
START OU-1106 RFI	29OCT91	
START OU-1106 DRAFT RFI REPORT	29JUN95	
FINISH OU-1106 RFI	11DEC96	
FINISH OU-1106 DRAFT RFI REPORT	11DEC96	
FINISH OU-1106 FINAL RFI REPORT	28MAY97	
START OU-1106 DRAFT CMS PLAN	28MAY97	
FINISH OU-1106 DRAFT CMS PLAN	21AUG97	



ACTIVITY DESCRIPTION	EARLY START	EARLY FINISH
TA-21 ASSESSMENT (1106)		
START OU-1106 CMS	21AUG97	
START OU-1106 DRAFT CMS REPORT	13JAN98	
FINISH OU-1106 FINAL CMS PLAN	10FEB98	
FINISH OU-1106 CMS	12FEB99	
FINISH OU-1106 DRAFT CMS REPORT	12FEB99	
FINISH OU-1106 FINAL CMS REPORT	21JUL99	
TA-6, 7, 22, 40, 58, 62 ASSESSMENT (1111)		
START OU-1111 DRAFT RFI WORKPLAN	10CT91	
FINISH OU-1111 DRAFT RFI WORKPLAN	24MAY93	
FINISH OU-1111 FINAL RFI WORKPLAN	29OCT93	
START OU-1111 RFI	29OCT93	
START OU-1111 DRAFT RFI REPORT	16MAY97	
FINISH OU-1111 RFI	28OCT98	
FINISH OU-1111 DRAFT RFI REPORT	28OCT98	
FINISH OU-1111 FINAL RFI REPORT	16APR99	
START OU-1111 DRAFT CMS PLAN	16APR99	
FINISH OU-1111 DRAFT CMS PLAN	13JUL99	
START OU-1111 CMS	13JUL99	
START OU-1111 DRAFT CMS REPORT	19NOV99	
FINISH OU-1111 FINAL CMS PLAN	21DEC99	
FINISH OU-1111 CMS	21DEC00	
FINISH OU-1111 DRAFT CMS REPORT	21DEC00	
FINISH OU-1111 FINAL CMS REPORT	6JUN01	
TA-3, 59, 60, 61, 64 ASSESSMENT (1114)		
START OU-1114 DRAFT RFI WORKPLAN	10CT91	
FINISH OU-1114 DRAFT RFI WORKPLAN	24MAY93	
FINISH OU-1114 FINAL RFI WORKPLAN	29OCT93	
START OU-1114 RFI	29OCT93	
START OU-1114 DRAFT RFI REPORT	16MAY97	
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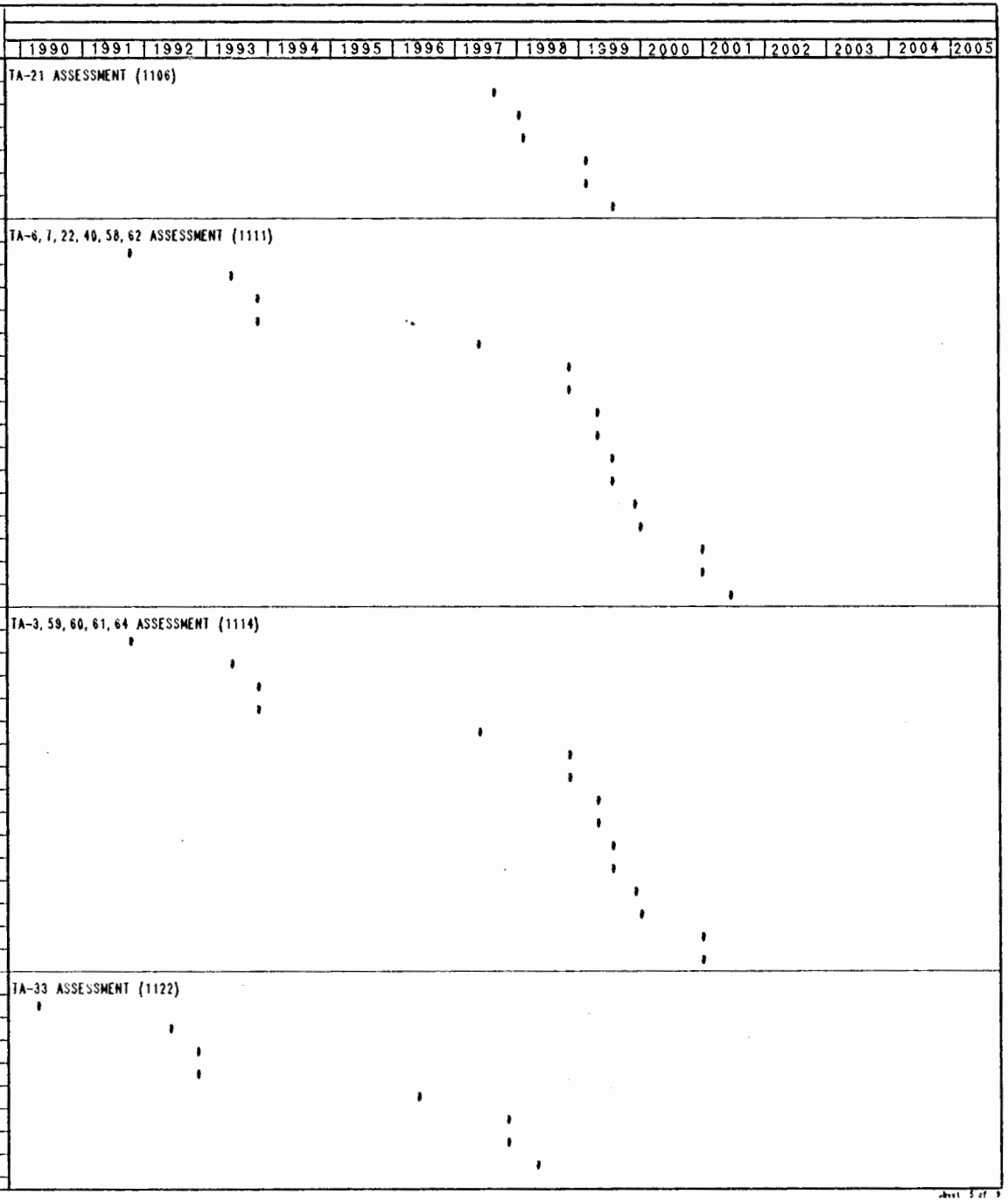
FINISH OU-1114 DRAFT RFI REPORT	28OCT98	
FINISH OU-1114 FINAL RFI REPORT	16APR99	
START OU-1114 DRAFT CMS PLAN	16APR99	
FINISH OU-1114 DRAFT CMS PLAN	13JUL99	
START OU-1114 CMS	13JUL99	
START OU-1114 DRAFT CMS REPORT	19NOV99	
FINISH OU-1114 FINAL CMS PLAN	21DEC99	
FINISH OU-1114 CMS	21DEC00	
FINISH OU-1114 DRAFT CMS REPORT	21DEC00	
TA-33 ASSESSMENT (1122)		
START OU-1122 DRAFT RFI WORK PLAN	2APR90	
FINISH OU-1122 DRAFT RFI WORKPLAN	22MAY92	
FINISH OU-1122 FINAL RFI WORKPLAN	29OCT92	
START OU-1122 RFI	29OCT92	
START OU-1122 DRAFT RFI REPORT	16MAY96	
FINISH OU-1122 RFI	28OCT97	
FINISH OU-1122 DRAFT RFI REPORT	28OCT97	
FINISH OU-1122 FINAL RFI REPORT	16APR98	



ACTIVITY DESCRIPTION	EARLY START	EARLY FINISH
TA-33 ASSESSMENT (1122)		
START OU-1122 DRAFT CMS PLAN	16APR98	
FINISH OU-1122 DRAFT CMS PLAN	13JUL98	
START OU-1122 CMS	13JUL98	
START OU-1122 DRAFT CMS REPORT	19NOV98	
FINISH OU-1122 FINAL CMS PLAN	21DEC98	
FINISH OU-1122 CMS	23DEC99	
FINISH OU-1122 DRAFT CMS REPORT	23DEC99	
FINISH OU-1122 FINAL CMS REPORT	7JUN00	
TA-4, 5, 35, 42, 48, 52, 55, 63, 66 ASSESSMENT (1129)		
START OU-1129 DRAFT WORKPLAN	10CT90	
FINISH OU-1129 DRAFT RFI WORKPLAN	22MAY92	
FINISH OU-1129 FINAL RFI WORKPLAN	29OCT92	
START OU-1129 RFI	29OCT92	
START OU-1129 DRAFT RFI REPORT	16MAY96	
FINISH OU-1129 RFI	28OCT97	
FINISH OU-1129 DRAFT RFI REPORT	28OCT97	
FINISH OU-1129 FINAL RFI REPORT	16APR98	
START OU-1129 DRAFT CMS PLAN	16APR98	
FINISH OU-1129 DRAFT CMS PLAN	13JUL98	
START OU-1129 CMS	13JUL98	
START OU-1129 DRAFT CMS REPORT	19NOV98	
FINISH OU-1129 FINAL CMS PLAN	21DEC98	
FINISH OU-1129 CMS	23DEC99	
FINISH OU-1129 DRAFT CMS REPORT	23DEC99	
FINISH OU-1129 FINAL CMS REPORT	7JUN00	
TA-36, 68, 71 ASSESSMENT (1130)		
START OU-1130 DRAFT RFI WORKPLAN	10CT91	
FINISH OU-1130 DRAFT RFI WORKPLAN	24MAY93	
FINISH OU-1130 FINAL RFI WORKPLAN	29OCT93	
START OU-1130 RFI	29OCT93	
START OU-1130 DRAFT RFI REPORT	16MAY97	
FINISH OU-1130 RFI	28OCT98	
FINISH OU-1130 DRAFT RFI REPORT	28OCT98	
FINISH OU-1130 FINAL RFI REPORT	16APR99	
START OU-1130 DRAFT CMS PLAN	16APR99	
FINISH OU-1130 DRAFT CMS PLAN	13JUL99	
START OU-1130 CMS	13JUL99	
START OU-1130 DRAFT CMS REPORT	19NOV99	
FINISH OU-1130 FINAL CMS PLAN	21DEC99	
FINISH OU-1130 CMS	21DEC00	
FINISH OU-1130 DRAFT CMS REPORT	21DEC00	
FINISH OU-1130 FINAL CMS REPORT	6JUN01	
TA-39 ASSESSMENT (1132)		
START OU-1132 DRAFT RFI WORKPLAN	10CT91	
FINISH OU-1132 DRAFT RFI WORKPLAN	24MAY93	
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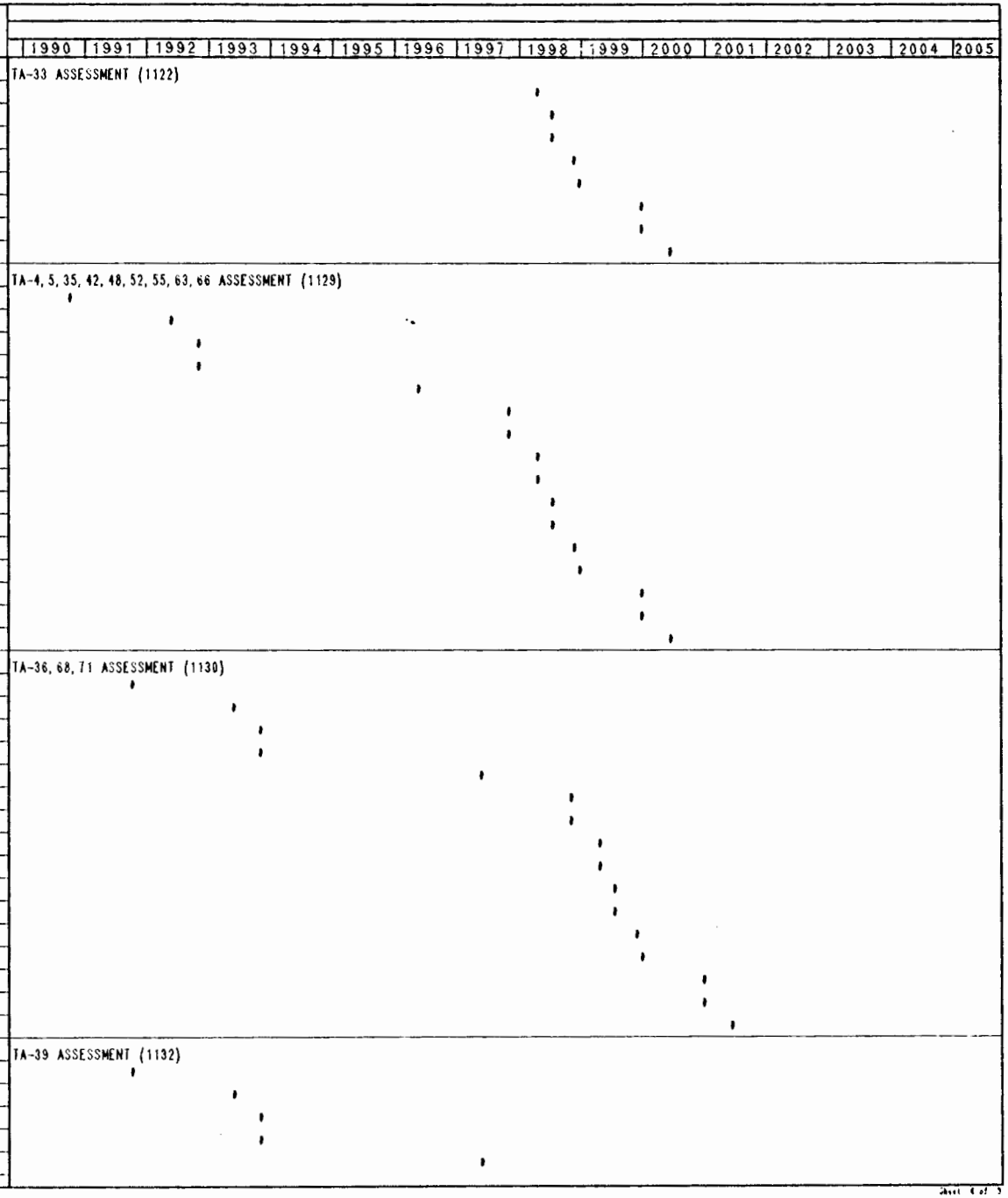

ACTIVITY DESCRIPTION	EARLY START	EARLY FINISH
FINISH OU-1132 RFI	28OCT98	
FINISH OU-1132 DRAFT RFI REPORT	28OCT98	
FINISH OU-1132 FINAL RFI REPORT	16APR99	
START OU-1132 DRAFT CMS PLAN	16APR99	
FINISH OU-1132 DRAFT CMS PLAN	13JUL99	
START OU-1132 CMS	13JUL99	
START OU-1132 DRAFT CMS REPORT	19NOV99	
FINISH OU-1132 FINAL CMS PLAN	21DEC99	
FINISH OU-1132 CMS	21DEC00	
FINISH OU-1132 DRAFT CMS REPORT	21DEC00	
FINISH OU-1132 FINAL CMS REPORT	6JUN01	
START OU-1136 DRAFT RFI WORKPLAN	10CT92	
FINISH OU-1136 DRAFT RFI WORKPLAN	24MAY94	
FINISH OU-1136 FINAL RFI WORKPLAN	31OCT94	
START OU-1136 RFI	31OCT94	
START OU-1136 DRAFT RFI REPORT	19MAY98	
FINISH OU-1136 RFI	29OCT99	
FINISH OU-1136 DRAFT RFI REPORT	29OCT99	
FINISH OU-1136 FINAL RFI REPORT	17APR00	
START OU-1136 DRAFT CMS PLAN	17APR00	
FINISH OU-1136 DRAFT CMS PLAN	12JUL00	
START OU-1136 CMS	12JUL00	
START OU-1136 DRAFT CMS REPORT	20NOV00	
FINISH OU-1136 FINAL CMS PLAN	20DEC00	
FINISH OU-1136 CMS	21DEC01	
FINISH OU-1136 DRAFT CMS REPORT	21DEC01	
FINISH OU-1136 FINAL CMS REPORT	7JUN02	
START OU-1140 DRAFT RFI WORKPLAN	10CT91	
FINISH OU-1140 DRAFT RFI WORKPLAN	24MAY93	
FINISH OU-1140 FINAL RFI WORKPLAN	29OCT93	
START OU-1140 RFI	29OCT93	
START OU-1140 DRAFT RFI REPORT	16MAY97	
FINISH OU-1140 RFI	28OCT98	
FINISH OU-1140 DRAFT RFI REPORT	28OCT98	
FINISH OU-1140 FINAL RFI REPORT	16APR99	
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START OU-1140 DRAFT CMS REPORT	19NOV99	
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FINISH OU-1140 DRAFT CMS REPORT	21DEC00	
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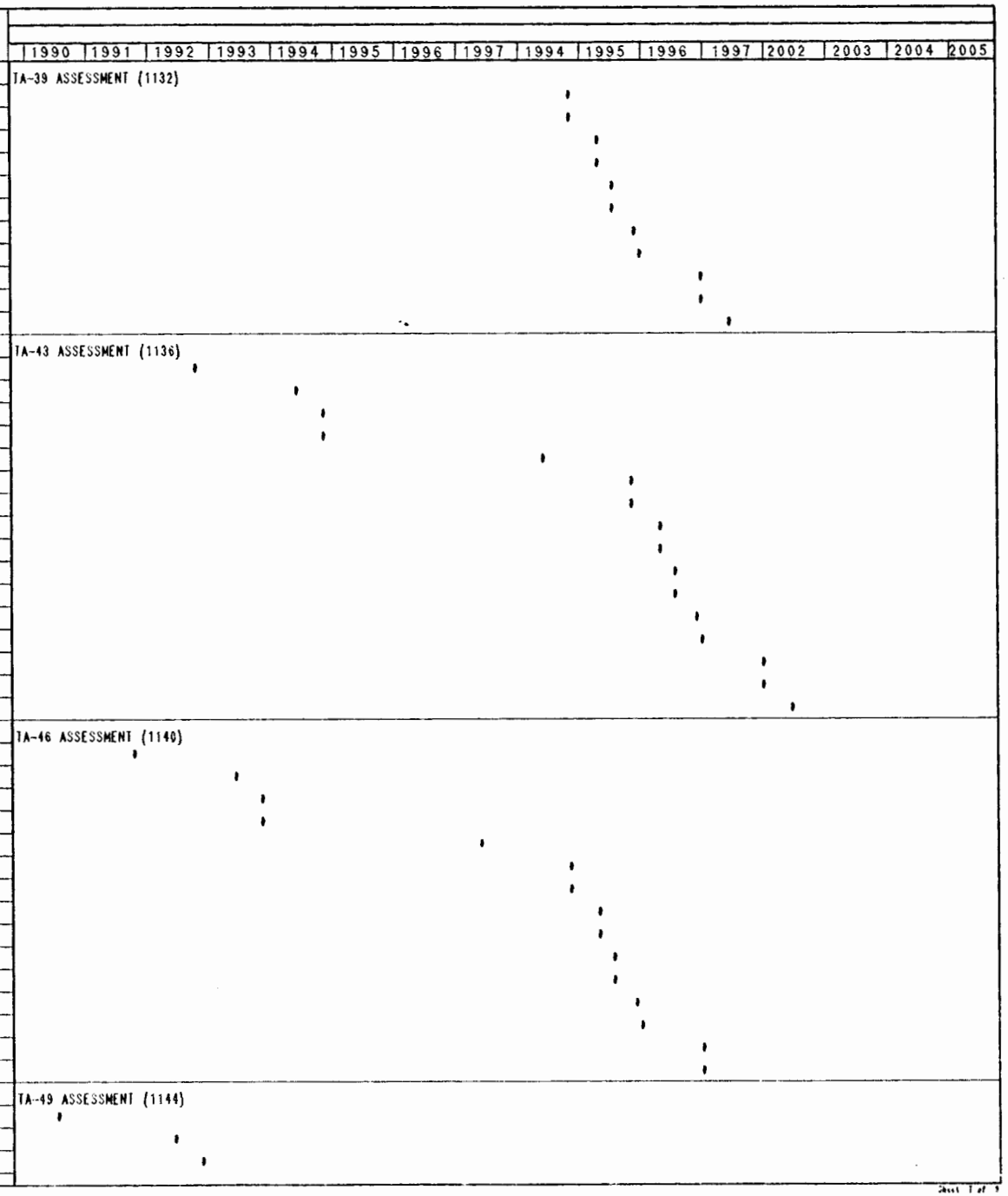
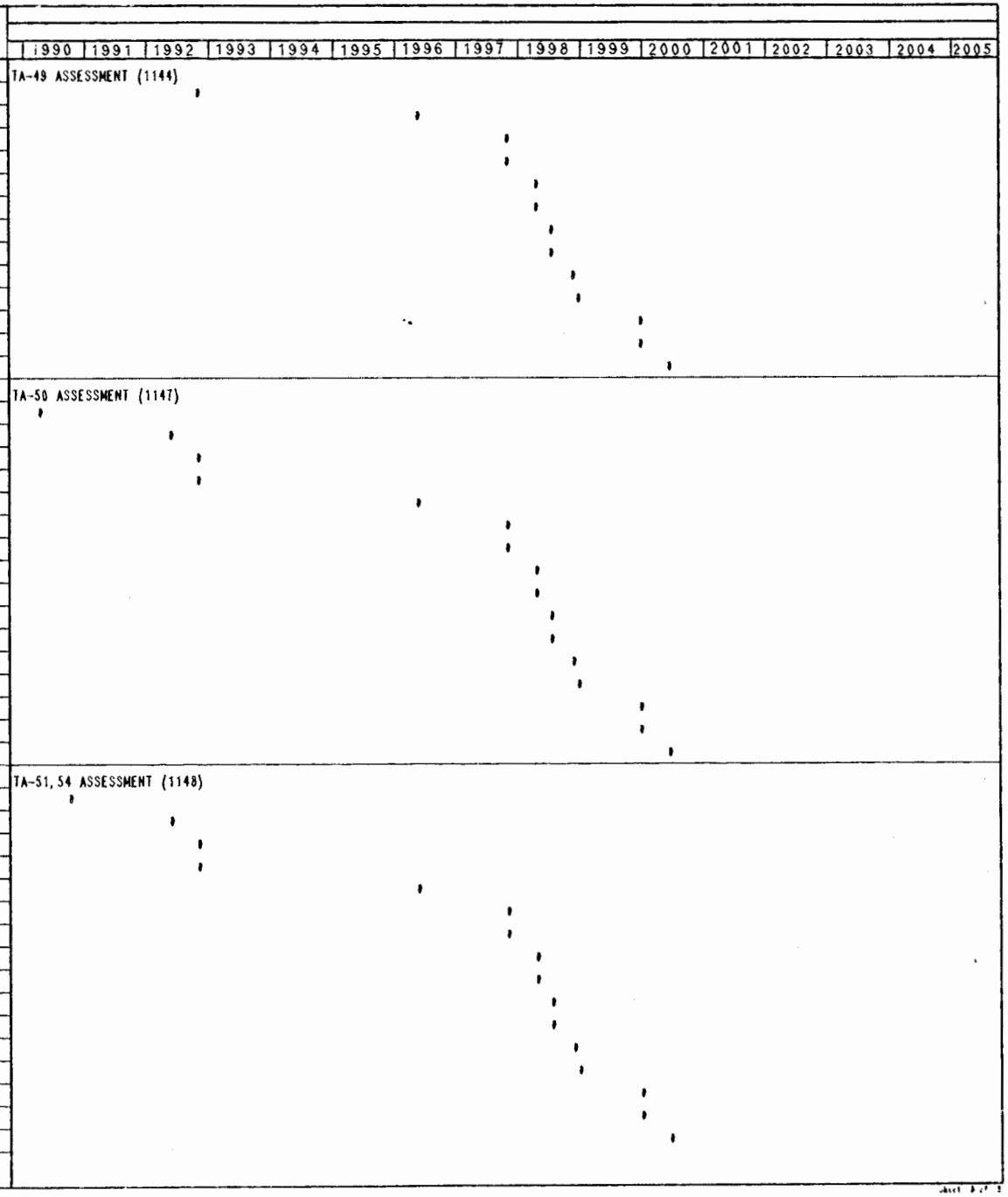
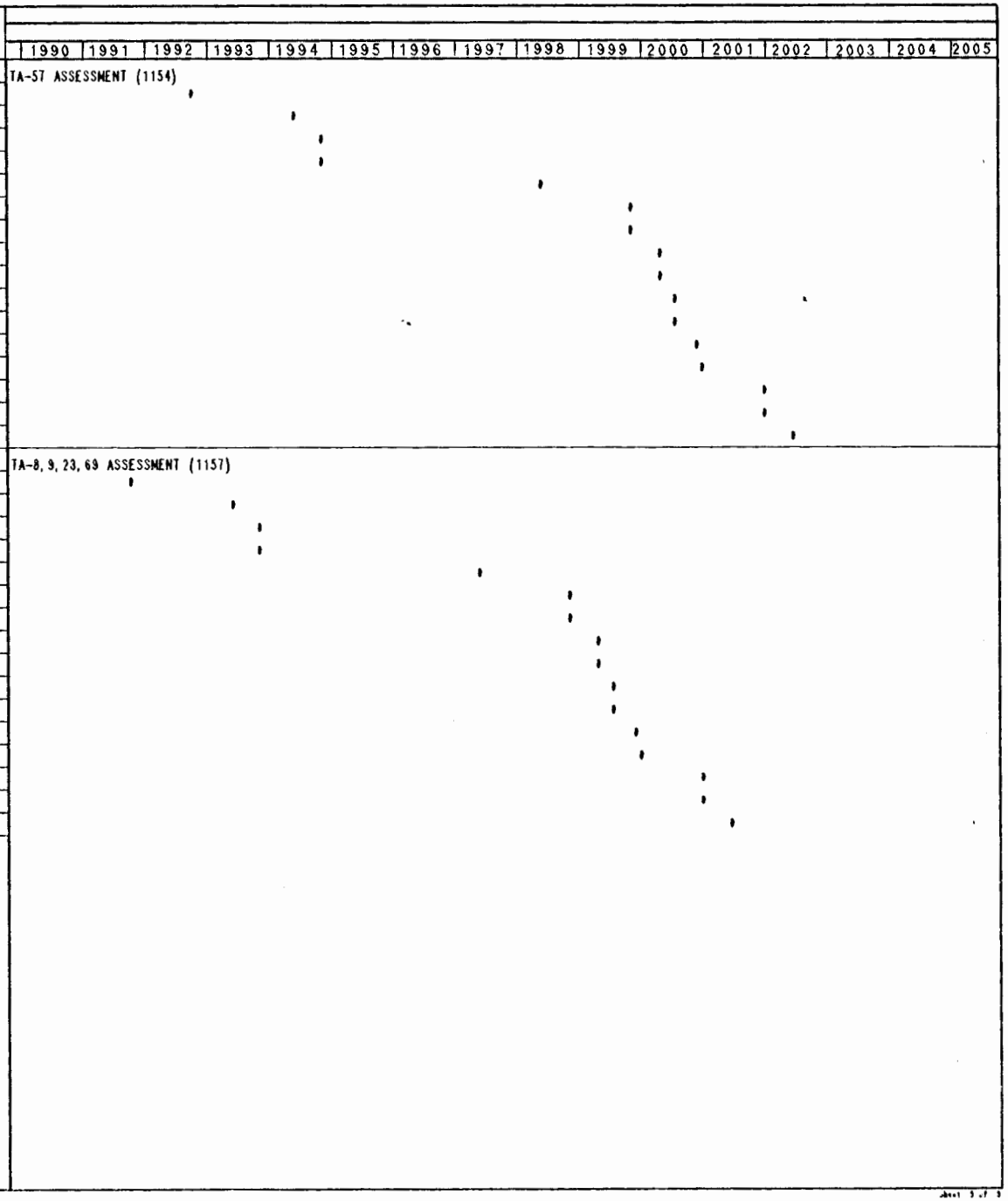
FINISH OU-1144 RFI WORKPLAN	29OCT92	



ACTIVITY DESCRIPTION	EARLY START	EARLY FINISH
TA-49 ASSESSMENT (1144)		
START OU-1144 RFI	29OCT92	
START OU-1144 DRAFT RFI REPORT	16MAY96	
FINISH OU-1144 RFI	28OCT97	
FINISH OU-1144 DRAFT RFI REPORT	28OCT97	
FINISH OU-1144 FINAL RFI REPORT	16APR98	
START OU-1144 DRAFT CMS PLAN	16APR98	
FINISH OU-1144 DRAFT CMS PLAN	13JUL98	
START OU-1144 CMS	13JUL98	
START OU-1144 DRAFT CMS REPORT	19NOV98	
FINISH OU-1144 FINAL CMS PLAN	21DEC98	
FINISH OU-1144 CMS	23DEC99	
FINISH OU-1144 DRAFT CMS REPORT	23DEC99	
FINISH OU-1144 FINAL CMS REPORT	7JUN00	
TA-50 ASSESSMENT (1147)		
START OU-1147 DRAFT RFI WORKPLAN	6APR90	
FINISH OU-1147 DRAFT RFI WORKPLAN	22MAY92	
FINISH OU-1147 FINAL RFI WORKPLAN	29OCT92	
START OU-1147 RFI	29OCT92	
START OU-1147 DRAFT RFI REPORT	16MAY96	
FINISH OU-1147 RFI	28OCT97	
FINISH OU-1147 DRAFT RFI REPORT	28OCT97	
FINISH OU-1147 FINAL RFI REPORT	16APR98	
START OU-1147 DRAFT CMS PLAN	16APR98	
FINISH OU-1147 DRAFT CMS PLAN	13JUL98	
START OU-1147 CMS	13JUL98	
START OU-1147 DRAFT CMS REPORT	19NOV98	
FINISH OU-1147 FINAL CMS PLAN	21DEC98	
FINISH OU-1147 CMS	23DEC99	
FINISH OU-1147 DRAFT CMS REPORT	23DEC99	
FINISH OU-1147 FINAL CMS REPORT	7JUN00	
TA-51, 54 ASSESSMENT (1148)		
START OU-1148 DRAFT RFI WORKPLAN	10CT90	
FINISH OU-1148 DRAFT RFI WORKPLAN	22MAY92	
FINISH OU-1148 RFI WORKPLAN	29OCT92	
START OU-1148 RFI	29OCT92	
START OU-1148 DRAFT RFI REPORT	16MAY96	
FINISH OU-1148 RFI	28OCT97	
FINISH OU-1148 DRAFT RFI REPORT	28OCT97	
FINISH OU-1148 FINAL RFI REPORT	16APR98	
START OU-1148 DRAFT CMS PLAN	16APR98	
FINISH OU-1148 DRAFT CMS PLAN	13JUL98	
START OU-1148 CMS	13JUL98	
START OU-1148 DRAFT CMS REPORT	19NOV98	
FINISH OU-1148 FINAL CMS PLAN	21DEC98	
FINISH OU-1148 CMS	23DEC99	
FINISH OU-1148 DRAFT CMS REPORT	23DEC99	
FINISH OU-1148 FINAL CMS REPORT	7JUN00	



ACTIVITY DESCRIPTION	EARLY START	EARLY FINISH
TA-57 ASSESSMENT (1154)		
START OU-1154 DRAFT RFI WORKPLAN	10CT92	
FINISH OU-1154 DRAFT RFI WORKPLAN	24MAY94	
FINISH OU-1154 FINAL RFI WORKPLAN	31OCT94	
START OU-1154 RFI	31OCT94	
START OU-1154 DRAFT RFI REPORT	19MAY98	
FINISH OU-1154 RFI	29OCT99	
FINISH OU-1154 DRAFT RFI REPORT	29OCT99	
FINISH OU-1154 FINAL RFI REPORT	17APR00	
START OU-1154 DRAFT CMS PLAN	17APR00	
FINISH OU-1154 DRAFT CMS PLAN	12JUL00	
START OU-1154 CMS	12JUL00	
START OU-1154 DRAFT CMS REPORT	20NOV00	
FINISH OU-1154 FINAL CMS PLAN	20DEC00	
FINISH OU-1154 CMS	21DEC01	
FINISH OU-1154 DRAFT CMS REPORT	21DEC01	
FINISH OU-1154 FINAL CMS REPORT	7JUN02	
TA-8, 9, 23, 69 ASSESSMENT (1157)		
START OU-1157 DRAFT RFI WORKPLAN	10CT91	
FINISH OU-1157 DRAFT RFI WORKPLAN	24MAY93	
FINISH OU-1157 FINAL RFI WORKPLAN	29OCT93	
START OU-1157 RFI	29OCT93	
START OU-1157 DRAFT RFI REPORT	16MAY97	
FINISH OU-1157 RFI	28OCT98	
FINISH OU-1157 DRAFT RFI REPORT	28OCT98	
FINISH OU-1157 FINAL RFI REPORT	16APR99	
START OU-1157 DRAFT CMS PLAN	16APR99	
FINISH OU-1147 DRAFT CMS PLAN	13JUL99	
START OU-1157 CMS	13JUL99	
START OU-1157 DRAFT CMS REPORT	19NOV99	
FINISH OU-1157 FINAL CMS PLAN	21DEC99	
FINISH OU-1157 CMS	21DEC00	
FINISH OU-1157 DRAFT CMS REPORT	21DEC00	
FINISH OU-1157 FINAL CMS REPORT	6JUN01	



APPENDIX T

Preliminary List of Activities in Records Management System

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1.0 Configuration Management
2.0 Control of Access to Data and Records
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7.6 Records Entry
7.7 Data Quality Objectives Screening and Validation
7.8 Data Reduction
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7.10 Derived Data
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7.13 Records Archiving
7.14 Records Disposal

8.0 Video Capture
9.0 Optical Storage
10.0 Records Inventory
11.0 Disaster Recovery Plan
12.0 Review Procedure

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12.2 Policy Reviews

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14.0 Formal Retention Schedules

PRELIMINARY LIST OF ACTIVITIES RELATED TO THE RECORDS MANAGEMENT PROGRAM

The activities listed in this appendix may or may not warrant a procedure exclusively written for the specific action. It is probable that certain sequences of related activities can be handled through a single quality administrative procedure (QP). The reference to some of these activities as a "procedure" will remain until this determination has been made. Also, some of these activities will be handled under guidance from the Quality Program Plan (QPP).

1.0 Configuration Management

A procedure/plan for "configuration management" documents the process of systems development for identifying the relevant system configuration at any given time in the life of the Environmental Restoration (ER) Program. The documentation may be brief as long as the necessary information is included.

2.0 Control of Access to Data and Records

Specific controls for access to ER Program data and records are necessary to ensure their integrity. These controls will be defined in procedures written for users and will be consistent with guidance from US Department of Energy (DOE) Order 1360.2 and procedures defined in AL Order 1360.2A.

3.0 Correction Request

Once a record has been submitted to the Records Processing Facility (RPF) for inclusion in the Facility for Information Management, Analysis, and Display (FIMAD), a formal "correction request" must be submitted to change information. A simple form will be used to implement a change that may be categorized as an "addition," "revision," or "deletion." This approach allows for changes to records previously submitted but also ensures that documentation will be in place. Superseded records will be disposed of when a correction request is implemented.

4.0 Controlled Documents

Certain documents within the ER Program will require a document control procedure. This procedure will define the assignment of document custody for a designated copy to a responsible party. This allows subsequent updates or revisions to be forwarded to the custodian without reissuing the entire revised/updated document. Typically, workstation user manuals or QP manuals will be controlled documents.

5.0 File Backup

A procedure for backing up ER Program files at the FIMAD will direct the use of a high-speed backup system to be used at regular intervals. A backup schedule and procedure will be defined before the system is implemented.

6.0 File Transfer by Electronic Media

A procedure is required to ensure that records transferred electronically are tracked and documented throughout the process and that transfer activities are conducted uniformly and consistently.

7.0 Processing of Data and Records

Specific steps in the processing of records are defined in the following activities.

7.1 Collection and Compilation

Collection and compilation activities will primarily be defined in Sampling Plans, Quality Technical Implementing Procedures, or similar elements of the program. This section is included as a place-holder for aspects of records collection that may not clearly fall within those areas.

7.2 Originator Review for Submittal to FIMAD

Records capture will be initiated through submittal to the referable information base called the FIMAD by way of the RPF. Submittal will be at the discretion of program participants, but will be documented by completing the ER Record Package Transmittal Form consistent with the Procedure for LANL ER Records Management (LANL-ER-QP-xx.x,R0) when the procedure is finalized and approved.

7.3 Records Review

Definition of the process for pre-entry data review and screening is needed.

7.4 Records Acceptance/Rejection

Pre-entry record package acceptance/rejection is based upon completeness of information on the ER Record Package Transmittal Form. If accepted, the record package will continue through the processing cycle delineated in Fig. V-1 of the Records Management Plan (RMP). If the package is not accepted, it is returned to the originator for appropriate action.

7.5 Indexing of Data/Record

Environmental restoration identification numbers will be assigned by the originating office to all record packages submitted. The numbers are unique identifiers for each record submittal. Specific guidance is included in the Procedure for LANL ER Records Management.

7.6 Records Entry

Procedures for entering records into the FIMAD will be written and closely coordinated with the Quality Program. Most of the steps for entry may become automated by using scanning, electronic transfer, or other record-capture techniques. The computerized application of screening methods using geostatistics, detection limits, and/or confidence levels for defining acceptable ranges of entered values will enhance data entry and verification.

7.7 Data Quality Objectives Screening and Validation

Definitive guidance is needed for how data quality objectives (DQOs) are defined and applied. The DQOs will be defined in the Operable Unit work plans and should be included with the record packages submitted to the FIMAD. Even if data are collected at a given DQO level following requirements in a field sampling plan, they need to be validated to make sure that the DQO level was actually met. If records are deleted based on failure to meet DQOs, how the criteria are applied must be documented.

7.8 Data Reduction

Guidelines are needed to protect the original values of certain types of data requiring additional processing (e.g., calibration-corrected data and data derived from other data sets).

7.9 Calibration Corrections

The means to identify and link corrected data to the relevant Quality Program documentation for instrument calibration must be identified. This activity may be completed before submitting the records package.

7.10 Derived Data

The means of identifying data derived from other data sets and a way of identifying contributing data to ensure reproducibility are needed.

7.11 Records Verification

The criteria that apply to verifying data for QP documentation need to be defined.

7.12 Records Filing Requirements

The means for periodic screening of program filing requirements for records must be defined. This will ensure consistency with OSWER Directive 9902.3 and coordination with DOE guidance on records disposition (DOE Orders 1324.2A and N 1324.11).

7.13 Records Archiving

The process for archiving records is included in the Procedure for LANL ER Records Management (LANL-ER-QP-xx.x,R0). How the archived records will be reviewed for retention and ultimately retired will have to be determined. Parts of the process may depend on FIMAD capabilities.

7.14 Records Disposal

Guidance for disposing of records will be developed in accordance with DOE guidance on records disposal, (e.g., DOE Orders 1324.2A and N 1324.11) in collaboration with the Communications and Records Management Division (CRM).

8.0 Video Capture

Video-capture techniques may be used in certain archive activities. This technology will complement the FIMAD and will involve developing a video server to handle image capture/retrieval of video images for the following:

- photo-documentation of cleanup activities and field procedures;
- "scientific visualization" of complex phenomena (e.g., hydrologic phenomena); and
- full-text retrieval for scientific documentation and reports.

9.0 Optical Storage

Optical storage systems will be used in records management activities where possible so Technical Implementing Procedures (TIPs) for handling records on optical storage media will be required. Defensibility of the optical records will depend upon the implementation of procedures, training, documentation that the procedures were used properly, and archival of original submissions at a separate location.

10.0 Records Inventory

Determining the extent and nature of the ER Program's present system of relevant records is an important preliminary step to developing and implementing an effective RMP. This is accomplished through a records inventory that identifies the types, quantities, locations, and values of the existing records. A preliminary inventory of existing and anticipated program records was completed to help justify and define the system configuration and storage requirements. A more definitive inventory should be done to provide a basis for better defining document conversion requirements and implementing retention schedules.

11.0 Disaster Recovery Plan

A disaster recovery plan is to be developed in collaboration with the Computing and Communications (C) Division . This plan will include relevant procedures to ensure a reasonable time-frame for business resuming. Important elements of the plan should include (but are not limited to) the following:

1) Disaster Recovery Plan Report
   - Assumptions and considerations
   - Recovery requirements
   - Description of all resources reviewed, highlighting the critical resources

- Strategies considered and recommended strategy
- Detailed recovery procedures
- Emergency Plan and Backup Plan
- Staffing and responsibilities
- Maintenance and testing procedures

2) Recommendations for actions to management
3) Documentation and related information

12.0 Review Procedure

12.1 *Technical Reviews*

How reports, or similar documents, will be reviewed for technical merit before being released outside the Laboratory needs to be defined. Each "technical team" will develop a list of approved technical reviewers with expertise relevant to the particular discipline.

12.2 *Policy Reviews*

Information can be misconstrued when released prematurely. It is imperative that the ER Program Office maintain "right of approval" pertaining to issues of policy that may be inherently included within reports or similar documents. Guidance is needed for accomplishing this expeditiously.

13.0 Data Dictionary

Input from Technical Teams is needed to assist with the development of a "data dictionary" for the ER Program. This document will define the characteristics of data sets so that they are consistently understood program wide.

14.0 Formal Retention Schedules

Collaboration with CRM Division has been established to ensure that periodic review of records for maintenance of retention schedules is performed. This will ensure that regulatory requirements are fulfilled and that records are retired in a timely manner to avoid unnecessary storage.

APPENDIX U

List of Contributors

LIST OF CONTRIBUTORS TO INSTALLATION WORK PLAN

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