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Date: December 20, 1996
Refer to: EM/ER:96-628

Mr. Benito Garcia
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LANL HSWA GW PERMIT/96

SUBJECT: SUBMITTAL OF THE LOS ALAMOS NATIONAL LABORATORY ER PROJECT'S 1996 IWP

Dear Mr. Garcia:

Enclosed is the Environmental Restoration (ER) Project's 1996 Installation Work Plan (IWP) update. Because we have not yet received a final budget for fiscal year 1997 (FY97), we have not included Appendix C, the Schedule of Compliance. Appendix C will be delivered when we have finished our baseline to reflect the FY97 budget. We request that the specific content and format of Appendix C be jointly agreed upon by members of our staff and yours at the regularly scheduled meeting in January 1997.

This revision of the IWP does not have significant changes; however, changes can be found in the hydrology section of Chapter 2, as per your request, and in Chapter 3, which have been updated to reflect the progress made over the last year.

Chapter 4, the ER Project's Quality Assurance Project Plan (QAPP) has also been updated. The QAPP is also used by the ER Project as a separate, stand-alone document; therefore, it is presented in a modified format from the rest of the IWP.

In addition, Appendix A, which describes the technical areas at the Laboratory, has been revised to show a more logical grouping of the technical areas (TAs) at the Laboratory rather than listing each TA separately. Appendix B, the potential release site list, is the current printout, which reflects the changes that have occurred since November 1995.

We expect to deliver the Schedule of Compliance no later then the end of February 1997. Please call Tracy Glatzmaier at (505) 665-2613 or Ted Taylor at (505) 665-7203 if you have any questions.

Sincerely,

Jorg Jansen, Program Manager
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Sincerely,

Theodore J. Taylor, Program Manager
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12

Enclosure: Final Version of the Installation Work Plan for ER (Rev. 6)

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CERTIFICATION

I certify under penalty of law that these documents and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated 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 violation.

Document Title: Installation Work Plan for Environmental Restoration Project, Revision 6

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Installation Work Plan for Environmental Restoration Program

Revision 6

December 1996

A Department of Energy
Environmental Cleanup Program

TRACKED COPY #2

Los Alamos
NATIONAL LABORATORY

LA-UR-96-4629

EXECUTIVE SUMMARY

Background

In 1989, the US Department of Energy (DOE) created the Office of Environmental Restoration and Waste Management (EM). The goal of this office is to implement the department's policy of ensuring that its past, present, and future operations do not threaten human health, 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. Among other responsibilities, the EM Office is responsible for assessing, cleaning up, and decommissioning sites at DOE facilities and at sites formerly used by DOE and its predecessors. This Installation Work Plan (IWP) describes how the DOE and the University of California (UC) are conducting the office's ER Project at Los Alamos National Laboratory (the 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 fingerlike mesas, whose 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's current central mission is reducing global nuclear danger. This mission supports core competencies that enable the Laboratory to also contribute to defense, civilian, and industrial needs. In turn, the intellectual challenges of civilian and industrial problems strengthen the core competencies for the defense programs. The core competencies include the following: complex experimentation and measurement; theory, modeling, and high-performance computing; analysis and assessment; nuclear weapons science and technology; earth and environmental science; nuclear and advanced materials; bioscience and biotechnology; and nuclear science, plasmas, and beams.

Since the early 1970s, the Laboratory has reported the results of an environmental surveillance program that routinely samples air, water, soil, and foodstuffs throughout the Los Alamos area to determine whether contamination from Laboratory operations is present and, if so, at what levels. The data collected under 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 threaten human health or the environment. The ER Project at the Laboratory augments the environmental surveillance program by identifying potential threats to human health and the environment from past Laboratory operations 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/or treatment of the source to remove hazards to health and the environment.

Statutory Basis of the ER Project

The ER Project at the Laboratory responds to two primary laws: the Resource Conservation and Recovery Act (RCRA), which is the statutory basis for the ER Project at the Laboratory, and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), which provides a reference for remediating sites at the Laboratory that contain certain hazardous substances not covered by RCRA. The hazardous waste provisions of RCRA govern the day-to-day

operations of hazardous waste management, treatment, storage, and disposal (TSD) facilities. The law established a permitting system and set standards for all hazardous-waste-producing operations at a 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 (HSWA). 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 investigate and clean up contamination in areas designated as solid waste management units (SWMUs).

The Environmental Protection Agency (EPA) issued the HSWA Module to the Laboratory's RCRA operating permit in 1990. The New Mexico Environment Department (NMED) obtained corrective action authority from EPA on January 2, 1996. The HSWA Module in DOE/UC's RCRA permit prescribes a specific corrective action program for the Laboratory and provides the primary guidance for the Laboratory's ER Project. The HSWA Module defines the principal requirements with which DOE/UC must comply in implementing the ER Project at the Laboratory. However, RCRA does not address several issues of concern at Los Alamos. For example, source, by-product, and special nuclear materials are exempt from RCRA's definition of solid waste and are therefore not subject to the provisions of the HSWA Module. DOE/UC recognize that these radioactive constituents are of concern and should not be separated from concerns about hazardous wastes. Thus, DOE/UC's ER Project 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 concerns at sites that may contain hazardous substances not regulated under RCRA and radioactive materials regulated under the Atomic Energy Act; ER Project also addresses the provisions of applicable DOE orders. DOE/UC understand that language in this IWP pertaining to subjects outside the scope of RCRA is not enforceable under the RCRA permit.

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

The primary goal of the RCRA facility investigation (RFI) is to identify the nature and extent of contamination that could lead to exposure of human and environmental receptors. The corrective measures study (CMS) evaluates alternatives that could reasonably be implemented if characterization indicates that corrective measures are needed. Finally, the corrective measures implementation (CMI) effects the chosen remedy, verifies its efficacy, and establishes ongoing control and monitoring requirements.

Public involvement is an important component of the Laboratory's ER Project; accordingly, the ER Project is pursuing a public participation plan in which the public is provided with accurate, complete, and timely information and early, meaningful participation opportunities. In addition, formal public meetings are held, as needed.

The HSWA Module provides a schedule for investigating the SWMUs that the EPA originally selected from potential release sites (PRSs) identified by DOE/UC. DOE/UC have aggregated all PRSs to be taken through the corrective action process in 5 field units (formerly 24 operable units). These units are addressed in RFI work plans, which provide information on how each PRS will be investigated. RFI work plans have been completed for all mesa-top PRSs and for Los Alamos Canyon and Pueblo Canyon. The canyons are being investigated after the mesa tops in order to more clearly identify potential contamination originating on the mesa tops. The NMED and EPA are continuing their review of the work plans and field investigations in all field units. The DOE has oversight of a sixth field unit which leads decommissioning activities in conjunction with remediation activities for the ER Project.

The current projection for the completion of the RFI/CMS process at the Laboratory is approximately the year 2008, depending on funding levels. This process will address the 2,121 PRSs at the Laboratory in order to meet all applicable environmental regulations. The schedule also addresses the spread of effort over a period compatible with the availability of national resources, including funding.

Current risks from known PRSs are low; however, DOE/UC have implemented a site-ranking system to aid in prioritizing PRSs. This system originated with input from the EPA, the NMED, DOE, Sandia National Laboratories, and UC personnel and is based primarily on human health and environmental risks from potential contamination at each PRS. Scores of the sites are updated as more information becomes available. In addition, consistent with DOE policy, the ER Project is giving priority to field work at former Laboratory locations in the Los Alamos townsite, which are no longer owned by the DOE.

Contents of the 1996 IWP

In accordance with the provisions of the HSWA Module, this IWP is revised annually to reflect the current status of the ER Project. The intent of the IWP is to capture any changes that have occurred since release of the 1995 IWP, including changes in Laboratory and ER Project structure, changes in DOE and regulator guidance and mandates, and changes in budget and ways of doing business.

Chapter 2 describes the Laboratory and its environmental setting. Chapter 3 contains two major sections: (1) the requirements of the corrective action process and (2) the assessment strategy for conducting corrective action. A discussion of the decision process leading to no further action, accelerated cleanup, or CMS is provided. There is also a discussion of waste minimization and management.

Chapter 4 presents the ER Project's Quality Assurance Project Plan (QAPP), which, when approved by the NMED, will supersede the Generic Quality Assurance Project Plan prepared by the ER Project in 1991. This plan has been developed to be consistent with the EPA's "Interim Final Requirements for QAPPs" and to address the current quality assurance needs of the ER Project. The Records Management Plan, which describes the mechanisms to be used to track information and data throughout the ER Project, is presented in Chapter 5.

Chapter 6 provides a detailed plan for ensuring the health and safety of workers during implementation of the ER Project. The plan complies with applicable Occupational Safety and Health Administration's Hazardous Waste Operations and Emergency Response requirements given in 29 CFR 1926.65 or 29 CFR 1910.120. It establishes generic health and safety requirements, procedures, and emergency actions that apply to all field operations projectwide and is intended to be used in conjunction with a site-specific health and safety plan prepared for each field project.

Chapter 7 contains the ER Project's public involvement plan. It describes the changes that have occurred in the last year that reflect increased emphasis on public outreach and public involvement in the decision-making process both at the Laboratory and project levels. The Laboratory's current approach to public involvement, including the recent formation of its Community Involvement and Outreach Office to coordinate the public participation activities of all Laboratory organizations and the Laboratory's increased outreach to Native Americans, is described.

This document also contains three appendices:

- Appendix A—Descriptions of Technical Areas at Los Alamos National Laboratory;

- Appendix B—Potential Release Sites at Los Alamos National Laboratory; and

- Appendix C—Projected Schedule and Cost for the Environmental Restoration Project at Los Alamos National Laboratory.

The appendices are followed by a table for converting metric to English units of measure.

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1.0 INTRODUCTION TO THE ENVIRONMENTAL RESTORATION PROJECT

1.1 Background

In 1989, the US Department of Energy-Headquarters (DOE-HQ) created the Office of Environmental Restoration and Waste Management (EM). The goal of this office is to implement the department's policy of ensuring that its past, present, and future operations do not threaten human or environmental health and safety (DOE 1993, 0992). The EM Office implements procedures to meet these goals through three associate directorates: Environmental Restoration (ER), Waste Operations, and Technology Development. Among other responsibilities, the EM Office is responsible for assessing, cleaning up, and decommissioning sites at DOE facilities and sites formerly used by DOE and its predecessors. As a facility operated by the DOE, Los Alamos National Laboratory (the Laboratory) is a part of this program.

The Laboratory is administered for the DOE by the University of California (UC). Since its inception in 1943, the Laboratory's primary mission has been nuclear weapons research and development. The Laboratory's current central mission is reducing global nuclear danger. This mission supports core competencies that enable the Laboratory to also contribute to defense, civilian, and industrial needs. In turn, the intellectual challenges of civilian and industrial problems strengthen the core competencies for the defense programs. The core competencies include the following: complex experimentation and measurement; theory, modeling, and high-performance computing; analysis and assessment; nuclear weapons science and technology; earth and environmental science; nuclear and advanced materials; bioscience and biotechnology; and nuclear science, plasmas, and beams.

Many of the processes used in carrying out the Laboratory's past and present missions involve the use of hazardous and radioactive materials. During World War II and for a while thereafter, some of these materials were disposed on the Laboratory site or were otherwise released into the environment. Beginning in the 1960s, Congress enacted basic legislation to protect the environment. In that period also, the DOE and the Laboratory began to conduct surveys and to clean up areas where spills and disposal had occurred.

The current investigation being conducted at Los Alamos under DOE's ER Project is intended to definitively determine the presence or absence of hazardous and radioactive wastes and to address any sites where such materials are still found to exist. The ER Project at the Laboratory is committed to excellence in carrying out its responsibilities for investigating and remediating hazardous waste disposal sites. This updated Installation Work Plan (IWP) describes how the DOE/UC are conducting the DOE's ER Project at the Laboratory.

This document consists of seven chapters containing information required by the Laboratory's permit to operate under the Resource Conservation and Recovery Act (RCRA). The Environmental Protection Agency (EPA) is the regulatory agency that issued this permit; however, in January 1996, the New Mexico Environment Department (NMED) received corrective action authority. EPA and NMED have since negotiated a work share agreement that delineates each agency's roles and responsibilities. This first chapter describes the ER Project and its management plan. Chapter 2 describes the Laboratory and its environment, and Chapter 3 describes the ER Project's technical approach to environmental restoration, including the requirements of the corrective action process and the project's assessment strategy. Chapters 4-7 present the project's plans for quality assurance, records management, health and safety, and public involvement, respectively. In addition, this document contains three appendices that supplement information provided in Chapters 1-7. The appendices are followed by a table showing conversion of metric to English units of measure.

This plan is revised annually to reflect the current status of the ER Project at the Laboratory, future plans, and near- and long-term schedules. This version is the sixth revision.

1.2 Description of the ER Project

DOE established its ER Project as a DOE ER Major Systems Acquisition (MSA) Project. One MSA project includes the national laboratories assigned to the DOE Operations Office in Albuquerque (ER MSA AL-1). MSA AL-1 at Los Alamos includes two integrated activities: one, the Remedial Action Project, hereafter referred to as the ER Project, addresses remedial actions at the Laboratory; the other is the Decommissioning Project, which is operated as part of the Laboratory's ER Project. The DOE's Albuquerque Field Office (DOE-AL) is responsible for implementing the DOE-AL's ER Project. DOE-HQ delegates authority for conducting the DOE-AL ER Project to the DOE-AL ER Division. DOE area offices and their prime contractors execute approved assessment and remediation tasks at their installations. The DOE's Los Alamos Area Office (DOE-LAAO) is the primary line of communication with UC for day-to-day operations.

LAAO oversees MSA AL-1 at the Laboratory as part of its Environment and Projects Office. The Laboratory's ER Project Office tracks and manages the ER Project as part of the Environmental Programs Directorate. The ER Project, including the Decommissioning Project, is conducted under the management principles outlined in DOE Order 4700.1, "Project Management System" (DOE 1992, 0823), and DOE Notice N4700.6, "Project Control System Guidelines" (DOE 1993, 1058).

In November 1989, the New Mexico Environmental Improvement Division [now New Mexico Environment Department (NMED)] issued a hazardous waste operating permit authorized under RCRA to the DOE/UC for operating the Laboratory (NMEID 1989, 0595). In addition, in March 1990, the EPA issued a Hazardous and Solid Waste Amendments (HSWA) attachment to the permit, known as the HSWA Module, which went into effect on May 23, 1990 (EPA 1990, 0306). The HSWA Module sets forth the procedural requirements for assessing and remediating sites known as solid waste management units (SWMUs). The NMED has responsibility for implementing HSWA regulations.

The purposes of the RCRA facility investigation (RFI) and the corrective measures study (CMS) are to evaluate existing and potential environmental impacts resulting from contaminated sites and to evaluate corrective measures proposed to mitigate these impacts. All corrective measures implemented at the Laboratory comply specifically with RCRA regulations and the HSWA Module; with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as appropriate; with the National Environmental Policy Act (NEPA); with applicable DOE Orders; with applicable Executive Orders; and with other applicable federal and state laws and regulations (Section 1.2.1.5).

Laboratory sites that are being investigated include SWMUs and areas of concern [sites that contain potentially hazardous substances (such as radionuclides) that are not regulated under RCRA], collectively called potential release sites (PRSs). Under the ER Project's original structure, the PRSs were aggregated into 24 operable units (OUs), based on geographical and other considerations. In 1994, the OUs were regrouped into 5 units, called field units, as described in Section 1.3.3. As a result of the corrective action process, all PRSs requiring remediation are remediated by means of accelerated cleanup, corrective measures implementation (CMI) after completion of a CMS, RCRA closure, or other remedial measures, as appropriate. The corrective action process is described further in Section 1.2.1.1.

1.2.1 Statutory and Regulatory Framework for the ER Project

The principal requirements for the ER Project are those derived from RCRA Sections 3004(u) and (v), the CERCLA, the Atomic Energy Act (AEA), and New Mexico state law. The ER Project must respond to RCRA requirements for assessing and cleaning up sites at active hazardous waste treatment and storage units. Section 3004(u) provides for remediation of all hazardous waste sites at a given facility regulated under RCRA. Section 3004(v) extends this requirement to contaminated properties located beyond but bordering the Laboratory boundary.

Decommissioning is conducted under the authority of the AEA. Hazardous wastes are regulated both by RCRA and by CERCLA, and radioactive materials are regulated under the AEA and/or CERCLA. The hazardous waste portion of mixed waste is also subject to RCRA. The DOE Order 5400 series establishes environmental protection and waste management guidelines. Specifically, DOE Order 5400.1 (DOE 1988, 0075) establishes the environmental protection program requirements, authorities, and responsibilities for DOE operations to ensure compliance with applicable federal, state, and local environmental protection laws, regulations, and executive orders. In addition, the ER Project complies with applicable Laboratory policies.

The statutes described in the following sections provide the criteria for evaluating the technical performance of the ER Project. Table 1-1 lists the current environmental permits under which the ER Project at the Laboratory operates. The scope and status of permits that control hazardous waste operations at the Laboratory are the responsibility of the Laboratory's Environment, Safety, and Health Division.

TABLE 1-1

CURRENT ENVIRONMENTAL PERMITS AVAILABLE TO THE ER PROJECT

Permit Type	Permitted Activity	Issue Date	Expiration Date	Administering Agency
HSWA Module VIII	Environmental Restoration	May 23, 1990	Dec. 31, 1999	NMED
RCRA Hazardous Waste Facility	Hazardous waste storage and treatment	Nov. 1990	Nov. 1999	NMED

1.2.1.1 Resource Conservation and Recovery Act

The ER Project is regulated by the RCRA. The hazardous waste management provisions of RCRA, as enacted in 1976 govern the day-to-day operations of hazardous waste generation, treatment, storage, and disposal (TSD) facilities. 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 HSWA. Sections 201, 202, 203, 206, 207, 212, 215, and 224 of HSWA modified the permitting sections of RCRA (Sections 3004 and 3005). In accordance with these provisions of HSWA, the Laboratory's permit to operate includes a section (the HSWA Module) that prescribes a specific corrective action program for the Laboratory, which primarily focuses on the investigation and cleanup, if required, of inactive sites.

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

- RFI—The goal of this step is to identify the nature and extent of contamination at the source and the environmental pathways along which contaminants could travel to human and environmental receptors. This step is implemented by characterizing the extent of contamination in the detail necessary to determine what corrective measures, if any, need to be taken. This approach focuses on answering those questions relevant to deciding further actions in a cost-effective manner.

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

- CMI—This step implements the remedy chosen by the regulatory authority, verifies its effectiveness, and establishes ongoing control and monitoring requirements.

This IWP has been prepared to comply with the HSWA Module of the Laboratory's RCRA permit (EPA 1990, 0306). The fundamental unit to which these requirements apply is the SWMU, defined by EPA in the HSWA Module as

> "...any discernible unit at which solid wastes have been placed at any time, irrespective of whether it was intended for the management of solid or hazardous waste. Such units include any area at or around a facility at which solid wastes have been routinely and systematically released."

1.2.1.2 Comprehensive Environmental Response, Compensation, and Liability Act

CERCLA addresses liability, compensation, cleanup, and emergency response relating to the release of hazardous substances into the environment and cleanup of inactive hazardous waste disposal sites. Under the provisions of the National Contingency Plan, a plan prepared by EPA under CERCLA, the EPA ranks facilities throughout the nation according to their potential hazard to human and environmental health and safety. The higher-ranking facilities listed on the National Priorities List are being assessed and cleaned up first. The Laboratory is not on the National Priorities List. The Laboratory is not regulated by EPA under CERCLA; however, it is striving to investigate and remediate sites suspected of being and known to be radiologically contaminated in a manner that would meet CERCLA requirements.

1.2.1.3 Integration of the Provisions of RCRA and CERCLA

Even though the Laboratory is a designated RCRA facility and is not on the National Priorities List, DOE Order 5400.4 (DOE 1989, 0078) specifies that the Laboratory conform to CERCLA requirements to the extent possible. DOE guidance resulting from Executive Order 12580, Superfund Implementation (DOE 1993, 0964), leads to the following interpretation under that guidance:

- CERCLA applies if hazardous substances 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.

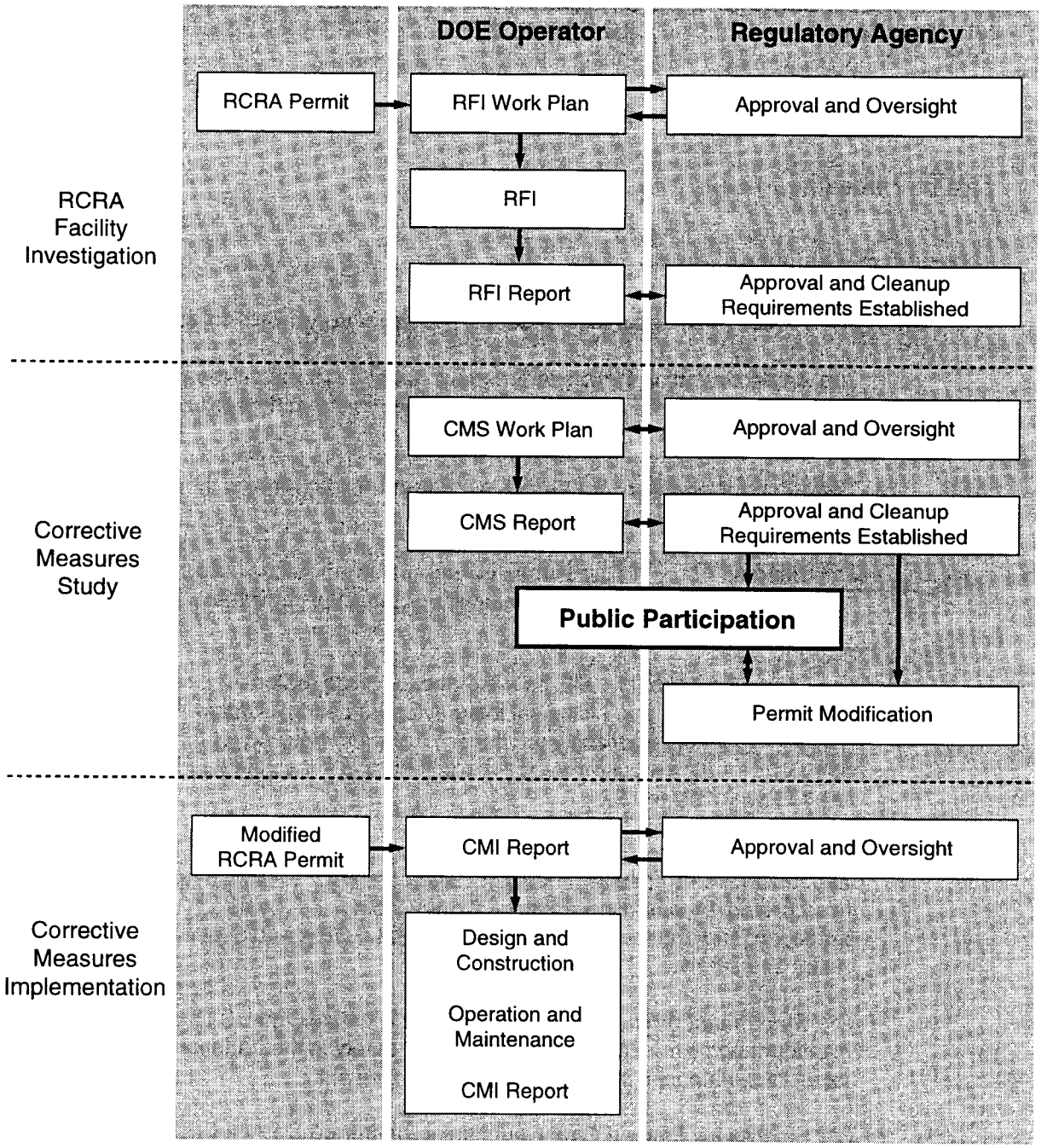

Figure 1-1. Three-step corrective action process.

1.2.1.4 Integration of the Provisions of RCRA and NEPA

NEPA provides a national policy to promote efforts that 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. In accordance with the provisions of DOE Order 5400.4 (DOE 1989, 0078), the ER Project has integrated NEPA procedural requirements and the RCRA process for assessing and cleaning up contaminated sites. In most cases, the primary instrument for this integration is the RFI/CMS process prescribed by RCRA.

1.2.1.5 Other Statutes and Regulations

1.2.1.5.1 Federal Statutes

The following federal acts also affect the conduct of the Laboratory's ER Project:

- The American Indian Religious Freedom Act of 1978 establishes a policy to protect and preserve for native Americans their inherent right to exercise their traditional religions.

- The Atomic Energy Act of 1948, as amended in 1954 and later years, authorizes energy research and development.

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

- The Department of Energy Organization Act of 1977 vests in DOE the responsibilities of ensuring that national environmental protection goals are incorporated in energy programs; of advancing the goals of restoration, protection, and enhancement of environmental quality; and of ensuring public health and safety.

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

- The Emergency Planning and Community Right-to-Know Act of 1986 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 spills and performing cleanup activities.

- The Endangered Species Act of 1973, as amended, requires federal agencies, "in consultation with and with the assistance of" the Secretaries of 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 Federal Facility Compliance Act of 1992 waives sovereign immunity under RCRA for federal facilities to the effect that the federal facilities are subject to enforcement actions, including fines and penalties, to the same extent as any private entity.

- The Fish and Wildlife Coordination Act of 1934 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 were withdrawn in 1982, have not yet been promulgated. Meanwhile, guidance for implementing the Fish and Wildlife Coordination Act is based on court interpretations and past DOE experience.

- The National Historic Preservation Act 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 of 1970 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 of 1974, as amended, defines safety standards for public water systems. The maximum contaminant levels developed under the Safe Drinking Water Act are the levels with which drinking water must comply.

- The Toxic Substances Control Act of 1976, 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. The Toxic Substances Control Act provides for the identification of toxic hazards posed by chemical substances and regulates their discharge into the environment.

1.2.1.5.2 State Statutes

This section lists state statutes that can affect the Laboratory's ER Project.

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

- The Ground Water Protection Act of 1990 provides for the regulation of hazards associated with leaks and spills from underground storage tanks, containment and remediation of pollution incidents, and funding of groundwater protection activities.

- The Hazardous Chemicals Information Act of 1990 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 about hazardous chemicals used in their communities and about any releases of those chemicals.

- The Hazardous Waste Act of 1977, as amended, establishes the State of New Mexico's program for hazardous waste management and control. Because this act meets federal requirements, EPA has granted the state authority to regulate site closures under RCRA (exclusive of HSWA).

- The Radiation Protection Act of 1978 establishes the general rule of radiation protection. The Radiation Protection Act specifies that levels of radiation be kept as low as reasonably achievable, taking into account the state of technology and the costs 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 of 1990 regulates the transportation of radioactive material on highways. Its requirements 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 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 of 1990 gives the New Mexico Oil Conservation Division exclusive authority over the prevention of water pollution resulting from oil or gas operations.

1.2.1.5.3 DOE Orders, Executive Orders, and Secretary of Energy Notices

A number of DOE Orders, Executive Orders, and Secretary of Energy Notices also apply to the ER Project.

The DOE Orders that apply to the ER MSA AL-1 Project are listed below:

DOE 1324.2A	Records Disposition
DOE 1332.1A	Uniform Reporting Systems
DOE 2200.4	Accounting Overview
DOE 2250.1C	Cost and Schedule Control Systems Criteria
DOE 3790.1A	Federal Employee Occupational Safety and Health Program
DOE 4700.1	Project Management System
DOE N4700.6	Project Control System Guidelines
DOE 5000.3B	Occurrence Reporting and Processing of Operations Information
DOE 5100.3	Field Budget Process
DOE 5400.1	General Environmental Protection Program
DOE 5400.2A	Environmental Compliance Issue Coordination
DOE 5400.3	Hazardous and Radioactive Mixed Waste Program
DOE 5400.4	Comprehensive Environmental Response, Compensation, and Liability Act Requirements
DOE 5400.5	Radiation Protection of the Public and the Environment
DOE 5440.1C	Implementation of the National Environmental Policy Act
DOE 5440.1D	National Environmental Policy Act Compliance Program
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 5480.5	Safety of Nuclear Facilities

DOE 5480.10	Contractor Industrial Hygiene Program
DOE 5480.11	Radiation Protection for Occupational Workers
DOE 5480.20	Personnel Selection, Qualification, Training, and Staffing Requirements at DOE Reactor and Nonreactor Nuclear Facilities
DOE 5480.23	Nuclear Safety Analysis Reports
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 5500.1B	Emergency Management System
DOE 5500.2B	Emergency Categories, Classes, and Notification and Reporting Requirements
DOE 5500.3A	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 5700.6C	Quality Assurance
DOE 5700.7B	Work Authorization System
DOE 5820.2A	Radioactive Waste Management
DOE 6430.1	General Design Criteria

The following Executive Orders (EOs) are applicable to the ER MSA AL-1 Project:

EO 11988, May 24, 1977	Floodplain Management
EO 11990, May 24, 1977	Protection of Wetlands
EO 11991, May 24, 1977	Relating to Protection or Enhancement of Environmental Quality
EO 12580, January 23, 1987	Superfund Implementation

The following Secretary of Energy Notices (SENs) are applicable to the ER MSA AL-1 Project:

SEN-15-90, February 5, 1990	National Environmental Policy Act
SEN-25A-91, October 2, 1991	Strategic Planning Initiative

1.2.2 Objectives of the ER Project

1.2.2.1 Project Management Objectives

The objectives of the Laboratory's ER Project Management Plan are to

- establish and maintain a management control system and project control procedures for efficient baseline management;
- establish at the Laboratory through the ER Project a procedural framework and schedules for developing, implementing, coordinating, and monitoring corrective actions that comply with RCRA, CERCLA, and all applicable environmental statutes;
- prioritize projects, taking into account resource availability, minimize duplication of analysis and documentation, and expedite corrective actions;
- provide both formal and informal mechanisms through which NMED, EPA, and the public can review, comment on, and participate in the corrective action review process at the Laboratory;

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

- ensure integration of the Decommissioning Project into the overall ER Project and provide a forum for the exchange of information among affected Laboratory organizations; and

- complete decommissioning activities at all facilities currently designated and at those that may be designated as surplus facilities in the future.

1.2.2.2 Technical Objectives

The overall technical objectives of the Laboratory's ER Project are to effectively formulate, evaluate, implement, and manage characterization, remediation, and decommissioning in a manner that fully complies with applicable environmental regulations and protects human health and the environment. These objectives are met in a cost-effective manner by using existing technologies or through pilot studies that demonstrate the efficacy of corrective measures.

1.2.2.3 Quality Assurance Objectives

The intent of all quality programs is to ensure that appropriate controls are built into 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 ER Project's Quality Assurance Project Plan (QAPP), presented in Chapter 4, has been prepared in accordance with Interim Guidelines and Specifications for Preparing Quality Assurance Program Plans (EPA 1980, 0283) and NQA-1, Quality Assurance Requirements for Nuclear Facilities (ANSI/ASME 1989, 0018), as specified by DOE Order 5700.6C (DOE 1991, 0703). The intent of the plan is to present a comprehensive, coherent quality assurance program. Personnel implement the guidelines established in the QAPP through quality assurance project plans, quality procedures, and standard operating procedures (SOPs).

1.2.2.4 Records Management Objectives

The statutory definition of "records" (44 USC 3301) includes technical data. The term is used in the Records Management Plan (Chapter 5) to reflect the need to protect all records essential to the ER Project. The specific activities implemented to achieve records management are delineated in quality procedures and SOPs developed in cooperation with the Quality Program staff.

The Records Management Plan ensures that records are managed to maintain their integrity and to ensure that ER Project actions are documented in an auditable manner. The ER Project Office has established the Records-Processing Facility to receive and process records and the Facility for Information Management, Analysis, and Display to provide project participants and the public with centralized access to information generated by the ER Project. The latter facility includes the hardware and software necessary to capture, display, and analyze data.

ER Project records, including technical data sets, are organized, indexed, and stored in a manner that provides efficient access to a diverse group of users. The information retrieval system is designed to protect the integrity of the data. The development of effective guidelines for handling record packages requires coordination with the quality, health and safety, resource planning, and public involvement programs.

1.2.2.5 Health and Safety Objectives

The ER Project is committed to performing its work in a manner that protects the health and safety of Laboratory workers and the public through compliance with all applicable federal, state, and local laws and regulations; with all applicable DOE orders and health and safety standards for the Laboratory; and with the health and safety requirements specified in the HSWA Module.

The Health and Safety Plan (Chapter 6) describes the health and safety issues of the corrective action process; is designed to identify, evaluate, and control safety and health hazards; and provides for emergency responses appropriate to the potential hazards of waste characterization and remediation operations. Audits are regularly conducted to ensure that the Health and Safety Plan is implemented effectively.

1.2.2.6 Public Involvement Objectives

DOE and the ER Project require a proactive approach to disseminating and exchanging ideas affecting the general public and Laboratory employees. In addition, the HSWA Module specifies that the Laboratory develop a public involvement plan (Chapter 7) to provide public access to information pertaining to the ER Project. To satisfy these requirements, the ER Project is implementing a public involvement plan that

- provides information about technical issues in a timely manner;
- responds to communities' concerns in a manner that encourages two-way communication between the interested parties and the Laboratory;
- reaches the broadest audiences and takes into account a variety of educational backgrounds and technical expertise;
- provides for public comment on ER Project activities as specified by regulation;
- provides a Laboratory's Outreach Center and Reading Room for the general public that contains documentation on past, current, and proposed ER Project activities;
- encourages public participation as a way of increasing the public's understanding of the ER Project.

1.2.2.7 Procurement Plan Objectives

The ER Project follows the Laboratory's procurement policies and procedures set forth in Chapter 7 of the Laboratory Manual (LANL 1981, 0142), which is based on the federal acquisition regulation, the DOE's acquisition regulation, UC procurement policy, federal laws, and executive orders. Subcontracts are awarded competitively to the maximum extent practicable. Sources are selected in general accord with the procedures of the DOE's acquisition regulations.

1.2.2.8 Site Prioritization Objectives

Los Alamos and Sandia national laboratories, together with DOE, EPA, and NMED, have developed a site prioritization system. This system provides a method for separately evaluating the relative risk posed by all the PRSs at each of the two laboratories. In addition, it incorporates other prioritization criteria (e.g., regulatory concerns and potential for accelerated cleanups) to aid decision makers in allocating available resources according to the degree of risk at each site. The system was developed with input from EPA and NMED and provides for public involvement in the ranking assessment.

1.3 Structure of the ER Project

This section describes the current structure of the ER Project.

1.3.1 Interaction with DOE/LAAO

The DOE and Laboratory interact as equal partners with the NMED. The intent is to work as partners to achieve objectives mutually acceptable to ourselves and to the regulatory agencies. DOE and the Laboratory are open and direct in cooperatively defining strategies and expect to negotiate with regulatory agencies the best mutually acceptable agreements.

Processing time is reduced and product quality is increased through a teaming approach by the LAAO Field Project Managers and the Laboratory Field Project Leaders. The teaming occurs during all phases of the ER Project. Figure 1-2 shows the current LAAO organization.

1.3.2 Organization of the Project Office

1.3.2.1 Management Team

Figure 1-3 shows the current composition of the ER Project management team. The ER Project Manager, who reports to the Program Director for Environmental Management Programs, is responsible for the effective implementation of the ER Project throughout the Laboratory. In executing his responsibilities, he is directly supported by six field project leaders (FPLs), a regulatory compliance manager, and a project consistency manager.

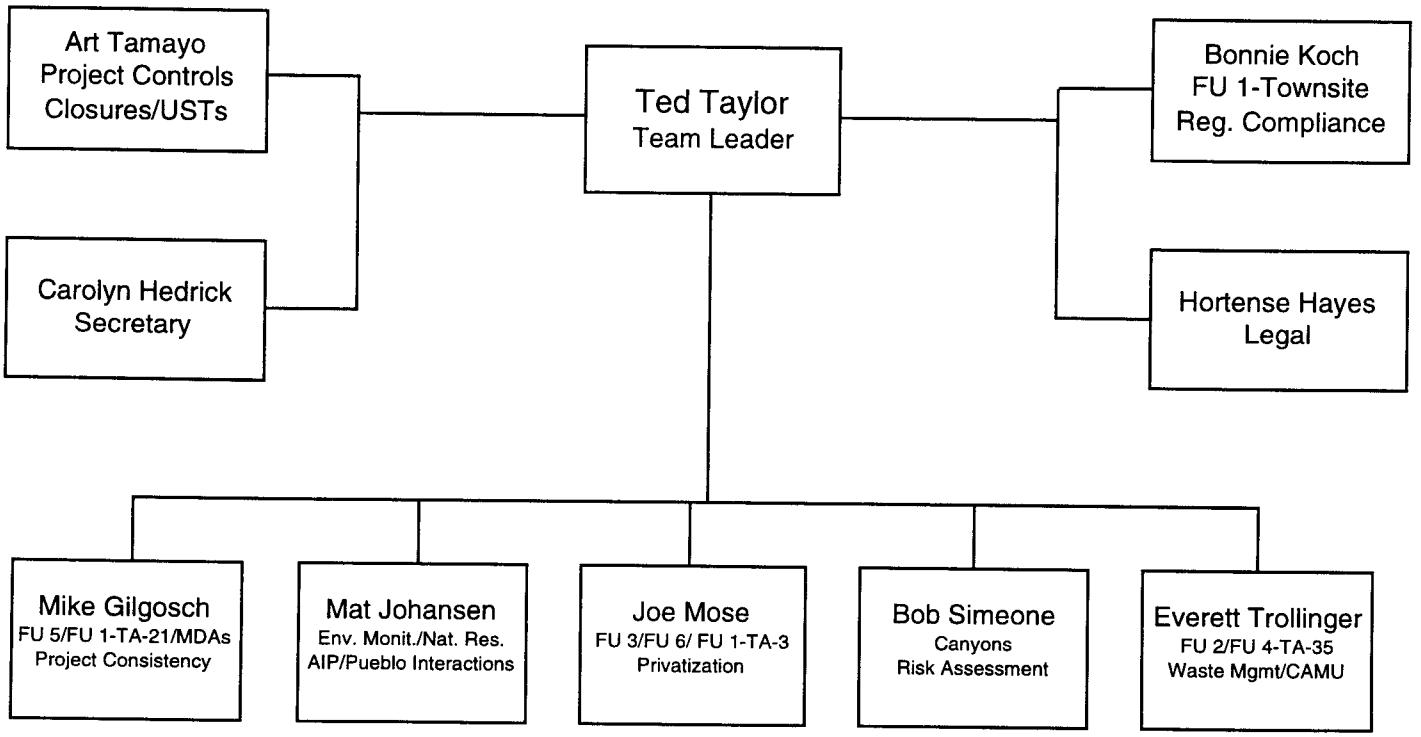

Figure 1-2. Organization of LAAO.

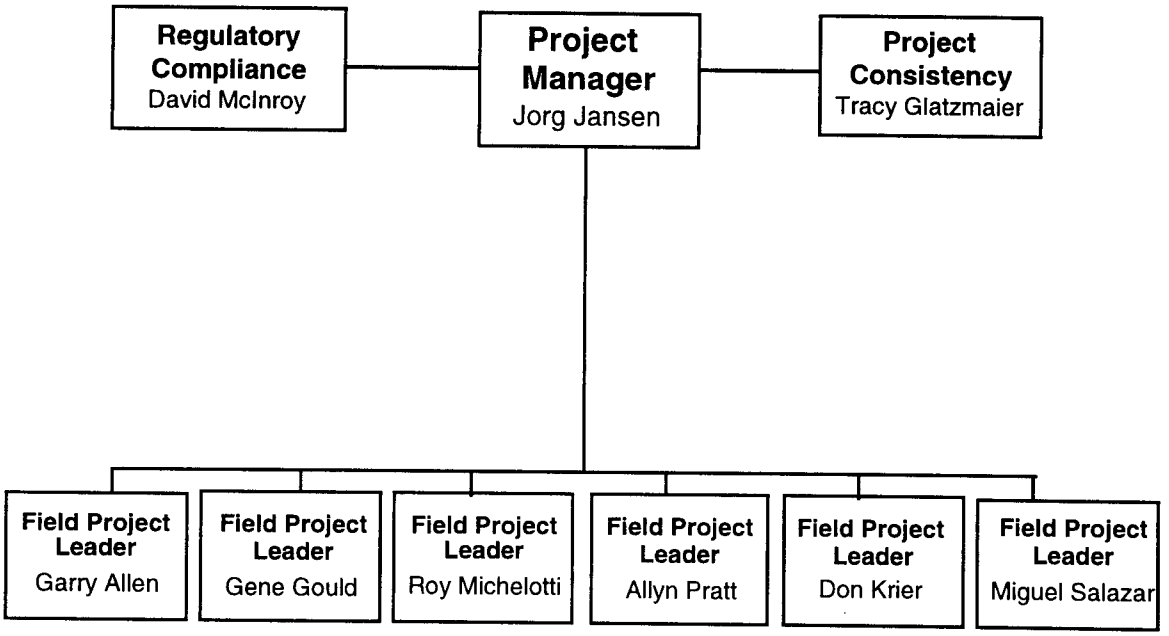

Figure 1-3. Organization of the ER Project.

1.3.2.2 Regulatory Compliance Manager

The regulatory compliance manager, a member of the management team, is the focal point for ER Project interactions with the NMED and the EPA Region 6. The coordinator interacts directly with NMED and Region 6 and coordinates technical interactions when they are most appropriately handled at lower levels.

1.3.2.3 Project Consistency Manager

The project consistency manager, also a member of the management team, works with all field units to help ensure that consistent approaches and solutions to common problems are implemented. This manager promotes consistency in technical approaches to investigations, remediation methods and technologies, report preparation, and financial reporting. The manager works with technical specialists from all field units to identify situations that require special techniques and to foster acceptance of new methods by the field units.

1.3.2.4 Field Project Leaders

Five of the FPLs have responsibility for effectively carrying out the corrective action requirements for all PRSs. The sixth FPL has responsibility for the Decommissioning Project. The organization of the field units managed by each FPL is discussed in Section 1.3.3. The FPLs are fully accountable for budget and schedule within their respective field unit; are responsible for all investigation and remediation of the PRSs in their field units; are members of the management team, which sets the direction for the project and conveys that direction to project personnel through their field units; and are responsible for the integration of projectwide procedures, technical approaches, contractor services, etc., in their field unit.

1.3.2.5 Other Key Personnel and Functions in the ER Project

1.3.2.5.1 Contract Administration Coordinator

The Laboratory's Business Systems Division (BUS) has assigned a contract administration coordinator to serve ER Project needs through a dedicated contract administration team assigned to the Environmental Management Division in which the ER Project resides. Having the contract administration coordinator in direct communication with an ER Project manager expedites the procurement of services required for implementing the ER Project.

1.3.2.5.2 Councils

Many disciplines represented on the field units are coordinated horizontally throughout the project by a council for each discipline. Each council has a chairperson, who calls council meetings as necessary to address projectwide issues and to develop policy proposals. The councils developed for the project are

- Earth Sciences,
- Decision Support,

- Health and Safety, and
- Document Preparation and Control.

1.3.3 Field Units

The previous structure of the ER Project, which consisted of 24 OUs, proved to be too cumbersome to provide for consistency in implementation and effective communication and to provide for accountability and cost control. The project has been simplified by combining the 24 OUs in 5 field units and a sixth field unit to address decommissioning.

A typical structure of a field unit is shown in Figure 1-4. This structure is based on the philosophy of moving many of the support functions to the field units to strengthen their ability to perform effectively. The structure increases internal control in the field units and improves the ER Project's productivity. As the figure implies, the vision is of a core technical team whose members represent all disciplines needed to address the full range of PRSs in the field unit. Likewise, a team of dedicated specialists in several support disciplines provides the required project tracking and implementation skills. The five remediation field teams prepare sampling plans, clarify site-specific technical issues with regulators, conduct investigations, evaluate results, prepare reports, and manage accelerated cleanups or CMS and CMI.

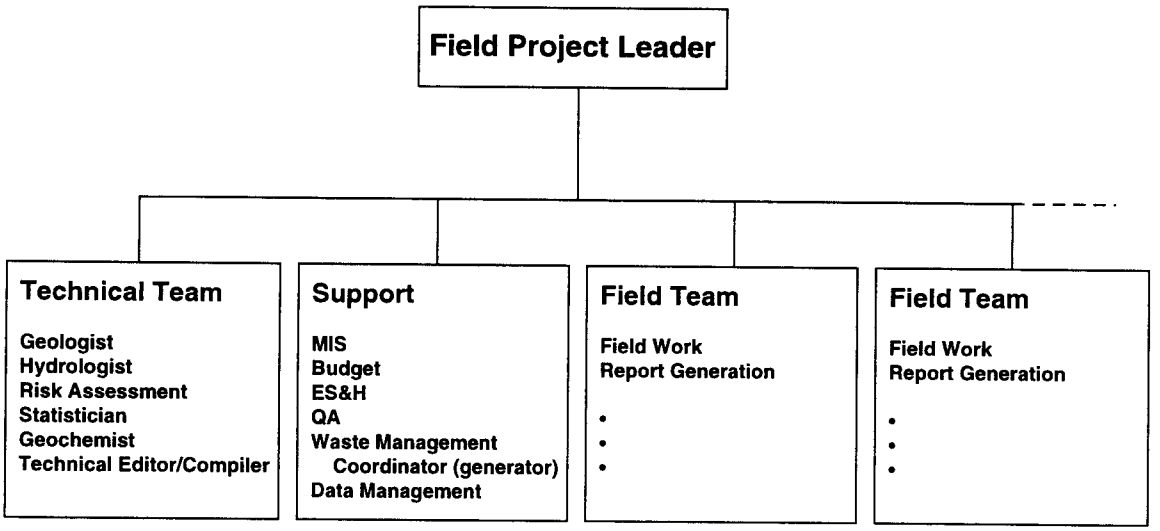

Figure 1-4. Typical structure of field units.

The ER Project's organizational structure lends itself to an efficient command and control system (Figure 1-5). The management structure can be compared to a wheel: The hub represents the central functions of the project office, where guidance, direction, and control originate. The spokes of the wheel represent the connections to the field units, typically through the field project leaders. The rim of the wheel represents the peripheral connections among the field units, which might represent the interaction of any set of specialists from all the field units, coordinating as a group representing their discipline for the entire ER Project. This management and communication structure ensures that directives, approaches, lessons learned, and issue resolution are addressed cooperatively and that they are consistently received and implemented.

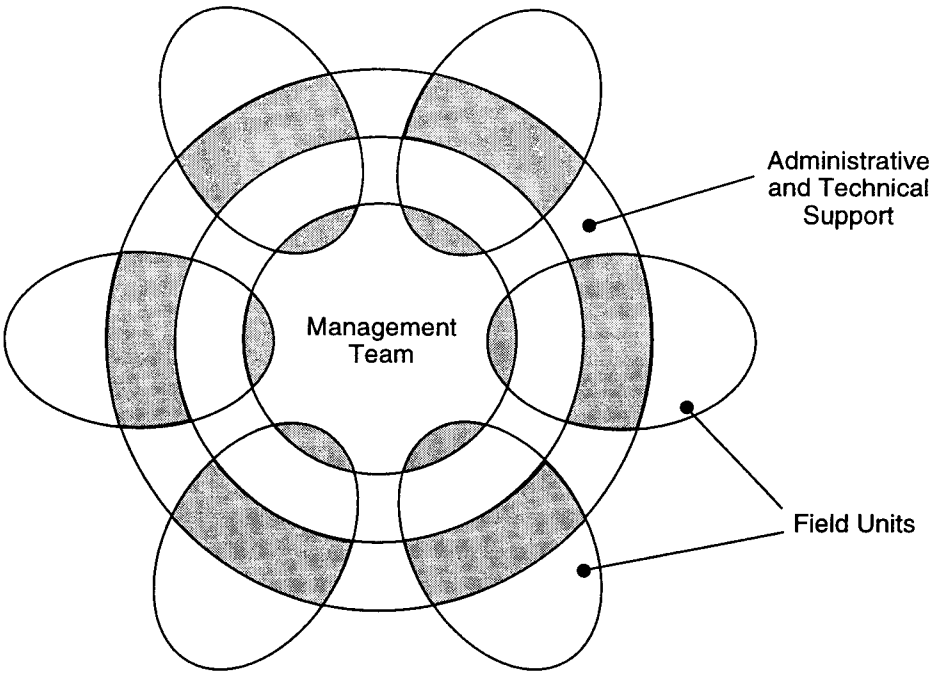

Figure 1-5. ER Project command and control systems.

1.3.4 Project Planning and Control System

The ER Project Planning and Control (PP&C) Team documents, for LANL ER management, the technical scope of the cleanup effort at the Laboratory in the form of an integrated cost and schedule baseline. The PP&C has been decentralized to provide direct support to the FPLs. The primary benefit for the field units is the ability to use the system for project management functions: cost and schedule planning, project tracking, resource management, and load leveling. A core group of the PP&C team is also used to support the project office. The team's primary function is to integrate information from the field units on a projectwide basis. The PP&C manager currently reports directly to the ER Project Manager. The information consolidated in the project office is used for the current-year baseline, five-year plan, and reporting to the project manager and DOE. Both the field unit and the project office use the system for critical path analysis, what-if scenarios, and load leveling.

Each field unit team includes a cost and schedule specialist. These specialists coordinate with the core PP&C team to ensure consistency in level of detail, unit costs, etc. The platform used for baseline development and management consists of Primavera Project Planner for scheduling and establishment of the performance measurement baseline, Excel for performance reporting, and G2 for estimating. Its basic structure is characterized by a risk-based graded approach to system design. In addition, the system as a tool is quite robust and reflects a conscious effort to accomodate different management styles and techniques. Its three basic elements consist of baseline development, performance reporting, and change control.

The current financial planning and control system integrates the ER Project's finances with the Laboratory's financial system. As each year's baseline plan is developed, budgets are negotiated between the project manager and the field project leaders. These negotiations allow the project to establish the baseline cost for the next fiscal year on the basis of a proposed budget.

The ER Project has integrated its financial system with the Laboratory's financial management information system to encompass all cost elements needed by the ER Project for cost planning and reporting down to the eighth level of the work breakdown structure. As Laboratory systems are improved (time-accounting improvements, authorization controls for charging to cost accounts, etc.), the ER Project will integrate these in the financial planning and control system.

1.3.5 Reporting Requirements

The development and implementation of reporting requirements for the ER Project are mandated by DOE and NMED through DOE/UC's permit to operate under RCRA. Appropriate DOE-LAAO and UC officials, as copermittees, sign the following certification for each deliverable to NMED.

> 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 conform to DOE Order 4700.1 and comply with applicable guidance from DOE-HQ, DOE-AL, DOE-LAAO, and internal Laboratory criteria.

To comply with applicable regulations and to keep all interested parties informed of progress made during the corrective action process, the ER Project prepares several types of plans and reports. The major plans and reports are associated with the RFI, accelerated cleanups, CMS, and CMI. In addition, periodic technical progress reports are submitted to DOE and the regulators.

In addition to the HSWA Module, it is the policy of the ER Project Office to see that all reports comply, to the extent feasible, with EPA's RFI guidance and DOE guidance regarding compliance with CERCLA. At a minimum, the reports describe the procedures, methods, and results of field investigations and include information on the type and extent of contamination, sources and migration pathways, and actual and potential receptors. The reports contain information adequate to support further corrective action decisions (e.g., comparisons with screening action level criteria). All reports are made available to the public through the Laboratory's Outreach Center and Reading Room and other information repositories maintained for the public (Chapter 7).

In addition, the Decommissioning Project prepares formal Laboratory reports upon completion of a decommissioning project. The formal report provides background information, characterization data, decommissioning methods and techniques, final survey and release data, and any lessons learned. The purpose of the final report is to capture project history and provide a formal record of completion.

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2.0 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 predominantly 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 intermittent streams that run from west to east. 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, 0051). The Department of Energy (DOE) controls the area within the Laboratory's boundaries and determines restrictions on access.

2.2 History of Los Alamos National Laboratory

In 1942, the US Army Manhattan Engineer District was established to develop the atomic bomb. The research quickly progressed to a point that necessitated a remote site for experimental work, and the Army selected the Los Alamos Ranch School for Boys as an appropriate location. The Undersecretary of War directed acquisition of the school site, which consisted of a group of some 50 log buildings on a 790-acre site northwest of Santa Fe. The project ultimately acquired an additional 3,120 privately owned acres and 45,666 acres of public land managed by the US Forest Service. In 1943, this land became known as the Los Alamos Site, later Los Alamos Scientific Laboratory.

Since its inception, the Laboratory has been operated by University of California (UC) for the federal government. Research 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 superiority 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. Since 1978, the Laboratory has operated under the control of the DOE and is currently officially known as Los Alamos National Laboratory. A map showing active technical areas at the Laboratory is shown in Figure 2.2.

2.3 Environmental Setting

2.3.1 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 and the Laboratory to the east.

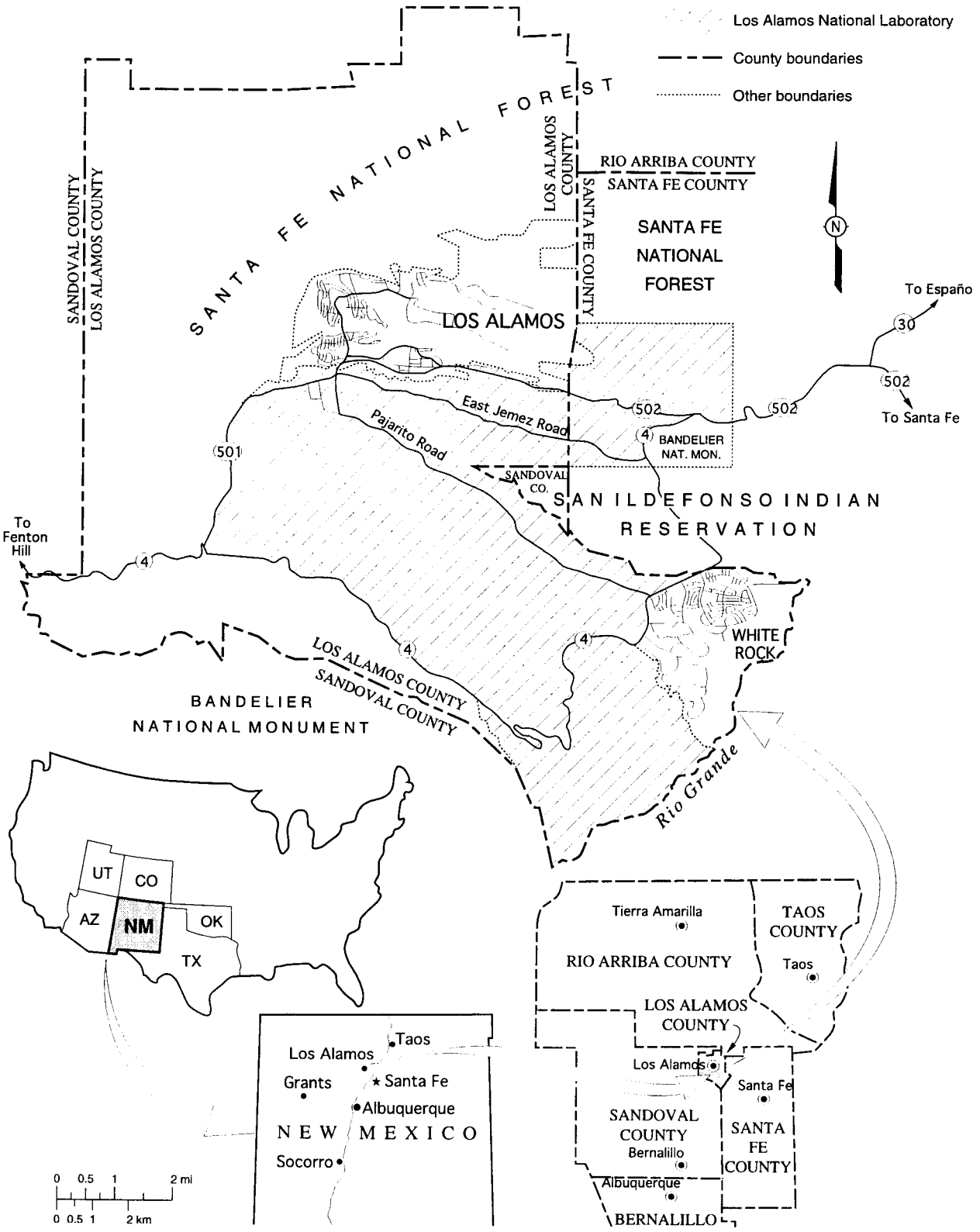

Figure 2-1. Location map of Los Alamos National Laboratory.

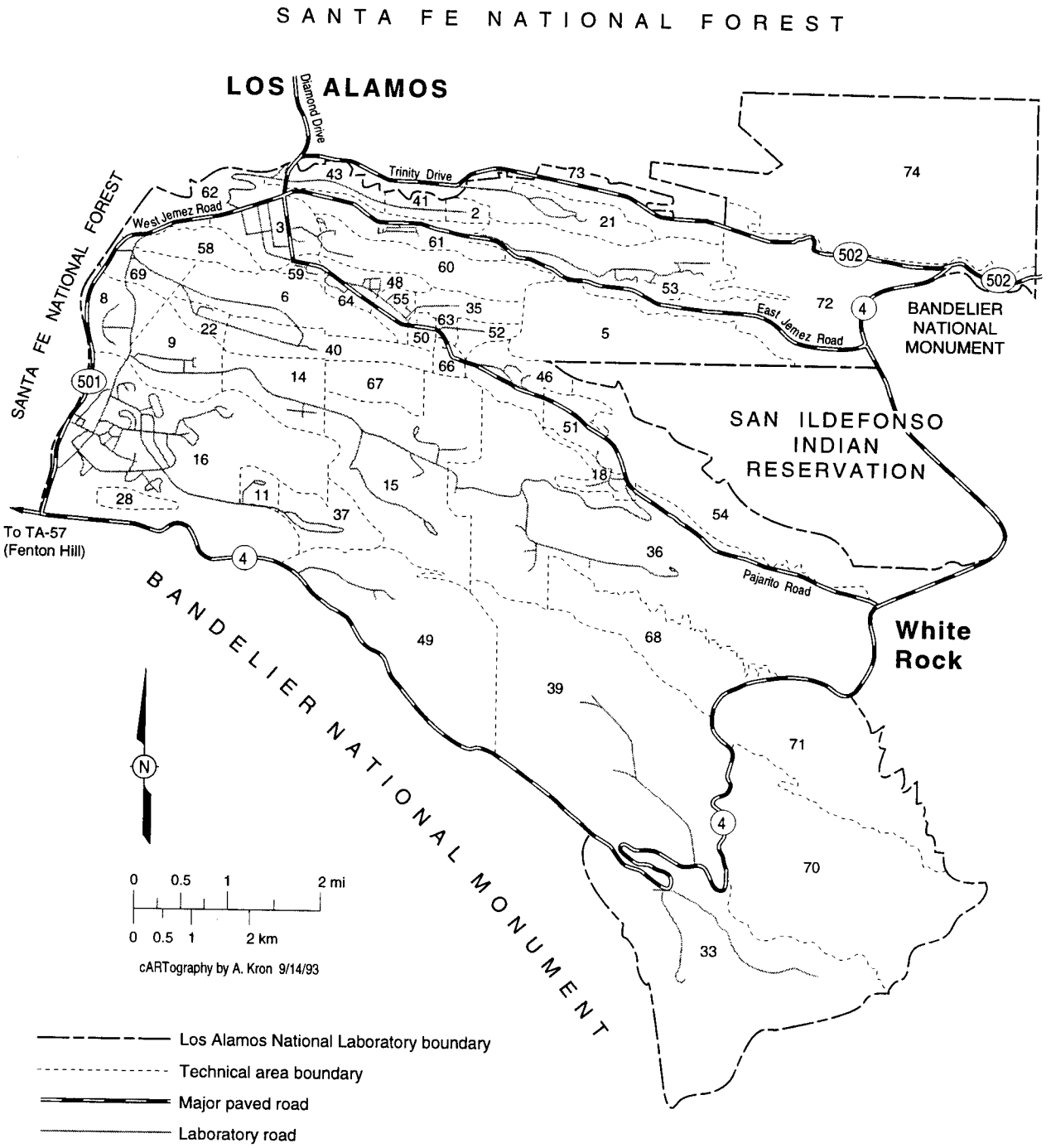

Figure 2-2. Technical areas at Los Alamos National Laboratory.

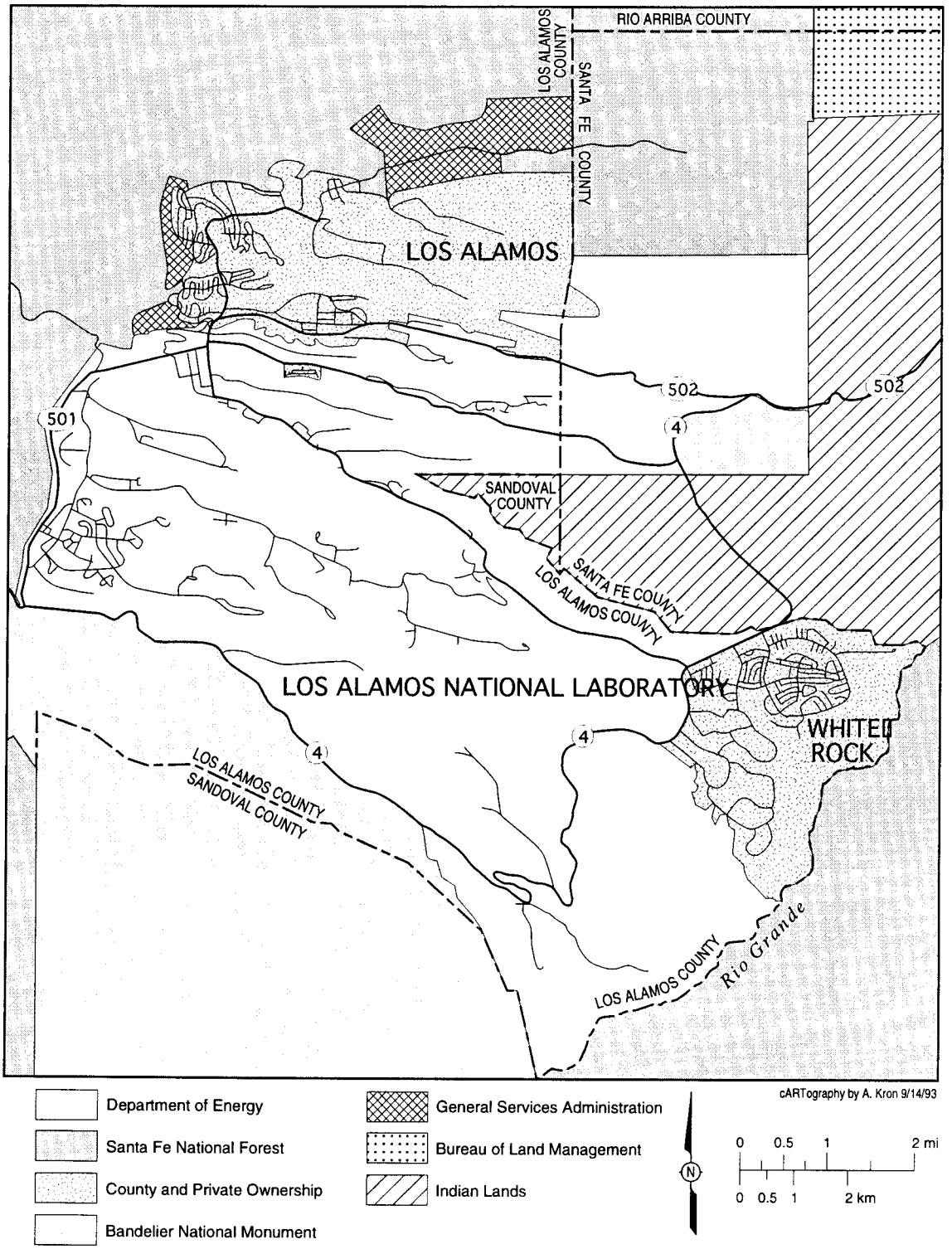

Figure 2-3. Land use map for the Laboratory and adjacent lands.

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 to the public, and as a reserve for future construction. The Laboratory's long-range site development plan (LANL 1995, 1376) addresses the best possible future uses of available Laboratory lands.

The public is allowed limited access to certain areas of the Laboratory site. An area north of Ancho Canyon between the Rio Grande and State Road 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.

2.3.2 Ecology

Understanding of the structural and functional relationships among Los Alamos area 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. Section 2.5.2 provides a detailed overview of the hydrogeological environment at Los Alamos.

2.3.2.1 Flora

Six major vegetative complexes (community types) are found in Los Alamos County. A piñon-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 to 6,200 ft in the eastern third).

Less is known about ecosystems other than the piñon-juniper woodland. Hakonson et al. (1973, 0118) provide a general description of the Laboratory and environs. Almost 900 plant species have been identified, and species lists have been prepared. Special studies have described the past and current status of the flora of the complex (Foxx and Tierney 1980, 0101; 1984, 0102; 1985, 0103). 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. Few construction and waste disposal activities have occurred 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 wood lily, which is a state listed plant species, has been documented in Los Alamos County. It can be found in canyons above 7,500 ft (Hinojosa and Nguyen 1996, 1375).

2.3.2.2 Fauna

Before the Laboratory was established, Native Americans and European settlers farmed the mesas, disturbing 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, 0051), but the occurrence of some species has not been verified. Special studies are currently under way to provide a more comprehensive survey of vertebrate fauna.

Based on published reports and ongoing surveys, at least three federally listed animal species, the peregrine falcon and the bald eagle (endangered) and the Mexican spotted owl (threatened), are known to inhabit Los Alamos County. The peregrine falcon establishes breeding territories near cliffs in areas of ponderosa and piñon pine. A historical aerie exists in the county, and peregrines are known to forage on Laboratory lands. The bald eagle winters along the Rio Grande. Mexican spotted owls have recently been documented nesting on US Forest Service lands in Los Alamos County. Nesting Mexican spotted owls inhabit mixed-conifer and ponderosa pine-Gambel oak forest in mountains and canyons. Nesting Mexican spotted owls have not been confirmed on Laboratory lands, but surveys are still ongoing.

The southwestern willow flycatcher has recently been upgraded to a federal candidate species. Survey efforts are under way to determine its potential for inhabiting wetland areas within Laboratory boundaries. Other federal candidate and state listed faunal species have been documented for Los Alamos County. They include the Jemez Mountain salamander, spotted bat, and Myotis bat. Other species that may occur in the area, but their presence has not been confirmed, include the New Mexico jumping mouse, loggerhead shrike, and gray vireo. (Hinojosa and Nguyen 1996, 1375).

2.3.2.3 Wetlands

Under the Resource Conservation and Recovery Act (RCRA) and the Hazardous and Solid Waste Amendments (HWSA) Module of the Laboratory's operating permit, the Environmental Protection Agency (EPA) required a determination of all wetlands located in areas that either lie within Laboratory boundaries or that drain Laboratory land (Figures 2-4 and 2-5).

US Fish and Wildlife personnel mapped the wetlands around Los Alamos, using US Geological Survey (USGS) quadrangle maps as base maps and infrared high-altitude aerial maps. To cover all of the watersheds that drain the Laboratory site, 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, which gives the location of the Laboratory's geothermal site at Fenton Hill, was mapped. A detailed on-the-ground and historical analysis of single sites is being conducted by personnel in the Assessment and Resource Evaluations (ESH-20) to delineate and characterize individual wetlands.

Wetlands within Laboratory boundaries fall primarily into two classifications: palustrine and riverine. Palustrine wetlands (ponds and marshes) have been identified in Sandia, Pajarito, and Pueblo canyons, and smaller ones have been identified in other parts of the Laboratory. Wetlands in Sandia and Pueblo canyons are primarily maintained by effluent releases. Beds of ephemeral and intermittent streams that traverse the Laboratory have been classified as temporarily flooded riverine wetlands.

Figure 2-6 shows the locations of wells in Los Alamos County and in adjacent locales. Wells LA-1, LA-3, LA-4, and LA-6 have been abandoned and plugged. The symbols on the map indicate where these wells were located.

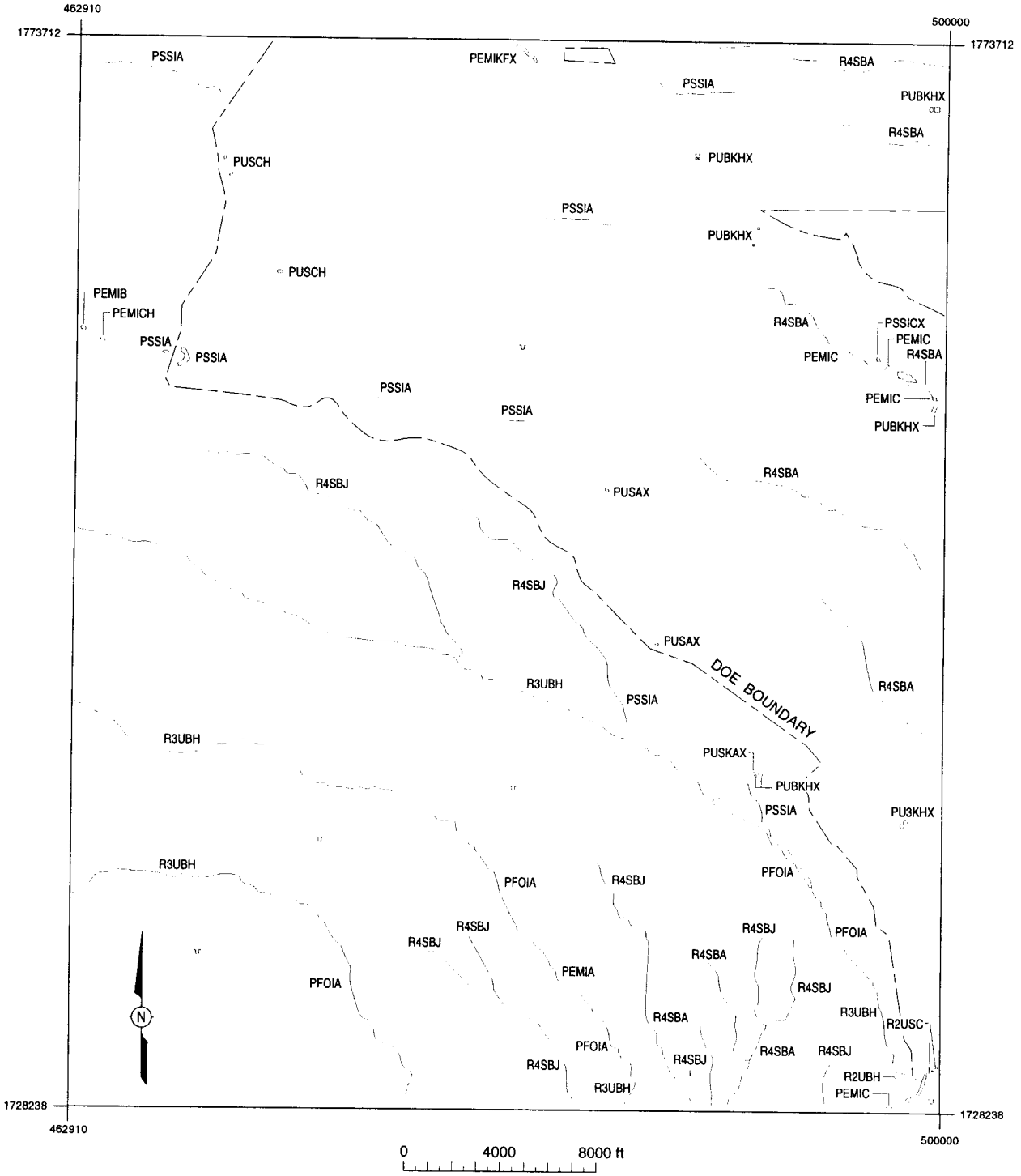

Figure 2-4. Map of wetlands for Los Alamos County, west half.

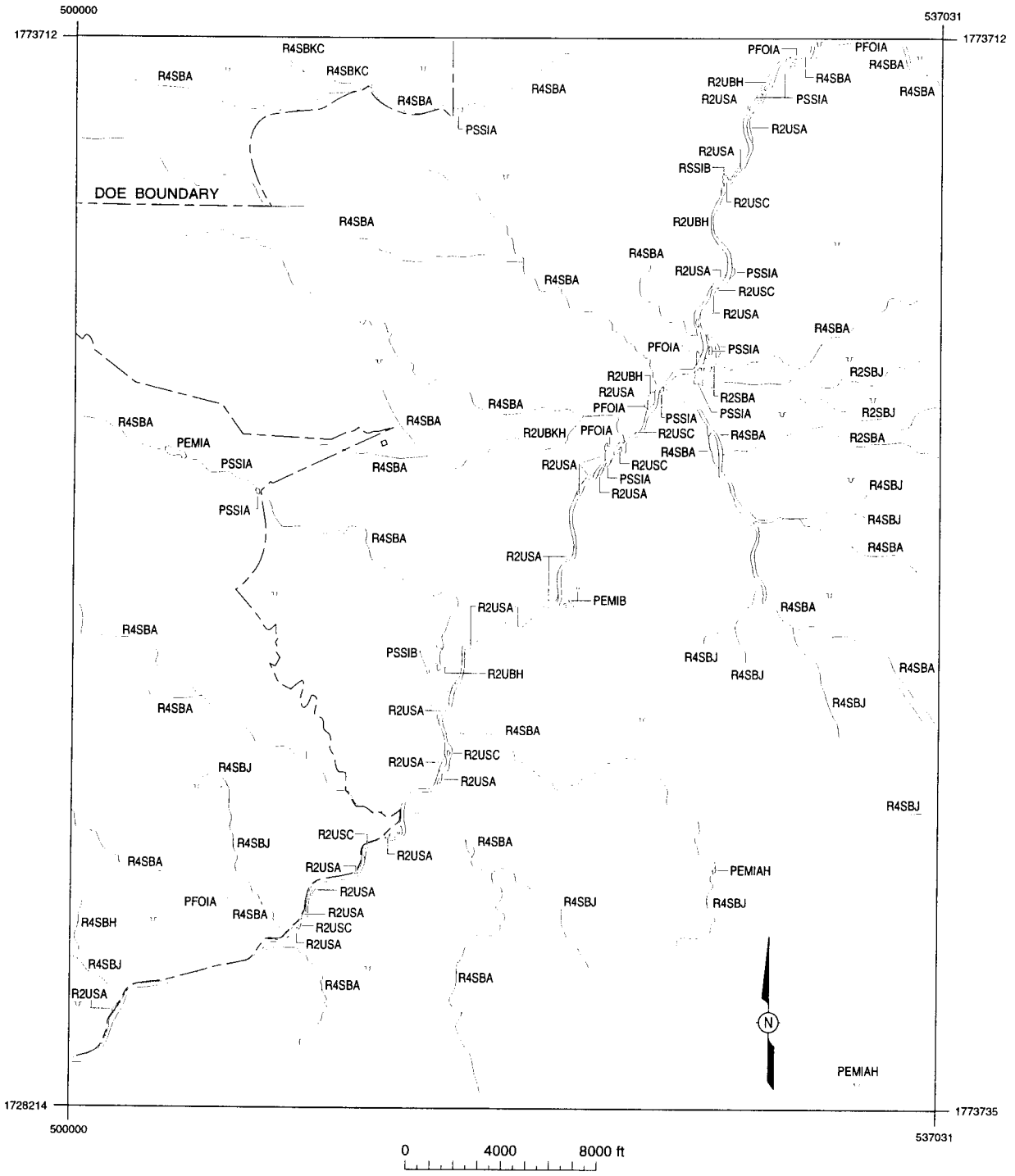

Figure 2-5. Map of wetlands for Los Alamos County, east half.

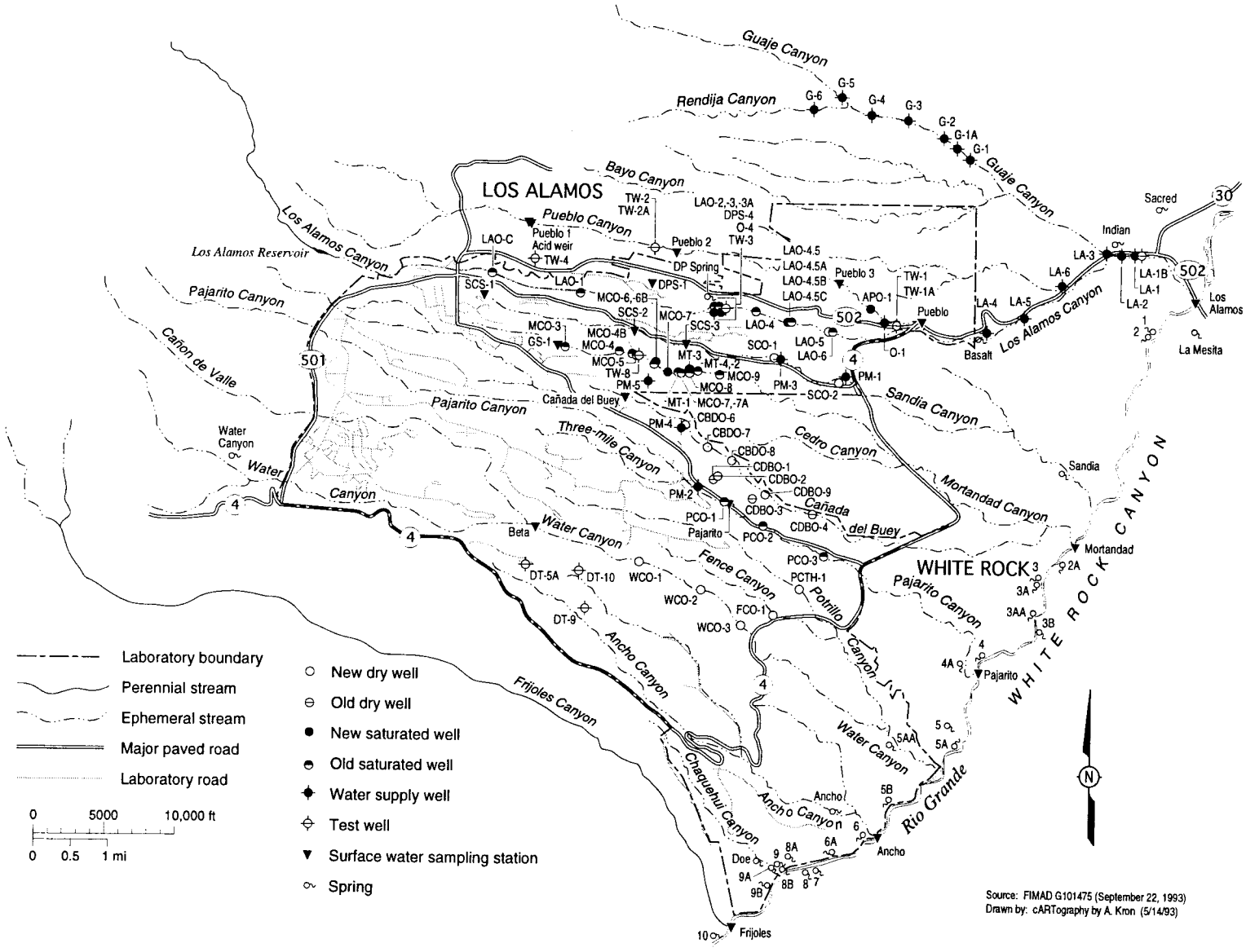

Figure 2-6. Well locations in Los Alamos County and in adjacent locales.

2.3.3 Climate

Bowen (1990, 0033) 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 from 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 from 1961 through 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 (Figure 2-7, from Environmental Protection Group 1990, 0497). 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. 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 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

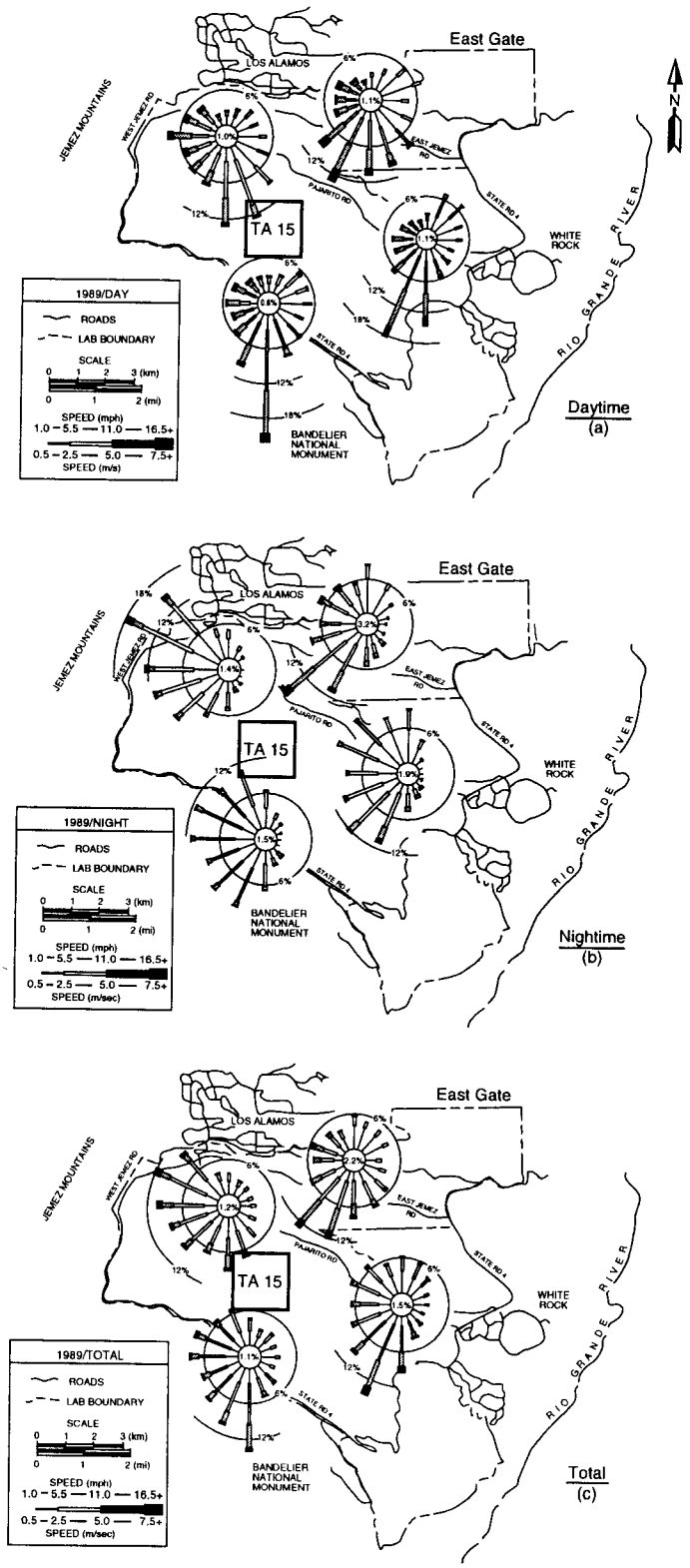

Figure 2-7. Wind roses at Laboratory stations during 1989.

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. 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 Technical Area [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.

2.3.4 Population Distribution

Los Alamos County had an estimated 1992 population of approximately 18,200, based on the 1990 census adjusted to 1992 (Environmental Protection Group 1994, 1179). 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 the residential areas known as Eastern Area, Western Area, North Community, Barranca Mesa, and North Mesa) has an estimated population of 11,400. The White Rock area (including the residential areas of White Rock, La Senda, and Pajarito Acres) has about 6,800 residents. About 40% of the people employed in Los Alamos commute from other counties. Population data from 1990, adjusted to 1992, place about 224,000 persons within a 50-mi radius of Los Alamos (Table 2-1) (Environmental Protection Group 1994, 1179).

TABLE 2-1

1992 POPULATION WITHIN 80 km OF LOS ALAMOS

	Distance from TA-53 (km)								
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	1,169	0	378
NNE	0	0	0	582	0	558	1,781	1,850	227
NE	1	0	0	0	326	15,860	1,039	1,170	3,965
ENE	0	0	0	2,031	1,609	2,843	2,827	1,222	2,267
E	0	0	87	26	582	1,199	728	0	1,422
ESE	0	0	0	0	0	306	24,239	1,091	1,511
SE	0	0	6,796	0	0	0	56,036	2,558	8
SSE	0	0	0	0	0	0	446	4,551	99
S	0	0	0	50	0	347	670	7,363	0
SSW	0	0	0	20	0	891	219	8,981	36,507
SW	0	0	0	0	0	0	343	4,532	0
WSW	0	0	0	0	0	343	341	2,775	225
W	0	0	0	0	0	0	0	179	144
WNW	0	1,443	6,572	0	0	0	0	0	3,359
NW	0	526	1,731	0	0	0	0	1,481	0
NNW	0	581	582	0	0	0	0	65	64
1992 Population Distribution	2	2,550	15,768	2,709	2,517	22,347	89,838	37,818	50,176

Note: Total population within 80 km of Los Alamos is 223,725.

2.4 Geologic and Hydrologic Setting

This summary 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 the hydrologic characteristics that affect surface water and groundwater occurrence and movement and their interactions as they relate to the potential for contaminant transport. 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 solid waste management units at the Laboratory (LANL 1990, 0143). This bibliography was submitted to EPA in September 1990. The bibliography and the literature it describes are available for review in the Laboratory's public reading room located at 1350 Central Avenue, Suite 101, in Los Alamos.

2.4.1 Geology

2.4.1.1 Regional Setting

The Laboratory is situated on the Pajarito Plateau on the east flank of the Jemez Mountains and on the west side of the Rio Grande valley (Figure 2-8). The Jemez Mountains are part of the Jemez volcanic field, which consists of some 432 mi of volcanic rocks erupted from numerous vents, including a giant, multistage caldera (Gardner et al. 1986, 0310). The Jemez volcanic field occurs at the intersection of the Jemez lineament, a northeast-trending alignment of volcanic fields, and the Rio Grande rift, a major north-trending zone of extensional tectonics (Aldrich 1986, 0554).

Two major volcanic eruptions in the Jemez Mountains, which occurred about 1.5 and 1.13 million years ago, produced widespread and voluminous ash flow sheets: the Otowi and Tshirege members of the Bandelier Tuff (Smith and Bailey 1966, 0377; Spell et al. 1990, 0607). The morphology of the Pajarito Plateau is dominated by a gently eastward-sloping surface formed on top of the Bandelier Tuff, which is dissected by numerous steep-sided canyons. The Otowi and Tshirege members of the Bandelier Tuff were erupted concomitantly with the collapse of the Toledo and Valles calderas, respectively. Following formation of the calderas, volcanism continued with the extrusion of domes along ring fractures. The latest eruption in the Jemez Mountains occurred about 130,000 years ago, producing the El Cajete pumice and Banco Bonito rhyolite flow (Gardner et al. 1986, 0310; Self et al. 1988, 0500). Vestiges of volcanic activity continue today, as evidenced by solfataric and hot spring activity both within and outside of the Valles caldera (Goff et al. 1989, 0774). Studies of P-wave arrival time delays suggest the presence of partially molten rock beneath the Valles caldera, possibly the remnants of the cooling Bandelier magma chamber (Roberts et al. 1991, 0775).

The Pajarito Plateau is in the western part of the Española basin of the Rio Grande rift, a major tectonic feature of the western United States. The Española basin lacks distinct major faults on its eastern margin, but faults of major vertical offset may exist in the Precambrian rocks of the Sangre de Cristo uplift (Vernon and Riecker 1989, 0558; Biehler et al. 1991, 0528). The western margin is characterized by a prominent zone of major faults, which cuts Miocene to Quaternary rocks of the Jemez volcanic field (Smith et al. 1980, 0776; Gardner and Goff 1984, 0719; Goff et al. 1990, 0557). These border faults exerted strong control on the location and development of the volcanic field (Gardner and Goff 1984, 0719; Gardner et al. 1986, 0310).

Rocks formed before the rift developed are exposed around the margins of and underlie the Española basin. These rocks consist of Mississippian to Permian marine limestones, sandstones, and shales; Mesozoic marine to terrestrial sandstones and shales; and Eocene sandstones, shales, and freshwater limestones. Precambrian rocks—predominantly quartzite, granitic gneiss and schist, and greenstone—are exposed in the cores of the flanking Sangre de Cristo, Nacimiento, and Brazos

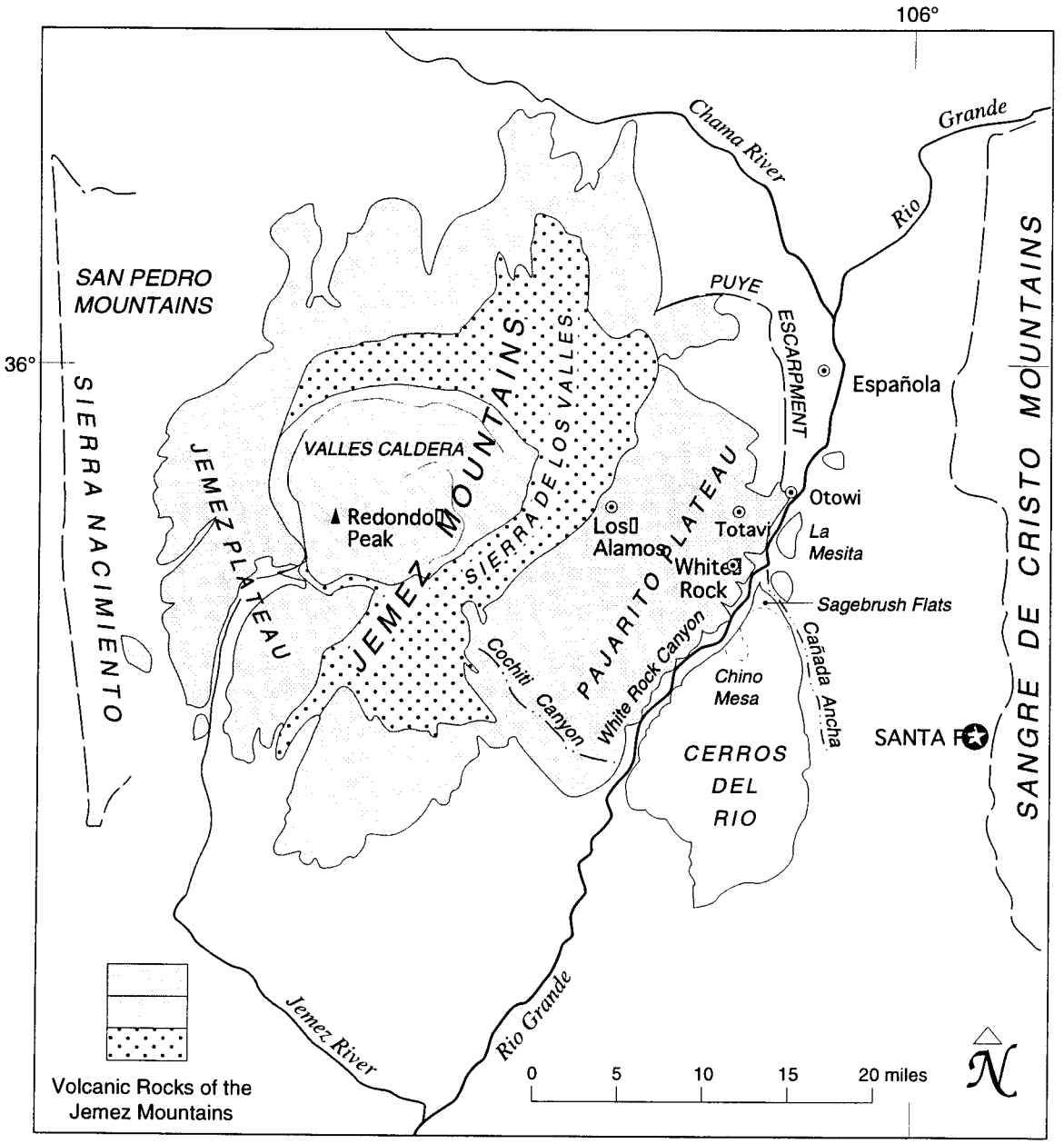

Figure 2-8. General geographic location map showing topographical features in the vicinity of Los Alamos.

uplifts (Kelley 1978, 0641). The earliest sediments deposited in the Tertiary Española basin are those of the Abiquiu, Picurís, and Los Piños formations, which consist of tuffaceous sandstones and volcaniclastic conglomerates derived largely from volcanic highlands to the north and northeast. These units range in age from about 28 to 17 million years old (Baldridge et al. 1980, 0527; May 1984, 0536; Ingersoll et al. 1990, 0533).

2.4.1.2 Stratigraphic Units

Beneath a veneer of soils and alluvial deposits, the mesas of the Pajarito Plateau are immediately underlain by the Bandelier Tuff of Pleistocene age, which is exposed in the canyon walls and is penetrated by numerous drill holes. Beneath the Bandelier Tuff, a sequence of interstratified sedimentary and volcanic rocks of Miocene to Pleistocene age occur, which have been penetrated by water supply wells and which have been studied where they outcrop in canyons on the margins of the Pajarito Plateau. These rock units include volcanic rocks of the Paliza Canyon Formation, Tschicoma Formation, and the Cerros del Rio volcanic field, and sedimentary deposits of the Puye Formation, the Totavi Formation, the Cochiti Formation, and the Santa Fe Group. These units are briefly discussed below. Figure 2-9 is a generalized geologic cross section from west to east of the Laboratory's geologic setting.

2.4.1.2.1 Santa Fe Group

The Santa Fe Group of Miocene and early Pliocene age (formed 18 to 4.5 million years ago) is a thick series of terrestrial conglomerates, sandstones, and mudstones, with minor limestones, evaporites, volcanic tuffs, and intercalated basalts. These rocks are the most extensive units filling the Rio Grande rift, and most production from water wells at Los Alamos is from the Santa Fe Group (Griggs and Hem 1964, 0313; Purtymun 1984, 0196). Sedimentary rocks usually dominate the Santa Fe Group, although basalts constitute up to 45% of the section penetrated by water supply wells at the Laboratory (Purtymun et al. 1984, 0713). In the Española basin and underlying the northern part of Los Alamos County, the Santa Fe Group is subdivided into two formations (Tesuque and Chamita formations) and several members, which reflects the diversity of the coalesced alluvial fans deposited in the Española basin (Galusha and Blick 1971, 0108; Ingersoll et al. 1990, 0533). Early investigators inferred that all Santa Fe Group rocks exposed around the flanks of the Pajarito Plateau and intersected by water wells beneath the plateau belonged to the Tesuque Formation (Griggs and Hem 1964, 0313; Cooper et al. 1965, 0495), although more recent investigations suggest that some of the upper Santa Fe Group in the vicinity of Los Alamos is instead Chamita Formation (Turbeville et al. 1989, 0221).

2.4.1.2.2 Keres Group

Two formations of the Keres Group (Bailey et al. 1969, 0019; Gardner et al. 1986, 0310), may be important in the pre-Bandelier Tuff subsurface in the southern parts of the Laboratory. These are the Paliza Canyon and Cochiti formations, each about 13 million to about 6 or 7 million years old. The St. Peter's Dome area lies about 3 mi from the southern boundary of the Laboratory and was a major center of Keres Group volcanism (Goff et al. 1990, 0557). Large volumes of Paliza Canyon andesite were erupted from the St. Peter's dome center and spread to the east and north. It appears that some of the volcanic units encountered in wells at TA-49 (Weir and Purtymun 1962, 0228) may be Paliza Canyon lavas that have been misidentified as Tschicoma and Cerros del Rio units, as discussed below.

Beneath the southern Pajarito Plateau, sedimentary deposits of the Cochiti Formation compose the Miocene basin fill and are therefore laterally equivalent to the sedimentary rocks of part of the Santa Fe Group and possibly also to those of the Puye Formation (Section 2.5.1.2.4) to the north (Gardner

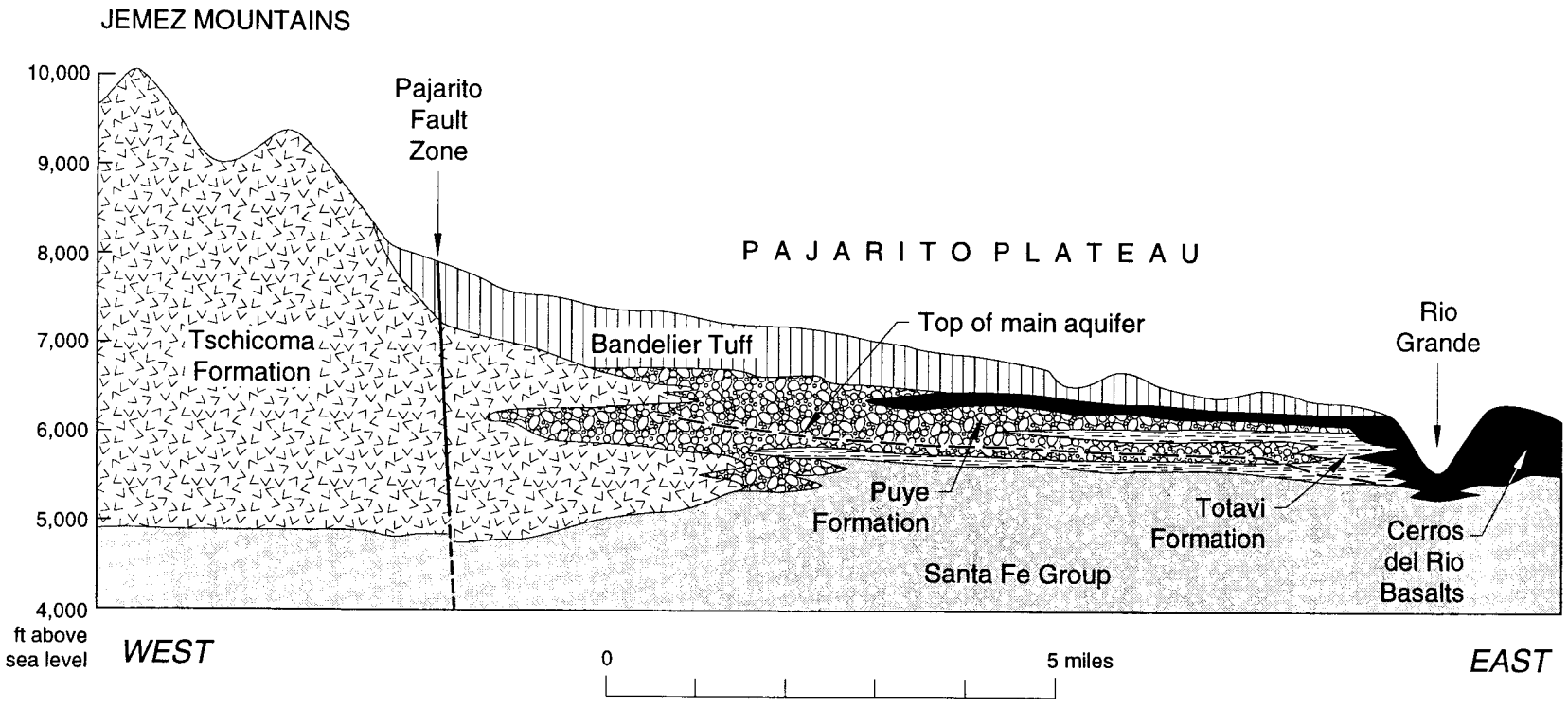

Figure 2-9. Generalized geologic section showing stratigraphy and structure from the Sierra de Los Valles across the Pajarito Plateau.

et al. 1986, 0310). The Cochiti Formation consists predominantly of basin fill gravels derived from the volcanic centers of the southern and central Jemez Mountains volcanic field. The transition between the Cochiti, Santa Fe, and Puye formations probably occurs somewhere beneath Los Alamos County; however, it is very poorly defined.

2.4.1.2.3 Tschicoma Formation

The Tschicoma Formation consists of a sequence of dacitic domes and lavas that were erupted from vents in the central to northeastern Jemez Mountains between about 7 and 3 million years ago (Gardner et al. 1986, 0310). These volcanic rocks outcrop extensively in the mountains immediately west of the Laboratory and are reported in the subsurface beneath the western and southern part of the Laboratory (Weir and Purtymun 1962, 0228; Griggs and Hem 1964, 0313; Dransfield and Gardner 1985, 0082).

2.4.1.2.4 Puye Formation

The Puye Formation consists of a Pliocene-to-Pleistocene fanglomerate that was shed eastward from Tschicoma volcanic centers in the northeastern Jemez volcanic field between about 4 and 1.7 million years ago. Earlier workers [e.g., Griggs and Hem (1964, 0313)] included the Totavi Lentil, now considered a separate formation (Section 2.5.1.2.5), as part of the Puye Formation. Most of the Puye conglomerates contain cobbles of dacitic to andesitic composition in a volcanic sand matrix. The beds include stream flow deposits, debris flow deposits, volcanic ash and block flow deposits, and ash fall and pumice fall deposits (Waresback and Turbeville 1990, 0543). The Puye Formation is best exposed north of the Laboratory, but lithologically similar rocks have been penetrated in drill holes as far south as Frijoles Mesa (Weir and Purtymun 1962, 0228; Dransfield and Gardner 1985, 0082). Under parts of the Laboratory, the Puye Formation is interstratified with basalts of the Cerros del Rio volcanic field. In Los Alamos water supply wells, the top of the main aquifer is usually within the Puye Formation.

2.4.1.2.5 Totavi Formation

Immediately beneath the fanglomerates of the Puye Formation, unconformably overlying the Santa Fe Group, is a section of poorly consolidated fluvial gravels, which Griggs originally named the Totavi Lentil of the Puye Formation (Griggs and Hem 1964, 0313). The gravels contain clasts that differ lithologically from those in the Puye, including abundant well-rounded cobbles and boulders of quartzite, granite, and pegmatite that record a source area distant from the Jemez Mountains; this unit probably represents axial channel gravels of an ancestral Rio Grande. Waresback and Turbeville (1990, 0543) redefined these fluvial gravels as a separate formation, the Totavi Formation, which also includes lacustrine sediments that are complexly interstratified with the upper Puye Formation ("old alluvium" of Griggs and Hem 1964, 0313). In some water supply wells beneath the Laboratory, the Totavi was reported between the Santa Fe and the Puye, occurring at lower elevations in the eastern wells (Cooper et al. 1965, 0495; Purtymun et al. 1983, 0712; Purtymun et al. 1984, 0713). The presence of the Totavi at these levels suggests that Rio Grande river gravels were deposited on erosional surfaces, a setting analogous to Quaternary terraces of the Rio Grande in the Española basin described by Dethier et al. (1988, 0773) before deposition of the Puye fans, which unconformably overlie older formations.

2.4.1.2.6 Cerros del Rio Basalts

Basaltic flows, breccias, and scoria of the Cerros del Rio occur in the subsurface beneath much of the Pajarito Plateau (Dransfield and Gardner 1985, 0082) and outcrop in the east and southeast parts

of Los Alamos County (Griggs and Hem, 1964, 0313). These volcanic rocks are associated with the Pliocene-to-Pleistocene Cerros del Rio basalt field east of the Rio Grande, and rocks from this field have been dated at 4.6 to 2.0 million years old (Gardner et al. 1986, 0310). The youngest lava flows in this area occurred between the two Bandelier Tuff eruptions, 1.5 and 1.13 million years ago ("basaltic andesite of Tank Nineteen" described by Smith et al. (1980, 0776). Part of this volcanic field is also known as basaltic rocks of Chino Mesa (Griggs and Hem 1964, 0313). The top of the main aquifer beneath the Laboratory is locally within this section of basaltic rocks.

2.4.1.2.7 Otowi Member, Bandelier Tuff

The Otowi Member of the Bandelier Tuff underlies the Tshirege Member in the subsurface beneath much of the Pajarito Plateau and outcrops in many of the canyons (Griggs and Hem 1964, 0313). The Otowi Member is mostly a nonwelded ash flow tuff (ignimbrite) that was erupted from the Jemez Mountains 1.5 million years ago (Spell et al. 1990, 0607). It is highly porous and poorly indurated and is composed of multiple flow units. Where it outcrops, cooling joints are typically absent because of relatively low emplacement temperatures and the lack of induration. The Guaje Pumice Bed generally occurs at the base of the Otowi Member and consists of sorted pumice fragments that average 0.8 to 1.6 in. in size (Crowe et al. 1978, 0041).

2.4.1.2.8 Cerro Toledo Rhyolite and Interbedded Sediments

An interbedded sequence of rhyolitic tuffs and sediments commonly occurs between the Otowi and Tshirege members of the Bandelier Tuff. The rhyolitic tuffs were erupted between 1.5 and 1.2 million years ago, predominantly from the Cerro Toledo domes in the northeastern Jemez Mountains (Heiken et al. 1986, 0316). Beneath the Pajarito Plateau, the sediments are epiclastic sands and sandy gravels that lithologically resemble Puye Formation fanglomerates. At the Laboratory, deposits in this interval have sometimes been referred to as "Tsankawi pumice" or "Tsankawi member." These units may play an important role in the migration of water in the subsurface beneath the Laboratory (Stoker et al. 1991, 0715).

2.4.1.2.9 Tshirege Member, Bandelier Tuff

The most widespread rock unit on the Pajarito Plateau is the Tshirege Member of the Bandelier Tuff (Griggs and Hem 1964, 0313), which was erupted from the Valles caldera in the Jemez Mountains about 1.13 million years ago (Spell et al. 1990, 0607). The Tshirege Member is composed of multiple flow units of crystal-rich ignimbrite and displays significant variations in welding and alteration, both in a single stratigraphic section and with varying distance from the caldera. Individual units tend to be more welded and thicker to the west. Flow units are locally separated by volcanic surge deposits of well-sorted, fine-grained, cross-bedded crystal and pumice fragments. Vapor phase alteration, caused by postemplacement cooling and migration of entrained magmatic gases, occurs in much of this unit. The base of the Tshirege Member is often marked by 1.5 to 10 ft of bedded, unconsolidated, pumice-rich ash fall tuff of the Tsankawi Pumice Bed (Bailey et al. 1969, 0019; Crowe et al. 1978, 0041). The Tsankawi Pumice Bed is generally poorly recognized in drill bit cuttings because rotary drills commonly grind the soft materials into dust.

The Tshirege Member has been subdivided into a sequence of mappable units based either on erosional characteristics (Weir and Purtymun 1962, 0228; Baltz et al. 1963, 0024; Purtymun and Kennedy 1971, 0200) or on primary cooling units (Crowe et al. 1978, 0041). These units have been correlated over large distances on the Pajarito Plateau. However, the boundaries between the units are not always distinct in the field and can be difficult to recognize in drill holes, causing investigators to place the contacts between units at different locations. Furthermore, in the absence of geologic mapping in the intervening areas, the validity of the correlations is uncertain.

Stratigraphic features in the tuff, such as volcanic surge deposits, may locally provide a preferential migration pathway for moisture and contaminants in the subsurface (Purtymun 1973, 0710; Crowe et al. 1978, 0041). Purtymun (1973, 0710) noted increased rates of vapor phase migration of tritium away from storage shafts at TA-54 along a stratigraphic boundary that includes surge layers. Individual flow units in the Tshirege Member contain vertical cooling joints that may or may not cross flow unit boundaries. In ash flow tuffs, cooling joint spacing varies primarily with the thickness of the unit, emplacement temperature, substrate temperature, and topography. Joint density tends to be greatest in welded tuff and least in nonwelded tuff. Hydraulic conductivities are generally greatest in the fractured, welded parts of ash flow tuffs and least in the nonwelded parts (Crowe et al. 1978, 0041).

2.4.1.2.10 Post-Bandelier Units

Stratigraphically overlying the Bandelier Tuff are discontinuous Quaternary alluvial units that occur as thin deposits (typically less than 15 ft thick) on mesa tops and as deposits in canyons. Alluvial fans consisting mostly of dacite debris are being shed over the Bandelier Tuff at the western boundary of the Laboratory. Well-sorted to poorly sorted sandy and gravelly alluvium occurs in the major drainages of the Pajarito Plateau, ranging up to at least 70 ft thick in some drill holes (Baltz et al. 1963, 0024). Additional, older alluvium occurs on stream terraces on the sides of the canyons, which can be buried by colluvial deposits from the canyon walls. The distribution of alluvial deposits on the mesas has not been mapped, but these deposits are most widespread on the western part of the Pajarito Plateau. Post-Bandelier alluvial units represent a range of ages from 1.1 million years ago to the present. Generally, alluvial units on the surface of the mesas are probably oldest, becoming inactive as drainages were incised into the plateau. Those units lowest in the drainages grade into the active alluvium along canyon bottoms.

The alluvial sediments in the canyon bottoms probably record a complex history of erosion and deposition, in part related to regional climatic changes. In Cabra Canyon, immediately north of Los Alamos, several cycles of erosion and deposition of sediment have occurred over the last 6,000 years, during which most of the previously stored sediment was eroded (Gardner et al. 1990, 0639). Similar cycles of erosion and deposition have been documented in many parts of the southwestern United States, and the older alluvial units in the vicinity of Los Alamos may also record the effects of regional climatic changes (Dethier et al. 1988, 0773).

The mesas of the Pajarito Plateau are also covered in part by deposits of the El Cajete pumice, erupted from El Cajete crater in the Jemez Mountains. Deposits of pumice on the mesas have not been mapped, but at the Laboratory they are generally most common to the south, and the axis of the volcanic dispersal plume is south of Los Alamos County. Available data suggest that the El Cajete pumice is 130,000 to 170,000 years old (Self et al. 1988, 0500).

2.4.1.3 Soils

A large variety of soils have developed on the Pajarito Plateau as the result of interactions of the underlying bedrock, slope, and climate (Nyhan et al. 1978, 0161). The mineral components of the soils are in large part derived from the Bandelier Tuff, but dacitic lavas of the Tschicoma Formation, basalts of the Cerros del Rio volcanic field, and sedimentary rocks of the Puye Formation are locally important. Alluvium derived from the Pajarito Plateau and from the east side of the Jemez Mountains contributes to soils in the canyons and also to those on some of the mesa tops. Layers of pumice derived from El Cajete in the Jemez Mountains and windblown sediment derived from other parts of New Mexico are also significant components of many soils on the Pajarito Plateau.

Soils formed on the tops of mesas on the Pajarito Plateau include the Carjo, Frijoles, Hackroy, Nyjack, Pogna, Prieta, Seaby, and Tocal series. These soils typically have loam or sandy loam surface horizons and clay or clay loam subsurface horizons. Some, including the Frijoles, Hackroy, and

Seaby soils, contain abundant pumice. Others, including the Prieta soils, contain abundant wind-deposited sediment. Soils on the mesas can vary widely in thickness and are typically thinnest near the edges of the mesas, where bedrock is often exposed. Soils formed from alluvial and colluvial deposits include the Potrillo, Puye, and Totavi series and are generally loose and sandy. The slopes between the mesa tops and canyon bottoms often consist of steep rock outcrops and patches of shallow, undeveloped colluvial soils. South-facing canyon walls are steep and usually have little or no soil material or vegetation; in contrast, the north-facing walls generally have areas of very shallow, dark-colored soils and are more heavily vegetated (Nyhan et al. 1978, 0161).

Soil-forming processes extend along fractures in bedrock, and coatings of clay and calcium carbonate on fractures record the transport of water to significant depths in the tuff. For example, at TA-54, Area G, calcium carbonate has been observed as deep as 39 ft and clay coatings as deep as 46 ft below the ground surface (Purtymun et al. 1978, 0207). Roots have also been observed at similar depths along fractures in core holes and pits, suggesting that these soil-forming processes continue at depth today.

2.4.1.4 Geologic Structure

As mentioned earlier, the Laboratory is on the Pajarito Plateau, which lies at the western margin of the Española basin of the Rio Grande rift, a major tectonic feature of the North American continent. The Pajarito fault system forms the western margin of the Española basin and exhibits Holocene movement and historic seismicity (Gardner and House 1987, 0110; Gardner et al. 1990, 0639; Gardner and House 1994, 0720). The fault system is made up of over 65 mi of mapped fault traces and connects with regional structures that extend at least as far as Cochiti to the south and Taos to the northeast (Gardner and House 1987, 0110).

Within Los Alamos County, the Pajarito fault system consists of three active, or potentially active, fault segments: the Frijoles Canyon, Rendija Canyon, and Guaje Mountain segments. The Frijoles Canyon fault segment is a zone of faulting over 0.25 mi in width, whose major scarp forms the western boundary of the Laboratory. Near the southwestern corner of the Laboratory, the major scarp of the Frijoles Canyon segment is over 410 ft high in rocks about 1 million years old. Movement on this fault segment is normal-oblique, and the fault's eastern side is relatively downdropped. Where exposed north of Los Alamos Canyon, the Rendija Canyon and Guaje Mountain faults are characterized by zones of gouge and breccia, generally 100 to 150 ft wide. Both fault segments produce visible offsets of stratigraphic horizons and are dominantly normal-oblique faults, whose west sides are downdropped. There are some indications of strike-slip movements on the Guaje Mountain fault segment (Wachs et al. 1988, 0502; Aldrich and Dethier 1990, 0017; Gardner et al. 1990, 0639). The youngest movements on the Guaje Mountain segment have been constrained to between roughly 4,000 and 6,000 years ago (Gardner et al. 1990, 0639). Displacement on the Guaje Mountain and Rendija Canyon faults apparently decreases south of Los Alamos Canyon, and narrow zones of faulting are replaced by wide (over 300 ft) zones of intense brecciation and fracturing superimposed on the network of cooling joints in the Bandelier Tuff (Vaniman and Wohletz 1990, 0541). In contrast to cooling joints, these tectonic fractures cross flow unit and lithologic unit boundaries; thus, tectonic fractures may provide more continuous and more deeply penetrating flow paths for groundwater migration than do cooling joints.

Dransfield and Gardner (1985, 0082) integrated a variety of data to produce structure contour and paleogeologic maps of the pre-Bandelier Tuff surface beneath the Pajarito Plateau. Their maps reveal that subsurface rock units are cut by a series of down-to-the-west normal faults; the overlying Bandelier Tuff is not obviously displaced by these buried faults. However, where detailed fracture studies have been done on the plateau, they have shown that fracture abundances and apertures increase in the Bandelier Tuff over fault projections, which indicates the tectonic fracturing mentioned

above (Vaniman and Wohletz 1990, 0541). In addition, small-scale offsets along fractures have been observed in various parts of the Laboratory, including Area G at TA-54 (Rogers 1977, 0216), which suggest additional unmapped fault zones. Unfortunately, detailed fracture studies on the Pajarito Plateau are few.

2.4.1.5 Seismicity and Volcanism

The Laboratory lies within a region that possesses a long and rich history of volcanic and tectonic activity dating from the distant past into the Late Pleistocene and present, respectively. Volcanism began in the Jemez Mountains volcanic field more than 13 million years ago and continued without significant hiatus up through about 130,000 years ago (Gardner et al. 1986, 0310). Reports of questionable reliability describe what were apparently phreatic explosions and possible associated earthquakes within the volcanic field around 100 years ago (Santa Fe *Daily New Mexican* 1882, 0780). Regardless, given the long history of spatially focused, geologically continuous volcanic activity, future volcanism can be expected. Although volcanic activity directly affecting the Laboratory may prove unlikely, sufficient data to quantify the probabilities and nature of future volcanism are lacking.

Direct effects of future seismicity at the Laboratory are likely, although quantification of probabilities is not possible at present. Numerous small earthquakes are recorded in the Los Alamos area and northern New Mexico each year (Sanford et al. 1979, 0540; Cash and Wolff 1984, 0530; Gardner and House 1987, 0110). Since establishment of the Laboratory, several earthquakes of Richter magnitude 3 to 4 have shaken Los Alamos (Gardner and House 1987, 0110). Recent work has shown that three fault segments in Los Alamos County are seismically active and that they are capable of generating large earthquakes of about 7 or more on the Richter scale (Gardner and House 1987, 0110; House and Cash 1988, 0132; Gardner et al. 1990, 0639; Gardner and House 1994, 0720). Unknown at this time are how frequently these large earthquakes occur and what their potential is for generating surface rupture and mass wasting (occurrences such as rockfalls and landslides, which are not caused primarily by the movement of water) within the confines of the Laboratory.

2.4.1.6 Geomorphic Processes

Significant geomorphic processes active on the Pajarito Plateau include (1) erosion of mesa top soils by run-off, (2) retreat of canyon walls by rockfall and landsliding, (3) colluvial transport on sloping portions of canyon walls, and (4) erosion and deposition of sediments by streams in the canyon bottoms. Few data exist on the rates of erosion and landscape change caused by these different processes on the Pajarito Plateau. Estimates of long-term vertical erosion rates on mesa tops have been made based on stripping of overlying units (Purtymun and Kennedy 1971, 0200), but these estimates may be of limited value because the resistant, cliff-forming units may be eroded primarily by lateral cliff retreat rather than by vertical erosion. Erosion rates vary considerably on the mesa tops; the highest rates occur in and near drainage channels and in areas of locally steeper slope gradient, and the lowest rates occur on relatively gently sloping portions of the mesa tops removed from channels. Areas where run-off is concentrated by roads and other development are especially prone to accelerated erosion.

The rates and processes of erosion may differ significantly between the north and south slopes of canyons. Given current vegetation and climate, the more extensive exposures of bedrock on south-facing sides and greater soil cover on north-facing sides suggest that erosion rates of fine-grained material that can be transported by run-off are higher on the drier, less-vegetated, south-facing sides of canyons, although this material is largely retained on the north-facing slopes. However, no studies have been conducted to quantify the rates and processes of erosion on canyon sides.

Cliff faces retreat primarily by dislodgement of blocks bounded by joints and, to a lesser extent, by large-scale landsliding, including the formation of huge toreva blocks in White Rock Canyon. At present, the rates of cliff retreat have not been documented. Neither is it known to what extent cliff retreat rates may vary with climatic changes, with evolution of the canyons, or with proximity to side drainages.

Thicknesses, detailed stratigraphy, and ages of alluvium in canyon bottoms are, in general, poorly known, and therefore the rates of deposition, erosion, and transport of sediments through canyons are largely unknown. Available studies that have examined alluvial stratigraphy on the Pajarito Plateau reveal multiple cycles of extensive erosion of sediment, followed by renewed deposition, in the past 6,000 years (Gardner et al. 1990, 0639). At Cabra Canyon, north of Los Alamos, the last few hundred years has been marked by the net accumulation of sediment in the canyon bottom (Gardner et al. 1990, 0639), but it is not known how long this sediment will stay in storage before being mobilized by floods and transported downcanyon. It is possible that these erosional cycles are climatically driven and regional in extent, but more extensive data from additional canyons are needed before this determination can be made. On a longer time scale, evidence from the adjacent Española basin does suggest a strong climatic control on periods of alluviation and canyon incision over the last million years (Dethier et al. 1988, 0773).

2.4.2 Hydrology

2.4.2.1 General Surface Water Conditions

The Rio Grande is the master stream in north-central New Mexico. All surface water drainage and groundwater discharge from the plateau ultimately arrives at the Rio Grande. The Rio Grande at Otowi, just east of Los Alamos, has a drainage area of 14,300 mi^2 in southern Colorado and northern New Mexico. The discharge for the period of record has ranged from a minimum of 60 cubic feet per second (cfs) in 1902 to 24,400 cfs in 1920. The river transports about 1 million tons of suspended sediments past Otowi annually.

Essentially all Rio Grande flow downstream of the Laboratory passes through Cochiti Reservoir, which began filling in 1976. It is designed to provide flood control, sediment retention, recreation, and fishery development. Flood flows are temporarily stored and released at safe rates. The dam is expected to trap at least 90% of the sediments carried by the Rio Grande.

Figure 2-10 shows the location of the major surface water drainages in the Los Alamos area. Los Alamos surface water occurs primarily as ephemeral streams in canyons cut into the Pajarito Plateau. Only four of the canyons contain perennial reaches inside Laboratory boundaries: Pajarito, Water, Ancho, and Chaquehui canyons. Of these four reaches, only Pajarito Canyon occurs upstream (to the west) of any Laboratory facilities or effluent discharge points. Other perennial reaches occur outside Laboratory lands in the drainage areas of Guaje, Los Alamos, Sandia, Pajarito, Water (and its tributary, Cañon de Valle), Ancho, and Chaquehui canyons.

Within Laboratory boundaries, perennial reaches in the lower portions of Ancho and Chaquehui canyons are close enough to the Rio Grande that they extend to the Rio Grande without being depleted. In lower Water Canyon, the perennial reach is very short, extends into an intermittent reach that is also short, and does not extend to the Rio Grande. In Pajarito Canyon, about 1 mi east of State Road 501, a spring sometimes called Homestead Spring feeds a perennial reach a few hundred yards long, followed by an intermittent reach that flows varying distances, depending on climate conditions.

Essentially all other reaches of canyons within the Laboratory's boundaries are ephemeral; that is, they flow naturally only briefly in response to precipitation or snowmelt in the immediate locality. Some

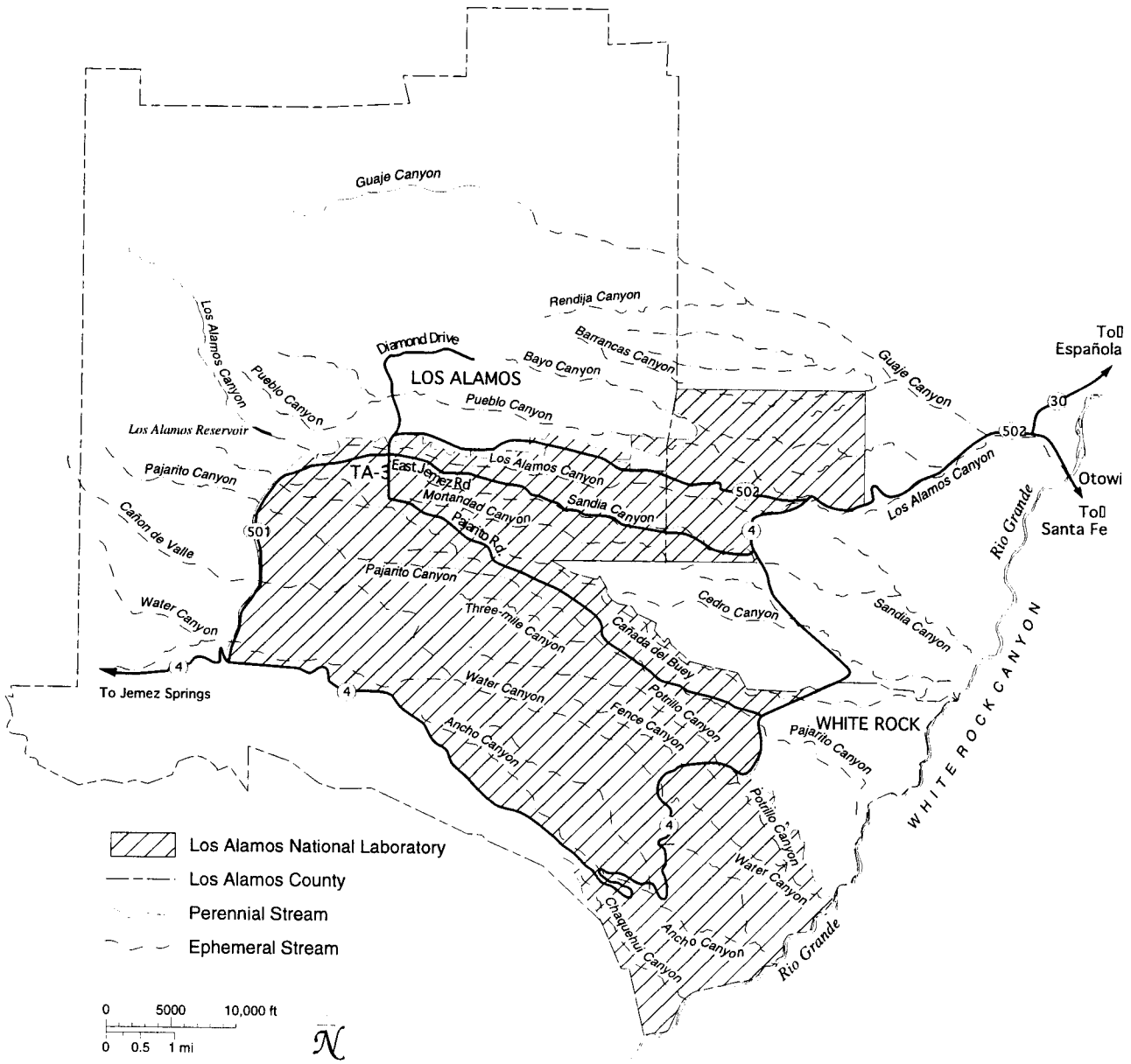

Figure 2-10. Location of the major surface water drainages in the Los Alamos area.

other reaches are intermittent, especially those that flow during part of the year as the result of snowmelt. This snowmelt recharges the alluvial perched groundwater, and discharge from the perched systems supports intermittent stream flow for a somewhat longer period.

Springs between elevations of 7,900 and 8,900 ft mean sea level on the flanks of the Jemez Mountains supply base flow throughout the year to the upper reaches of Cañon de Valle and in Guaje, Los Alamos, Pajarito, and Water canyons (Purtymun 1975, 0194). These springs discharge water perched in the Bandelier Tuff and Tschicoma Formation at rates from 2 to 135 gal./min (Abeele et al. 1981, 0009). The volume of flow from the springs is insufficient to maintain surface flow within more than the western third of the canyons before it is depleted by evaporation, transpiration, and infiltration into the underlying alluvium.

Eleven drainage areas, with a total area of 82 mi^2, pass through the Laboratory's eastern boundary. Run-off from heavy thunderstorms and heavy snowmelt reaches the Rio Grande several times a year in some drainages. Los Alamos, Pajarito, and Water canyons have drainage areas at the east boundary of greater than 10 mi^2. Pueblo Canyon has approximately 8 mi^2; the rest (Barrancas [a tributary to Guaje Canyon], Bayo, Sandia, Mortandad, Cañada del Buey, Ancho, and Chaquehui canyons) have less than 6 mi^2 each. Theoretical maximum flood peaks range from 24 cfs for a 2-yr frequency to 686 cfs for a 50-yr frequency (McLin 1992, 0825). The overall flooding risk to community and Laboratory buildings is low because nearly all the structures are located on the mesa tops, from which run-off drains rapidly into the deep canyons.

Contaminants enter the surface water drainages by surface run-off, by liquid discharges, and occasionally by air deposition (Becker et al. 1985, 0029; Becker 1986, 0027). Run-off-derived contaminants are largely bound to sediments; their rate of downstream travel is governed by the scouring and carrying power of subsequent run-off events (Lane et al. 1985, 0140). Given sufficient time, these sediments eventually will be moved across the Laboratory boundary.

Nearly every drainage has received liquid industrial or sanitary effluents discharged from the Laboratory. The effluent discharges determine the flow and water quality characteristics in drainages that contain little natural water. With travel downstream, most of the effluent-derived metals and radionuclides become sediment-bound and remain near the surface of the stream channel; other contaminants, such as nitrate, are lost by evaporation or move downward into the alluvium. Detailed field investigations in Mortandad Canyon, for example, demonstrate that generally more than 99% of the total inventory of transuranic radioactivity discharged from the treatment plant effluents is associated with sediments in or immediately adjacent to the stream channel (Stoker et al. 1991, 0715).

In canyons that have received treated, low-level radioactive effluents (Acid-Pueblo, DP-Los Alamos, and Mortandad canyons) concentrations of radioactivity in the alluvium are generally highest near the treated effluent outfall and decrease downstream in the canyon as the sediments and radionuclides are transported and dispersed by other treated industrial effluents, sanitary effluents, and surface run-off.

A study of transport of plutonium by snowmelt run-off published in 1990 (Purtymun et al. 1990, 0215) includes the finding that most plutonium moved by run-off in Los Alamos and Pueblo canyons that reached the Rio Grande is transported with sediments—about 57% with suspended sediments and 40% with bed sediments. A total of about 600 µCi of plutonium was carried to the Rio Grande by 5 snowmelt run-off events studied during the years 1975 to 1986.

A regional plutonium analysis for the Rio Grande upstream of Elephant Butte Reservoir shows that fallout contributes about 90% of the total plutonium moving through the drainage system in any given

year (Graf 1993, 1161). The remaining 10% is from releases at Los Alamos. The contribution to the plutonium budget from Los Alamos is associated with relatively coarse sediment, which often behaves as bedload in the Rio Grande (Graf 1993, 1161).

Environmental monitoring for chemical and radiochemical quality in surface water began with USGS investigations (Purtymun 1964, 0183; 1975, 0194; Purtymun and Kunkler 1967, 0202; Purtymun 1967, 0188) and has been continued by the Laboratory (ESG until 1971; Environmental Protection Group 1994, 1179).

2.4.2.2 General Groundwater Conditions

Groundwater occurs in three modes in the Los Alamos Area: (1) water in shallow alluvium in some of the larger canyons, (2) intermediate perched groundwater (a perched groundwater body lies above a less permeable layer and is separated from the underlying aquifer by an unsaturated zone), and (3) the main aquifer of the Los Alamos area.

2.4.2.2.1 Perched Groundwater in Alluvium

Intermittent and ephemeral streamflows in the canyons of the Pajarito Plateau have deposited alluvium that ranges in thickness to as much as 100 ft. The alluvium in canyons that head on the Jemez Mountains is generally composed of sands, gravels, pebbles, cobbles, and boulders derived from the Tschicoma Formation and Bandelier Tuff on the flank of the mountains. The alluvium in canyons that head on the plateau is comparatively more finely grained, consisting of clays, silts, sands, and gravels derived from the Bandelier Tuff. Saturated hydraulic conductivity of the alluvium typically ranges from 10^{-2} cm/s for a sand to 10^{-4} cm/s for a silty sand (Abeele et al. 1981, 0009).

In contrast to the underlying volcanic tuff and sediments, the alluvium is quite permeable. Ephemeral run-off in some canyons infiltrates the alluvium until downward movement is impeded by the less permeable tuff and sediments, which results in a buildup of a shallow alluvial groundwater body. Depletion by evapotranspiration and movement into the underlying rocks limit the horizontal and vertical extent of the alluvial water (Purtymun et al. 1977, 0206). The limited saturated thickness and extent of the alluvial groundwater preclude its use as a viable source of municipal and industrial supply to the community and the Laboratory. Lateral flow of the alluvial perched groundwaters is in an easterly, downcanyon direction. Tracer studies in Mortandad Canyon have shown that the velocity of water ranges from about 60 ft/day in the upper reach to about 7 ft/day in the lower reach of the canyon (Purtymun 1974, 0192).

The water quality in the alluvial perched groundwaters is variable, depending on the location and history of effluent discharges. In Mortandad Canyon, for example, plutonium concentrations fluctuate up and down in response to variations in treatment plant effluent and storm run-off water, which cause some dilution of the shallow alluvial perched groundwater. Tritium concentrations have fluctuated almost in direct response to the average annual concentration of tritium in the TA-50 effluent, with a lag time of about 1 year (Environmental Protection Group 1992, 0740).

Purtymun (1975, 0194; 1973, 0191) has written reviews of alluvial perched groundwaters by drainage area. The results of an extensive monitoring study of the alluvial perched groundwater in Mortandad Canyon are presented by Abrahams et al. (1962, 0231), Baltz et al. (1963, 0024), Purtymun (1973, 0191), Purtymun (1974, 0192), Purtymun et al. (1977, 0206), Purtymun et al. (1983, 0209), and Stoker et al. (1991, 0715).

2.4.2.2.2 Intermediate Perched Groundwater

Localized bodies of perched groundwater occur beneath several canyons in the eastern portion of the Laboratory, along the eastern flanks of the Jemez Mountains west of the Laboratory, and possibly beneath the mesas and canyons at S Site (TA-16), located in the southwestern part of the Laboratory near the Jemez Mountains. Perched groundwater may exist beneath other canyons in the south and central portions of the Laboratory, which have not yet been investigated by drilling. These perched groundwater bodies are found in areas where a sufficient water source is present to maintain saturation within the deeper units. Thus perched groundwater beneath canyon bottoms may be maintained by infiltration from the overlying stream, and perched groundwater within the Bandelier Tuff along the Jemez Mountains may be maintained by seepage from streams exiting the mountains. The presence of these perched groundwater bodies is controlled by the occurrence of a perching layer, whose lower permeability causes water to pond in a more permeable horizon above it. Perching layers are found within the interlayered Cerros del Rio Basalt flows and the sediments of the Puye Formation, for example, where they underlie the more permeable Guaje Pumice Bed in Los Alamos Canyon. The presence of perched water at S Site and on the flanks of the Jemez Mountains is evidently controlled by contrasts in lithologic properties within the Bandelier Tuff, which might exist at boundaries between flow units.

Perched water bodies occur in the conglomerates and basalts beneath the alluvium in the mid- and lower reaches of Pueblo and Los Alamos canyons and in the lower reach of Sandia Canyon. Depth to perched water ranges from about 90 ft in the midreach of Pueblo Canyon to about 450 ft in lower Sandia. The vertical and lateral extent of the perched groundwaters, the nature and extent of perching units, and the potential for migration of perched water to the main aquifer is not yet fully understood by investigators. Only the body in lower Pueblo and Los Alamos canyons has been studied in some detail.

Patterns of chemical quality and water level measurements indicate that the intermediate perched groundwater in Pueblo Canyon is hydrologically connected to the stream in Pueblo Canyon (Abrahams and Purtymun 1966, 0014). Water from this perched groundwater discharges at the base of the basalt at Basalt Spring, which is off the Laboratory site in lower Los Alamos Canyon on the San Ildefonso Pueblo. The rate of movement of the perched groundwater in this vicinity has been estimated at about 60 ft/day or about 6 mo from recharge to discharge (Purtymun 1975, 0194).

It is unknown whether the perched water systems are hydraulically interconnected. Available data, however, suggest that most of the systems are of limited extent: testing of the perched system in mid-Pueblo Canyon depleted the perched groundwater after about an hour's pumping at 2 to 3 gal./min (Weir et al. 1963, 0395). Perched water was encountered in mid-Los Alamos Canyon during the drilling of the Otowi 4 supply well (Stoker et al. 1992, 0826), but it was not reported in an adjacent well (Test Well 3) located 300 ft to the east. (However, Test Well 3 was drilled with a cable tool rig in 1947, and the driller may not have noticed the perched groundwater if it was present.)

Measurements of tritium in perched groundwater at intermediate depths demonstrate that recharge to those depths has occurred during the last several decades. The levels of tritium in those locations are high enough to be attributed to recharge of surface water contaminated by effluent or other releases from Laboratory operations.

These observations have been made at four locations in Pueblo and Los Alamos canyons. For several years, tritium has been observed in Test Well 2A in Pueblo Canyon at levels between 2,000 and 3,000 pCi/L. Starting in 1991, low-detection-limit tritium measurements have consistently revealed tritium at levels of about 150 pCi/L in samples from Test Well 1A, located in lower Pueblo Canyon near its confluence with Los Alamos Canyon, and in Basalt Spring, located in Los Alamos Canyon just downstream from its confluence with Pueblo Canyon. The measurements at these three

locations are consistent with previous understanding. The intermediate perched groundwater has long been known to be affected by effluents discharged into Pueblo Canyon, starting with measurements made by the USGS in the 1950s and 1960s (Abrahams et al. 1961, 0015).

The most recent observation of tritium in intermediate-depth groundwater was made in Well LADP-3, completed in 1993 by the Environmental Restoration (ER) Project in the middle reach of Los Alamos Canyon about 1 mi down gradient of TA-2, the Omega Reactor site (Broxton and Eller 1995, 1162). Well LADP-3 encountered perched water at a depth of about 320 to 330 ft, just at the contact of the Otowi Tuff and the Puye Conglomerate. Samples of water from that well contained about 6,000 pCi/L.

Some perched water occurs in volcanics on the flanks of the Jemez Mountains offsite to the west of the Laboratory. This water discharges in several springs (including American and Armistead springs) and provides flow for the gallery in Water Canyon. The gallery contributed to the Los Alamos water supply for 41 years, producing 23 to 96 million gal. annually.

Several springs have been noted in the area of S Site by the New Mexico Environment Department (NMED) DOE Oversight Bureau (unpublished data). Some of these springs are located within canyon bottom alluvium where groundwater return flow to the dry stream channel occurs and do not represent springs in the usual sense. In other cases flow issues from canyon walls well above the alluvium. The origin of water supplying these springs is uncertain at present. In some cases the flow may have its source from nearby outfalls. The NMED DOE Oversight Bureau (unpublished data) has discovered high-explosives residuals in samples from some of these springs.

2.4.2.2.3 Main Aquifer

The main aquifer of the Los Alamos area is the only aquifer capable of large-scale municipal water supply (Purtymun 1984, 0196). In 1989, water for the Laboratory, the communities of Los Alamos and White Rock, and Bandelier National Monument was supplied from 11 deep wells in 3 well fields. The wells are located on the Pajarito Plateau and in Los Alamos and Guaje canyons east of the plateau. Municipal and industrial water supply during 1992 was 1.43 billion gal. Yields from individual wells ranged from about 175 to 1,400 gpm (Stoker et al. 1992, 0826). Purtymun (1984, 0196) summarizes the hydraulic characteristics of the aquifer as determined during aquifer tests and during periods of production of supply wells and test holes.

The surface of the main aquifer rises westward from the Rio Grande within the Santa Fe Group into the lower part of the Puye Conglomerate beneath the central and western part of the plateau. The depths to water below the mesa tops range from about 1,200 ft along the western margin of the plateau to about 600 ft at the eastern margin. The main aquifer is separated from the water in the alluvium and perched water in the volcanics by 350 to 620 ft of tuff and volcanic sediments (Environmental Protection Group 1993, 0829). The main aquifer exhibits artesian conditions in the eastern part along the Rio Grande (Purtymun 1984, 0196). Continuously recorded water level data collected in test wells since the fall of 1992 indicate that, throughout the plateau, the main aquifer responds to barometric and earth tide effects in the manner typical of confined aquifers.

The exact source of recharge to the main aquifer is unknown. Cushman (1965, 0042) suggested three sources of recharge: infiltration of run-off in canyons, underflow from the Valles Caldera through the Tschicoma Formation, and infiltration on mesas. However, a large quantity of hydrologic, structural, and geochemical data indicate that the caldera may not serve as an appreciable source of recharge to the main aquifer (Conover et al. 1963, 0246; Griggs and Hem 1964, 0313; Goff 1991, 1020). Furthermore, natural recharge through undisturbed Bandelier Tuff on the mesa tops is believed to be insignificant (Purtymun and Kennedy 1971, 0200; Kearl et al. 1986, 0135), and few or no data exist to support an evaluation of canyon run-off as a recharge source. It is inferred that major recharge of the main aquifer occurs from the west because the piezometric surface slopes downward to the east.

Water level elevations suggest that groundwater flows from the Jemez Mountains east and east-southeast toward the Rio Grande, where a part is discharged into the river through seeps and springs (Purtymun et al. 1980, 0208). Springs fed by the main aquifer discharge an estimated 4,300 to 5,000 acre-ft of water annually into White Rock Canyon along an 11-mi reach between Otowi Bridge at State Road 502 and the mouth of Rito de Frijoles (Cushman 1965, 0042).

The hydraulic gradient of the aquifer averages about 60 to 80 ft/mi within the Puye Conglomerate but increases to 80 to 100 ft/mi along the eastern edge of the plateau as the water in the aquifer enters the less permeable sediments of the Santa Fe Group. The rate of movement of water in the upper section of the aquifer varies, depending on the materials in the aquifer. Aquifer tests indicate that the movement ranges from 20 ft/yr in the Tesuque Formation to 345 ft/yr in the more permeable Puye Conglomerate (Purtymun 1984, 0196).

In an effort to better understand the nature of recharge to the main aquifer in the Los Alamos area, a series of isotope and age-dating measurements on selected water samples has been initiated by Laboratory and other DOE researchers. The study is attempting to apply a range of geochemical and geochronological techniques to help identify potential sources and ages of water in the main aquifer. Samples have been collected from the test wells and from the water supply wells that penetrate the main aquifer. Investigators are using a variety of radioactive and stable isotope measurements. At present, a number of measurements of carbon-14 and low-level tritium measurements are available that permit some preliminary estimates of the age of the water in the main aquifer at various locations.

"Age of water" means the time elapsed since the water, as precipitation, entered the ground to form recharge and became isolated from the atmosphere. The precipitation at the time of entry into the ground is assumed to have contained atmospheric equilibrium amounts of both tritium and carbon. Radioactive carbon-14 comes mainly from natural sources. Tritium comes from both natural sources and fallout from nuclear weapons testing in the atmosphere.

Preliminary interpretation of the results of 7 carbon-14 analyses indicates that the minimum age of water in the main aquifer ranges from about 1,000 years under the western portion of the Pajarito Plateau, increasing as it moves eastward, to about 30,000 years near the Rio Grande. These values are consistent with the general understanding of the Los Alamos main aquifer, based on physical and geologic conditions, which indicate flow from west to east, with major recharge occurring from the west.

Several measurements of tritium by extremely low-detection-limit analytical methods appear to show the presence of some recent recharge (within the last 40 years) in water samples taken from 5 wells in the main aquifer at locations near Los Alamos. Another 30 wells show no apparent influence of recent recharge on the main aquifer. The levels measured range from less than a percent to less than a hundredth of a percent of current drinking water standards and are less than levels that could be detected by the EPA-specified analytical methods normally used to determine compliance with drinking water regulations.

The first location is Test Well 1, located in Pueblo Canyon near the confluence with Los Alamos Canyon. Consistent analytical results indicate that tritium is present at this location; however, the pathway mechanisms are not yet understood. This well has been suspected for several years of having a well-bore leakage or other communication from the surface, as inferred from other types of data (Abrahams et al. 1961, 0015). One possible route of communication is along the ungrouted cable-tool-installed casing. Another possibility is a downward movement through the rock beneath the canyon.

The second location is in Los Alamos Canyon near its confluence with the Rio Grande. An observation well (LA-1A), an old water supply well (LA-2), and a domestic well show the presence of tritium.

The third location is at Test Well 8 in Mortandad Canyon. Test Well 8 is located about a mile downstream of the outfall of the Laboratory's radioactive liquid waste treatment plant at TA-50. The well was sampled at the end of 1993 as part of the Environmental Surveillance Program. The well was completed in 1960 to a depth of 1,065 ft. The upper part of the well penetrates shallow alluvial perched groundwater that contains the residual contaminants discharged by the TA-50 treatment plant. Tritium levels in the alluvial groundwater in the vicinity of Test Well 8 have been about 100,000 pCi/L in the last few years, ranging to as much as 1,000,000 pCi/L in the mid-1970s.

At least three possible pathways exist by which tritium in Mortandad Canyon could move toward the main aquifer: (1) migration down the wellbore outside the steel casing because cable tool drilling does not include an annular seal, (2) saturated movement through fractures or faults, and (3) movement in unsaturated flow through the vadose zone (the vadose zone is the zone between the land surface and the main aquifer). Tritium is known to be migrating downward in the unsaturated zone beneath the alluvial perched groundwater in Mortandad Canyon, based on measurement of cores collected to a depth of 100-200 ft at locations farther west (Stoker et al. 1991, 0715).

2.4.2.3 Hydrologic Properties and Conditions of the Bandelier Tuff

At the central portion of the Laboratory, there is in excess of 1,000 ft of unsaturated volcanic tuff, sediments, and basalts of the Bandelier Tuff, the Puye Conglomerate, and the basaltic rocks of Chino Mesa. Numerous investigations focusing on hydrologic characterization of the upper 100 ft of the Bandelier Tuff have been conducted in the Los Alamos area since the 1950s (e.g., Abrahams et al. 1961, 0015; Weir and Purtymun 1962, 0228; Abrahams 1963, 0011; Purtymun and Koopman 1965, 0201; Purtymun and Kennedy 1971, 0200; Purtymun et al. 1978, 0207; Abeele et al. 1981, 0009; Kearl et al. 1986, 0135; Purtymun et al. 1989, 0214; Stoker et al. 1991, 0715). The vadose zone below about 100 ft has not been adequately characterized.

Most of the investigations of the hydrogeologic properties of the Bandelier Tuff have been conducted on samples of crushed or disturbed tuff. Hydrologic property tests conducted since the mid-1980s largely have been on undisturbed cores (e.g., Kearl et al. 1986, 0135; Stoker et al. 1991, 0715). To aid the reader in evaluating the variablity in hydraulic properties, a summary of hydraulic properties measured in undisturbed cores from the Bandelier Tuff is presented in Table 2-2.

Table 2-2 includes measured values for bulk density, porosity, and saturated hydraulic conductivity. The values for residual saturation, alpha, and N are the parameters for van Genuchten's formulation of the moisture characteristic curve (van Genuchten 1980, 1193):

$$\tilde{\theta} = \frac{\theta - \theta_r}{\theta_s - \theta_r} = \frac{1}{\left[1 + |\alpha h|^N\right]^M}$$

where

$\tilde{\theta}$	effective saturation,
θ	volumetric moisture content,
θ_s	saturated moisture content,
θ_r	residual moisture content,
h	suction,
α, N	van Genuchten fitting parameters,
M	= 1-1/N.

TABLE 2-2

SUMMARY OF HYDRAULIC PROPERTIES DATA FOR BANDELIER TUFF OBTAINED SINCE 1984

				van Genuchten Parameters		
	Bulk Density (g/cm^3)	**Porosity (%)**	**Ksat (cm/sec)**	**Residual Saturation (%)** [b]	**α**	**N**
Tshirege Member						
Minimum	0.94	34.6	5.6×10^{-6}	0.0	0.0011	1.152
Median	1.18	48.8	1.1×10^{-4}	2.3	0.0056	1.696
Harmonic Mean			5.8×10^{-5}			
Maximum	1.49	74.2	3.9×10^{-3}	7.9	0.2312	2.877
Number of Observations	43	63	85	32	32	32
Tsankawi Pumice						
Minimum	0.90	36.7	4.7×10^{-5}	0.0	0.0005	1.106
Median	1.25	46.0	6.8×10^{-4}	0.23	0.0187	1.481
Harmonic Mean			1.7×10^{-4}			
Maximum	1.60	65.6	4.3×10^{-3}	7.28	0.0513	1.890
Number of Observations	18	12	9	9	9	9
Otowi Member						
Minimum	0.98	40.3	1.1×10^{-5}	0.0	0.0039	1.388
Median	1.18	44.0	2.7×10^{-4}	2.5	0.0060	1.653
Harmonic Mean			1.3×10^{-4}			
Maximum	1.49	59.0	7.8×10^{-3}	12.1	0.0185	2.307
Number of Observations	31	25	25	21	21	21

a. Samples represent a compilation by D. Rogers and B. Gallaher (1995, 1182) of available hydraulic property determinations on undisturbed core samples taken between 1984 and 1992. Field and laboratory data from USGS work in the 1950s and 1960s and air/water injection tests conducted by Bendix Corporation in the mid-1980s (Kearl et al. 1986, 0135) are not included in the compilation because of concerns relating to the comparability of different measurement techniques.

b. Most cores with θ_r >10 are omitted because of the absence of thermocouple psychrometer measurements at high matric suctions.

2.4.2.3.1 Effects of Physical Characteristics

Physical characteristics of the tuff that affect fluid flow result primarily from the degree of welding and jointing. The degree of welding, which varies markedly within and between tuff units, influences the nature and variability of hydrologic characteristics. Welding results in increased density, decreased porosity, and decreased hydraulic conductivity of the rock matrix (Purtymun and Koopman 1965, 0201). However, welded tuffs tend to be more highly fractured (jointed) than nonwelded tuff, and the overall permeability of the welded tuff may be locally enhanced (Crowe et al. 1978, 0041).

2.4.2.3.2 Porosity

Porosity measurements by Abrahams (1963, 0011) range from 20% to 60% by volume, generally decreasing with increasing degree of welding. Measurements reported by IT Corporation (1987, 0327) are higher, from approximately 39% to 74%. A great deal of the high porosity occurs when pumice fragments are incorporated in the tuff. The higher porosities are comparable to those of the upper ranges found in fine clays. Such high porosities, however, are unusual for indurated materials. Extreme changes in porosity over a short vertical distance have been observed (Abrahams 1963, 0011).

2.4.2.3.3 Moisture Content

A number of hydraulic properties of the Bandelier Tuff vary with changing moisture content. The tuff is only partially saturated throughout the Laboratory, even beneath stream channels containing alluvial perched groundwater systems. The moisture contents of the tuff beneath mesa tops are very low, typically less than 5% by volume (Abrahams 1963, 0011). Abrahams shows that tuff moisture content is higher beneath disturbed soils than beneath undisturbed soils and, generally, moisture content decreases with depth. At sites with relatively high near-surface moisture contents, the volumetric moisture content decreases rapidly with depth to less than 5% (Abrahams 1963, 0011). Moisture contents of the tuff beneath the canyon bottoms are considerably higher than those beneath the mesas and typically range from 20% to 50% by volume (Weir and Purtymun 1962, 0228; Stoker et al. 1991, 0715). Field studies in Mortandad, Sandia, and Potrillo canyons show that moisture content varies greatly with depth, depending on texture (Stoker et al. 1991, 0715; Environmental Protection Group 1993, 0829). Generally, moisture content decreases with depth below stream channels.

2.4.2.3.4 Moisture Characteristic Curves

The relationship between moisture content and soil-water potential has been obtained from more than 60 undisturbed mesa top and canyon bottom cores at TA-54 (Rogers and Gallaher, 1995, 1182). The data indicate residual moisture content (0% to 4%). Purtymun and Stoker (1987, 0204) indicate that at TA-49 specific retention (residual moisture content) ranged from 11% to 27%. Detailed analyses in Mortandad Canyon show that there are significant differences in moisture retention characteristics between and within formational units (Stoker et al. 1991, 0715). Abrahams (1963, 0011) determined the energy relationship with moisture content of a moderately welded tuff. The saturated moisture content of the tuff was about 41% by volume. When moisture contents are below about 4%, there is no movement of water; from about 4% to 8%, moisture is redistributed by diffusion; from about 8% to 23%, distribution is governed by gravity and capillarity; and above 23%, movement is controlled by gravity only (Abrahams 1963, 0011).

2.4.2.3.5 Hydraulic Conductivity

Hydraulic conductivity is the parameter that describes rate of flow of fluid through a porous medium in response to a hydraulic gradient; it is a function of both the fluid and the medium. Saturated hydraulic conductivities have been measured for tuff many times under laboratory and field conditions, with values ranging from 1.9×10^{-5} to 2.3×10^{-2} cm/s (0.054 to 6.5 ft/day), comparable to those of silty sand. In general, nonwelded tuff has greater saturated conductivity than welded tuff, and horizontal conductivities are greater than vertical conductivities (Abrahams 1963, 0011). Unsaturated hydraulic conductivities may be many orders of magnitude lower, typically ranging from 10^{-6} to 10^{-11} cm/s (Stoker et al. 1991, 0715; Rogers and Gallaher 1995, 1182), depending on in-situ moisture contents.

2.4.2.3.6 Joints

Joints formed by cooling of the ash flows or by later faulting typically divide the tuff into irregular blocks. The major joint sets are vertical or nearly vertical, with dips greater than 70°, and joint frequency increases with the degree of welding and proximity to faults (Vaniman and Wohletz 1990, 0541). Joints and fractures in moderately welded tuffs generally terminate in nonwelded tuffs (Baltz et al. 1963, 0024). The joints are often vertically limited to a single ash flow or ash fall unit (Purtymun and Kennedy 1971, 0200). Joint apertures range from closed to open as much as 15 cm (Wohletz 1995, 1183). The joints are commonly filled with caliche near the surface, grading downward to clay, and may be open to depths greater than 30 ft (Purtymun et al. 1978, 0207; Abeele et al. 1981, 0009). Examination of cores obtained from horizontal drilling beneath a waste disposal site at TA-54 showed that about 80% of the joints were filled or plated with clay or secondary mineralization (Purtymun et al. 1978, 0207). Fracture apertures at TA-54 are typically small, with median values of about 3 mm; median fracture spacing is 1.9- 4.0 ft (Reneau and Vaniman, in preparation, 1181). Reneau and Vaniman note the general absence of clay illuviation in any fractures to depths greater than 10-20 ft within an excavated pit at TA-54.

2.4.2.4 Movement of Moisture in the Bandelier Tuff

The movement of moisture in the Bandelier Tuff is governed by a complex interaction of many factors. Climatic and site-specific land use factors control the supply of moisture available for infiltration, and hydrogeological characteristics control the redistribution of moisture in the tuff.

Perhaps the most significant aspect of the tuff is its ability to imbibe water, i.e., act as a sponge. Most of the pore spaces in the tuff are of capillary size and have a strong tendency to hold water against gravity by surface tension forces. Thus, a slug of water entering dry tuff is slowed or retained by capillary tension forces.

Water moves through the tuff in two ways: (1) by liquid and vapor movement through the pores of the tuff and (2) by movement through open, interconnected joints (Abrahams 1963, 0011). When moisture content is low, movement in the vapor (gaseous) phase becomes more preponderant, and liquid movement through the rock matrix is extremely slow. Water entering open, interconnected joints might move rapidly downward through the joints; however, to maintain continuous flow through the fractures, it is likely that large volumes and a continuous supply of water are necessary because of the sponge effect of the adjacent tuff that forms the wall of the fracture. The existence of a low-permeability coating on the wall of the fracture, on the other hand, could increase the travel depth of water flowing through fractures (Thoma et al. 1992, 0827). If the joints are not continuous through contacts between subunits of the tuff, the water might be perched above the contact and would tend to move laterally, potentially to the walls of canyons. These factors are discussed as they pertain to subsurface contaminant transport beneath the mesa tops and canyon bottoms.

2.4.2.4.1 Migration of Moisture Beneath Mesa Tops

The natural moisture content of the tuff forming the mesas between the canyons is generally less than 5% by volume at depths greater than a few tens of feet, the zone affected by seasonal inputs of moisture and evapotranspiration. Weir and Purtymun (1962, 0228) attributed the low moisture content to the protective cap of clay soil derived by weathering of the tuff near the surface, low rainfall, and high evapotranspiration. The existence of low moisture content is further supported historically by the absence of weathering below 10 m (Wheeler et al. 1977, 0828) and the overall absence of perched water in the tuff at potential perching horizons.

Kearl et al. (1986, 0135) concluded that vapor phase transport is the predominant transport mechanism controlling the potential subsurface movement of contaminants beneath the mesa top at TA-54. They also conclude that there is no interconnection or movement of liquid water in the interval of Bandelier Tuff examined (upper 100 ft of the Tshirege Member). Other laboratory analyses on cores of moderately welded tuff support the possibility of vapor phase dominance at most mesa top locations (Abrahams 1963, 0011).

From a waste containment perspective, the possibility of vapor phase dominance is significant: in extremely dry rock, only contaminants existing in a gaseous state, such as tritium or volatile organic solvents, migrate through the rock matrix. Other radionuclides and metals can be removed from their original location only under wetter conditions, when the uninterrupted movement of liquid water (i.e., capillarity) is more predominant.

Few definitive field measurement techniques exist by which to quantify natural recharge through mesa tops. One exception is the use of natural tracer profiles to infer recharge rates by comparing them with analytical solute transport solutions. As an alternative, the flux of liquid water through the rock matrix that could eventually become recharge can be estimated as being approximately equal to the unsaturated hydraulic conductivity, assuming that flow is downward and at steady state.

In-situ hydraulic conductivities for tuff beneath the mesa top Material Disposal Area (MDA) L at TA-54 were computed by Rogers and Gallaher (1995, 1182) from laboratory analyses of five undisturbed Bandelier Tuff cores obtained from three separate coreholes. Computed in-situ unsaturated hydraulic conductivities (i.e., fluxes) range from 3.0 x 10-12 to 1.5 x 10^{-1} cm/sec (3.7 x 10^{-5} to 1.9 x 10^{-1} ft/yr). For uniform flow through media with spatially varying hydraulic conductivity, the average hydraulic conductivity lies between the harmonic and arithmetic mean hydraulic conductivity (de Marsily 1986, 1163). The arithmetic and harmonic mean hydraulic conductivities for this set of cores are 4.7 x 10^{-9} and 8.7 x 10^{-12} cm/sec (5.8 x 10^{-2} and 1.1 x 10^{-4} ft/yr). At the moisture conditions and calculated unsaturated hydraulic conductivities at MDA L, the rates of water movement in the upper part of the mesa top are estimated to lie between 1.2 and 0.002 ft/yr, based on the assumption that there are no "fast paths" of water movement, such as fracture flow, to significant depths.

These calculated rates, which are relatively low, imply very little water movement from the mesa tops to the main aquifer under natural conditions, which probably also applies to a one-time spill of contaminants at the land surface. Because of geochemical interaction between the rock and dissolved constituents, the rate of constituent movement (except for movement of constituents that are highly soluble) should be lower than that of water.

The greatest concern about subsurface migration at mesa tops is the potential for a large volume of contaminants to be chronically released in the vicinity of open and interconnected joints, which could occur beneath a surface impoundment or a leaky chemical storage tank. The movement of water through joints would negate the protection provided to the groundwater when water moves only through pores in the tuff (Abrahams 1963, 0011).

Filled fractures strongly inhibit moisture movement. Open fractures are effective barriers to liquid phase unsaturated flow but may provide preferential flow paths for vapor transport or rapid movement of liquid under saturated or near-saturated conditions (Abeele et al. 1981, 0009). Roots have been found in joints to depths of at least 42 ft (Weir and Purtymun 1962, 0228), which suggests that joints may be important local infiltration pathways. Several fracture zones at TA-54 show an increase in moisture content relative to adjacent porous media (Kearl et al. 1986, 0135).

Although fractures have a local effect on infiltration in the upper portions of the mesas, it is less clear to what depth they play a role, for three key reasons. First, water passing through a fracture system has a tendency to be "wicked" into the adjacent rock matrix by capillary suction forces in the tuff, provided the fracture/rock interface is not sealed with material of low permeability (Thoma et al. 1992, 0827). Analytical and numerical modeling at TA-54 indicates that transient infiltration pulses in fractures likely affect only the very near surface before being imbibed by the adjacent tuff (Rosenberg et al. 1993, 1180). Second, most of the open fractures occur in the moderately welded to welded Tshirege Member of the Bandelier Tuff, and the underlying nonwelded Otowi Member is significantly less fractured (Baltz et al. 1963, 0024). Flow in the lower portions of the Bandelier Tuff, therefore, is far more likely to be dominated by the relatively slow process of capillarity.

Finally, although fractures may initially provide a pathway for movement of water into the mesas, they may later play a role in removing water (as water vapor) from within the mesa. Under low barometric pressure conditions, air transfers from the tuff to the atmosphere through boreholes (Purtymun et al. 1974, 0651). Barometric and air pressure variations along the canyon walls could cause the exchange of gas and water vapor between the atmosphere and the mesas, especially via interconnected fractures and joints, which are highly permeable to air. Air transfer has been documented in boreholes penetrating the tuff at TA-49 (Purtymun et al. 1974, 0651) and has been observed elsewhere on the plateau; however, studies at TA-54 have been inconclusive (Abeele et al. 1981, 0009; Kearl et al. 1986, 0135).

In conclusion, the combination of the Bandelier Tuff's low moisture content beneath the mesa tops, its associated hydraulic characteristics, and its thickness provides the main aquifer a substantial degree of protection from the mesa tops. At suspected waste sites at which contaminated liquids have not been disposed, the risks to the main aquifer are quite low. Detailed characterization of the subsurface probably is not warranted for most such sites. Site-specific conditions must always be considered, however, before making such a determination. At waste sites with large potential contaminant source terms, such as material disposal areas, phased subsurface investigations should be conducted to verify that the waste is sufficiently contained.

Waste disposal activities that chronically released large volumes of and highly contaminated liquids or that contained volatile contaminants have the potential for migration within the mesas and should also be investigated for subsurface transport. Open fractures may be a key factor in determining whether contaminants migrate to deeper sections of the tuff or travel laterally to release areas on the mesa walls. All of these subsurface investigations should initially focus on the upper 100 to 200 ft of the vadose zone.

2.4.2.4.2 Migration of Moisture Beneath Canyon Bottoms

The canyons with alluvial perched groundwaters are presumed to present a greater potential for downward movement than do the mesa tops because there is a constant driving force and because the moisture content of the tuff below the saturated alluvium is significantly higher than that beneath the mesas. Additionally, the depth to the main aquifer in the canyons is several hundred feet less than from the adjacent mesa tops. The effect of this greater potential for fluid flow, though, is somewhat compensated by the general lack of highly concentrated contaminant sources in the canyon bottoms.

Recent investigations provide some important information on the movement of moisture and contaminants in the unsaturated tuff. The best field evidence that can be used to estimate potential downward rates of movement beneath canyon bottoms is obtained from corehole data collected by Stoker et al. (1991, 0715) in Mortandad Canyon. Because treated liquid radioactive effluents have been discharged to the canyon for almost 30 years, the radioactive constituents in effluent from the Laboratory serve as accurate tracers for fluid and contaminant migration studies.

The basic conclusions of the Mortandad study regarding the movement of radioactive contaminants below the alluvial perched groundwater are (1) soluble and particulate radioactive constituents have moved less than about 10 ft into the unsaturated zone beneath the alluvial perched groundwater and (2) tritium, as tritiated water, has moved at least 150 ft below the alluvial perched groundwater to a total depth of 195 ft. Tritium concentrations in Corehole MCM-5.9 (the deepest corehole drilled so far in the canyon) decrease by a factor of about 100 between 150 and 195 ft, suggesting the possibility that tritium has not moved much deeper in the almost 30 years since effluents were first released from the TA-50 treatment plant (Stoker et al. 1991, 0715). The tritium data suggest a downward rate of movement of at least 6 ft/yr. However, this conclusion must be considered tentative until additional, deeper coreholes can confirm the pattern.

Recent drilling of Characterization Well LADP-3 in Los Alamos Canyon has shown that Laboratory-derived tritium has migrated to depths of at least 330 ft beneath the canyon bottom (Broxton and Eller 1995, 1162). Because the history of tritium releases to the canyon is uncertain, it is difficult to calculate a downward rate of contaminant movement at this location.

Stoker et al. (1991, 0715) evaluated the moisture content in tuff beneath the alluvial perched groundwater in Mortandad Canyon. Most values for gravimetric moisture content in the Tshirege tuff beneath the alluvial perched groundwater ranged from 10% to 30%, corresponding to about 20% to 60% of saturation. Several peaks occurred at higher values, approaching 90% of saturation near the contact with or in the Tsankawi tuff and fluvial Cerro Toledo rhyolite deposits on the top of the Otowi member of the tuff at depths around 100 ft. In the Otowi tuff, the gravimetric moisture content decreased and leveled off at about 12% to 18%, which corresponds to 20% to 40% saturation. A similar pattern occurred in a corehole farther downstream in Mortandad Canyon, past the end of the alluvial perched groundwater (Stoker et al. 1991, 0715), and also in Sandia and Potrillo canyons (Environmental Protection Group 1993, 0829).

The data suggest that there are complex variations in hydrologic properties in the layers from the base of the Tshirege through to the top of the Otowi tuff that significantly affect the movement of moisture in the unsaturated zone. There is also a suggestion that moisture conditions in the Otowi tuff become very uniform, with only moderate differences in magnitude, depending on whether there are saturated conditions in overlying layers (Environmental Protection Group 1993, 0829). Additional field data and theoretical interpretation are required to confirm the patterns and quantify movement.

2.4.2.5 Groundwater Monitoring

The Laboratory has formulated a comprehensive groundwater protection plan (LANL 1995, 1377) for an enhanced set of characterization and monitoring activities. The Hydrogeologic Workplan (LANL 1996, 1378) details the implementation of the extensive groundwater monitoring network across the Pajarito Plateau within an area potentially affected by Laboratory operations. The locations of the monitoring wells and their proposed drilling and sampling plans address many areas of concern, in particular,

- delineating individual zones of saturation, and defining the hydraulic interconnection between them;
- delineating the recharge areas for the regional aquifer and intermediate perched zones;
- groundwater flow directions of the regional aquifer and intermediate perched zones, and the influence of resource withdrawal by production wells; and
- assessment of aquifer characteristics using the additional data from wells installed within specific intervals of the various aquifers beneath the Laboratory.

Installation of the boreholes and the information gained from them are coordinated with ongoing Environmental Restoration Project and environmental surveillance activities, including use of common resources and data collection/retrieval techniques. Installation of the 32 proposed boreholes is expected to commence in FY98 and continue through FY02; progress of this schedule is highly dependent on future funding.

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3.0 TECHNICAL APPROACH TO ENVIRONMENTAL RESTORATION

3.1 Background

The Environmental Restoration (ER) Project's approach to implementing the corrective action process at Los Alamos National Laboratory (the Laboratory) is to use a modified version of the Department of Energy's (DOE's) streamlined approach. The ER Project has documented this approach in its draft Risk-Based Corrective Action Process document (Dorries 1996, 1297). This approach incorporates elements of data quality objectives (DQOs), risk assessment, and EPA's Superfund Accelerated Cleanup Model to facilitate the rapid cleanup of potential release sites (PRSs) (EPA 1993, 1264). Both the technical approach and decision logic are tied to the Environmental Protection Agency's (EPA's) regulations and guidance. For any given site, the ultimate objective of the approach is to reach a point at which no further action is necessary. The approach stresses

- use of conceptual models and early identification of potential response actions based on existing information to assess sites,
- phased site characterization to close sites as early as possible, and
- integration of the phases of the corrective action process [Resource Conservation and Recovery Act (RCRA) facility investigation (RFI), corrective measures study (CMS), and corrective measures implementation (CMI)] to collect data applicable to all three phases and to apply engineering analysis as early as possible in the process.

Defined below are several terms used frequently in this chapter that carry meanings specific to ER Project decision processes and risk assessment:

Background level Naturally occurring concentrations of a certain constituent in soils. The concentrations represent the results of the statistical analysis chosen to describe distributions of certain constituents observed in the background soils. Background levels may also describe certain anthropogenic compounds (i.e., nuclear fallout or organic chemicals associated with urban activities).

Chemical Any naturally occurring or man-made chemical, including radionuclides.

Chemical of concern A chemical that is identified as a concern as the result of performing a human health or ecological risk assessment.

Chemical of potential concern (COPC) A chemical that is potentially a human health risk based on available information and measured concentrations at the site. The chemical remains a potential concern until exposure pathways and receptors are evaluated in a site-specific human health risk assessment.

Cleanup level A concentration in soils based on regulatory- or risk-based criteria, at which no further action is required at a site.

Constituent Any of the elements or chemicals included in a list of analytes or hazardous substances.

Screening action level (SAL) A chemical concentration in soil or water below which there is no human health concern under RCRA for ingestion and inhalation, provided certain conditions are met as specified in 40 CFR 264.521 (Subpart S; EPA 1990, 0432).

3.1.1 Potential Release Sites

As part of the Hazardous and Solid Waste Amendments (HSWA) requirement for a facility-specific description, the HSWA Module contains a list of potentially contaminated sites (Section 1.2.1.1). To develop the original list, EPA Region 6, DOE, and the Laboratory conducted several investigations to identify potentially contaminated sites. Based on (1) a RCRA facility assessment conducted in 1987 by EPA Region 6 to identify potential solid waste management units (SWMUs) at the Laboratory, (2) subsequent lists from the Comprehensive Environmental Assessment and Response Program's Phase I report (DOE 1987, 0264), and (3) internal records searches and interviews, approximately 1,100 units were identified in a SWMU report (International Technology Corporation 1988, 0329). EPA selected 605 of these units as SWMUs to be listed in the original HSWA Module (Section 1.2.1.1), based on the agency's preliminary assessment of the units' potential impact on human health and the environment.

In 1990, the Laboratory and DOE added areas of concern (AOCs) to the total list of potentially contaminated sites. These units potentially contain hazardous substances, such as radionuclides, that are not regulated under RCRA or HSWA but are being addressed by DOE's ER Project. All field information collected for this effort was obtained by extensive research of maps and archives. The term PRS refers to SWMUs and AOCs collectively. Each PRS bears a unique alphanumeric identifier keyed to the technical area in which it is found.

From time to time, as additional data about PRSs at the Laboratory become available, the Laboratory initiates a formal process for modifying the list of potentially contaminated sites contained in the HSWA Module. In March of 1993, the Laboratory submitted its first request for a permit modification to EPA. That modification, approved in May 1993, and subsequent Class I permit modifications for newly discovered PRSs increased the total number of SWMUs to 1098 as of October 1995. Two Class III permit modifications to remove SWMUs that require no further action were submitted to EPA in 1995 and a third Class III permit modification was submitted to the New Mexico Environment Department (NMED) in September of 1996; none of the three Class III permit modifications has been approved. If approved, the total number of SWMUs will decrease to 909. The list of total PRSs being addressed by the ER Project currently stands at 2,121.

A current database listing of all PRSs is provided in Appendix B. As new information becomes available, the list is updated to reflect the current status of each PRS in the project. A detailed discussion of each PRS is found in the 24 RFI work plans prepared between 1990 and 1996, which are available in the Laboratory's Outreach Center and Reading Room and other information repositories (Section 7.1).

3.1.2 Notification of New Units and Releases

If a new site is identified during the RFI process, environmental surveillance, audits, or other activities, the Laboratory must notify NMED of a proposed new SWMU within 15 days of its discovery. This notification identifies the new SWMU, and the Laboratory must propose the schedule for corrective action for the new SWMU. Guidance is provided in Administrative Procedure (AP) LANL-ER-AP-04.1, "Identification, Documentation, and Reporting of Newly Discovered Potential Release Sites for the Environmental Restoration Program," in accordance with Section F of the HSWA Module.

Discovery of new releases of hazardous materials from existing SWMUs or sites previously identified as needing no further action (NFA) must be reported to NMED within 24 hours of discovery. For the purposes of the ER Project, a release is considered to exist when hazardous wastes are found in concentrations that exceed human-health- or environmental-risk-based screening concentrations. This procedure is described in detail in "Reporting of Newly Identified Releases from Solid Waste Management Units," LANL-ER-AP-04.2, to meet the requirements of Section G of the HSWA Module.

3.1.3 Site Prioritization

Los Alamos and Sandia national laboratories, together with the DOE, EPA, and NMED, have developed a system for prioritizing sites that provides an efficient method for evaluating the relative risk posed by each of the PRSs at the two laboratories. The process also incorporates other prioritization criteria concerning regulatory compliance and the potential for accelerated cleanup to aid decision makers in allocating available resources according to the degree of risk at each PRS. The methodology provides for public involvement in the ranking assessment.

3.2 ER Project Assessment Strategy

The technical approach to planning, collecting, and evaluating data for environmental restoration at Los Alamos is based on EPA's DQO process and risk-based decision making (EPA 1994, 1187; 1989, 0305; Dorries 1996, 1297). This approach recognizes that focusing characterization of a site on the data required to support a series of well-defined decisions will streamline the decision-making process and, at the same time, will diminish the likelihood of making incorrect decisions. Using this approach, the ER Project collects data to support decision making with a known and acceptable level of uncertainty so that the corrective action process can move forward.

The Laboratory's approach uses a decision framework that provides for phased site investigations, early identification of important problems to facilitate site prioritization, and timely implementation of corrective actions. The general decision framework adopted by the ER Project is illustrated in Figure 3-1. Decision points in the general framework depend on a number of statistical and risk-based technical assumptions (Section 3.2.2).

3.2.1 Decisions in the RCRA Corrective Action Process

3.2.1.1 Decision-Oriented Approach

Progress during the RCRA corrective action process is demarcated by several decision points during the RFI and CMS processes. Many of these decisions require collecting and assimilating environmental data. The Laboratory's technical approach to environmental restoration begins with decision criteria that are sufficiently explicit to guide the design of field investigations and the evaluation of the resulting data. Decisions required during the RFI include

- determining whether contaminants have been released to the environment—the site-screening decision,
- determining whether corrective action is required for the site—a risk-based decision that may be made before or after a CMS has been initiated, and
- determining whether a formal CMS is required to select and design an appropriate corrective action.

Also, the ER Project is currently finalizing its approach to ecological risk assessment. The approach is being developed with input from NMED and EPA. Ecological risk assessments will be conducted on a parallel track with human health risk assessments, and therefore, the possibility exists that the decision made based on ecological risk will differ from the decision made based on human health risk. When the ecological risk assessment process is finalized, it will be incorporated into all RFI decisions and into the next revision of the IWP. Applicable decisions that have been made based solely on human health risk will also be revisited for impacts based on ecological risks.

FRAMEWORK FOR ER PROJECT DECISIONS

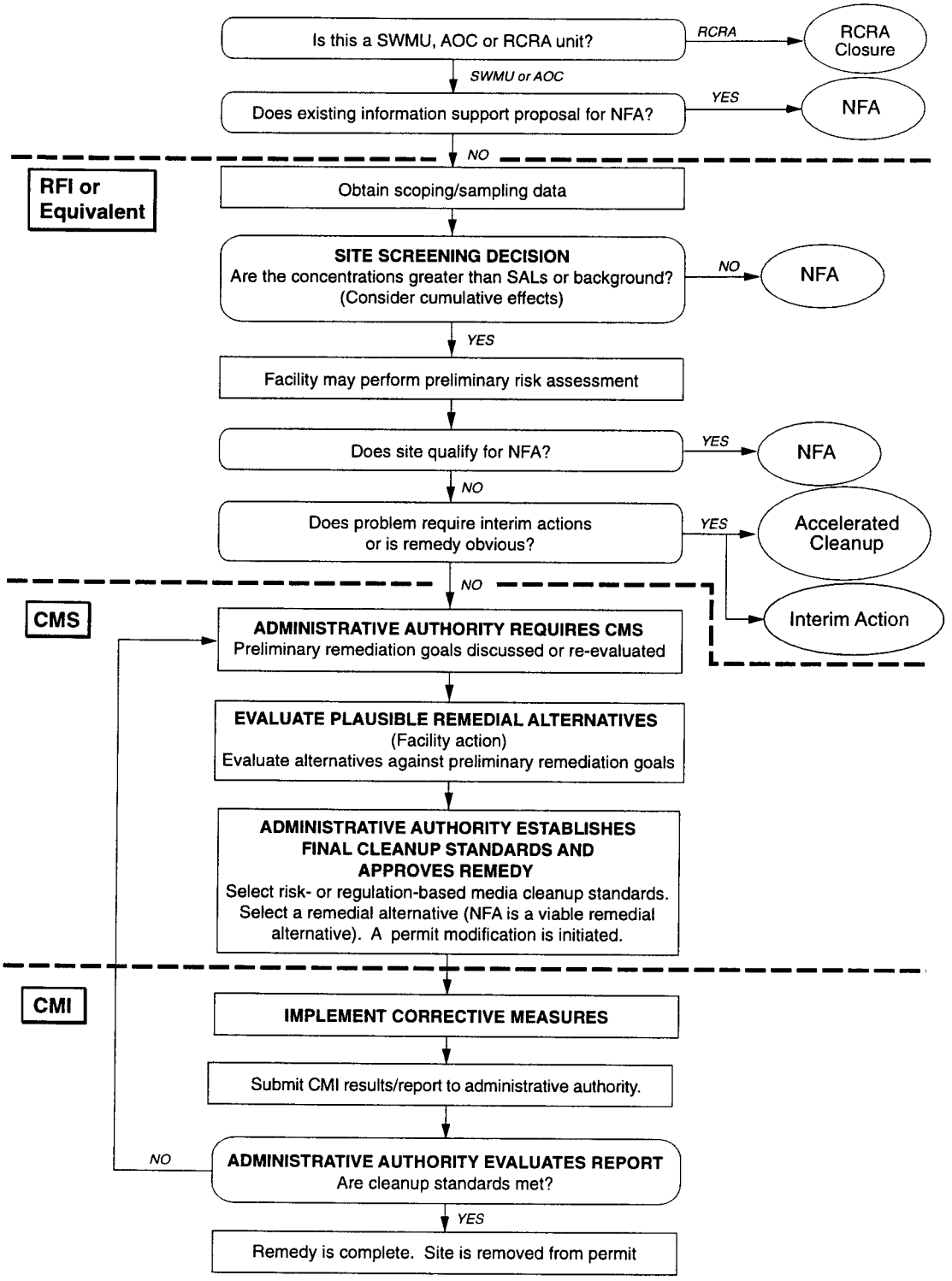

Figure 3-1. Decision framework for the ER Project.

The first step in this decision-oriented approach is to develop a site conceptual model and technical approach based on existing information. Depending on the nature and complexity of the site and the quality of existing information, it may be possible to propose a site for no further action. The remaining sites fall into the following categories:

- sites where accelerated cleanup (Section 3.3.2) under a voluntary corrective action (VCA) is possible,
- sites where CMS and CMI are expected, and
- sites for which existing information is not adequate to support a decision concerning potential outcomes that include NFA, accelerated cleanup, and further investigation.

If a site is identified as a possible candidate for an accelerated cleanup or CMS/CMI based on the initial review of historical information, an initial investigation, designed to collect data to support this decision, is conducted. For many sites, existing data are not adequate to make this decision. The initial investigation then involves collecting data to support a screening assessment or a risk management decision. For those sites that are likely candidates for NFA, the screening investigation is aimed at confirming or denying the existence of a release to the environment at concentrations sufficient to require further investigation. A risk-based investigation is aimed at assessing risk to human health or the environment.

Designs for data collection to support screening decisions have generally used biased sampling to determine whether chemicals are present at levels of potential concern. Samples taken from areas deemed most likely to have been affected by historical activities are analyzed for a broad range of potential contaminants. The most frequent criterion used for the screening decision is the presence of chemicals in environmental media above SALs.

Additional information for the initial analysis is obtained by maximizing the use of field screening instruments. When appropriate, sampling designs make extensive use of field screening techniques (geophysics, remote sensing, field analytical instruments, etc.) to focus sampling and to give adequate coverage while reducing the number of samples needed for laboratory analysis.

Those sites that are not eligible for NFA based on the results of initial investigations or accelerated cleanup (Section 3.3.2) may require a baseline risk assessment to determine whether a significant risk to human health or the environment exists. Risk assessments are focused on those chemicals identified as chemicals of potential concern (COPCs) for the site during initial review of historical information or results from initial investigation. Current and future land use scenarios for each site are evaluated to identify the most likely receptor populations. Realistic exposure scenarios relevant to those populations are derived to complete the risk assessment. For those sites requiring remediation, risk-based remediation goals will be developed based on the exposure scenarios developed.

3.2.1.2 Future Land Use Planning

A key component of the ER Project's future land use strategy is the recognition that DOE and the Laboratory will control most of the Laboratory site for the foreseeable future. Some areas are being considered for transfer to Los Alamos County, and other areas, principally buffer areas, may be reduced in size. However, the Laboratory is an active DOE facility whose Site Development Plan for its 43-mi^2 area covers the next 20 years (LANL 1995, 1376) and the Laboratory's mission requires the continued use of most of these lands.

DOE and the Laboratory have the responsibility for determining future land use within Laboratory boundaries for the period specified in the long-range plan (LANL 1995, 1376). DOE and the Laboratory may seek input from their stakeholders on future land use. The results will be provided to the regulators as reference information. Land uses designated by DOE and the Laboratory include, but are not limited to, industrial, recreational, and residential. These terms are not intended to represent zoning areas as they relate to city planning zones.

Human exposure scenarios developed for risk assessments can be combined under individual land use categories. Exposure scenarios include, but are not limited to, industrial, recreational, and residential. These scenarios describe and determine the risk approach that will be used at a PRS and, therefore, will determine in part the potential remediation goals for the site. NMED has approval authority for the cleanup level, or acceptable risk level, and may require that a different exposure scenario (one other than that proposed by DOE and the Laboratory) be considered when evaluating remedial alternatives. Public input will be sought in determining the exposure scenario.

Institutional controls are inherent in all land use scenarios except for the residential scenario. The regulators must be satisfied that these controls are adequate for a specific site at which they are used. For PRSs remediated to cleanup levels other than background or residential, a deed restriction or equivalent land use restriction will be entered with the appropriate authority and submitted to the Administrative Authority during the HSWA permit modification process (NMED et al., 1995, 1328).

Site-specific land use assumptions and exposure scenarios will be considered in establishing preliminary remediation goals and media cleanup standards, as well as in risk assessments, to estimate the reduction of risk that could be realized by a potential corrective action. Target risk and dose levels will be set following regulator and DOE guidance. Following EPA guidance, preliminary remediation goals and media cleanup standards for nonradioactive carcinogens will be derived using EPA's target incremental risk range of 10^{-4} to 10^{-6}. A target hazard index value of 1 is used for noncarcinogens. Hazardous constituents and radionuclide cleanup levels will be evaluated based on total overall risk from a site. If radionuclides are the only contaminant of concern, the cleanup will be conducted under the jurisdiction of DOE in accordance with DOE orders.

3.2.2 Approach to Data Collection and Evaluation

3.2.2.1 Site-Screening Decisions

Sites with sufficient archival information to document that the site does not present a threat to human health or the environment are proposed for NFA without additional RFI field work. Investigators use their knowledge of the processes used in the past at a particular site to focus sampling and analysis on chemicals associated with those processes rather than perform a full scan on all samples. When information on historical processes indicates that certain contaminants were never handled at a site, analyses for those chemicals are not performed.

Sampling plans for site-screening decisions can incorporate directed sampling based on professional judgment and/or the results of field surveys when this approach is more likely than purely random sampling approaches to increase detection of contaminants. Comparison with background levels and SALs is used to identify chemicals of potential concern and to determine the need for further investigation.

Because background levels may exceed SALs for some soil chemicals, it is necessary to compare chemical concentrations at a given site with background levels. A number of statistical tests are used to compare concentrations measured at a site with background distributions. Statistical comparisons with background are documented in "Application of LANL Background Data to ER Project Decision

Making, Part I: Inorganics," EM/ER:96-PCT-010, March 29, 1996 (Project Consistency Team, 1210). This document provides ER Project personnel with guidance for the selection of appropriate methods for statistical comparisons between potential release site data and naturally occurring concentrations of metals, including radionuclides, in soils. Chemicals whose concentrations are statistically indistinguishable from background should not be identified as COPCs, even if the concentrations exceed the risk-related SALs.

For most applications, risk-related SALs, based on EPA Region 9's preliminary remediation goals for residential soil and tap water, are appropriate for making site-screening decisions.

- Where appropriate, certain EPA Region 9 water preliminary remediation goals are superseded by Native American Pueblo Water Quality Standards, NMED Drinking Water Standards, NMED Surface Water Standards, or USEPA Safe Drinking Water Maximum Contaminant Levels (MCLs), respectively.

- As required, LANL ER Decision Support Council personnel will calculate SALs for chemicals not included in the Region 9 database. SALs are calculated using the standard Risk Assessment Guidance for Superfund (EPA 1989, 0305) default parameters for the residential scenario. In general, the scenario includes only the ingestion pathway. However, for organic volatiles, the inhalation pathway is also included.

- For PCBs, a SAL of 1 ppm will be used for field screening at industrial sites. (EPA 1993, 1244: Section [a][3][ii]). A SAL of 0.1 ppm will be used for residential scenarios.

- SALs were developed for surface soils, but are appropriate (though conservative) for subsurface soils. Suspected contamination below 10 ft will consider potential for transport to groundwater.

SALs for radioactive constituents are based on dose rather than on carcinogenic risk and are calculated using the RESRAD code. Standard residential default values are used in radionuclide models for body weight, intake rate, exposure duration, etc., and doses are summed over multiple pathways [e.g., inhalation and ingestion (produce, soil)]. Environmental parameters required by radionuclide models are set conservatively but appropriately for the Laboratory.

The target dose level used for radionuclide SAL calculations is 10 mrem/yr, based on the DOE's annual effective dose rate of 100 mrem/yr from all sources. DOE also recommends that doses to the public exceeding 10 mrem/yr at DOE facilities be reported to DOE Headquarters (DOE 1993, 1270). Therefore, further investigation of sites exceeding 10 mrem/yr is consistent with regulatory guidance.

In general, the maximum observed concentrations of a chemical, rather than averages of several observations, are compared with SALs to identify COPCs. SAL comparisons are based on measured concentrations, unadjusted for natural or anthropogenic background (e.g., atmospheric fallout). In some cases, observations made on composite samples or on averages of closely related samples such as field duplicates may be compared with SALs to identify COPCs. When screening shows that chemicals are at levels below SALs, further analyses of these constituents is not necessary.

Whenever possible, analytical methods are selected to ensure that SAL concentrations can be detected.

- SW-846 methods (EPA 1990, 0967), when available, are used for fixed laboratories unless other methods are justified.

- If field analytical techniques are not sufficient to detect constituents at SAL concentrations or if the precision and accuracy of the screening method are not sufficient to support DQOs, fixed analytical laboratory methods approved by the regulators may be used.

- If the detection limit of the fixed analytical laboratory method is above the SAL, and the chemical is expected to be present at the site, then the chemical will be identified as a COPC.

Identification of COPCs at a site indicates only that a problem may exist. SALs must not be used as target cleanup levels unless supported by site-specific risk calculations.

Further action, which may take several forms, will be determined on a case-by-case basis.

- Further Evaluation. More in-depth analysis of available data, e.g. using site-specific exposure assumptions, or collection of additional data following screening. Results of these further evaluations could be either NFA, accelerated cleanup, baseline risk assessment, or CMS.

- Risk assessment. If one or more measurements at a site are found to be above SALs and background, a preliminary and/or baseline risk assessment may be used to determine if corrective action is required. Preliminary risk can be assessed using conservative assumptions and existing data. Additional data may be required for the baseline risk assessment if the current data are not adequate to support a risk assessment decision.

- Accelerated Cleanup. Accelerated cleanups can proceed without further evaluation and/or a baseline risk assessment under the following conditions:

  - the remedy is obvious;

  - the remedy will be the final solution;

  - the COPC list is known;

  - adequate waste treatment, storage or disposal capacity is available (including mixed waste if applicable);

  - the remedy is not worse for the ecosystem, worker safety, or public health than the problem;

  - uncertainties can be handled by contingencies in the accelerated cleanup plan, and stopping criteria are defined; and

  - the estimated cost of remediation is expected to be less than the cost of moving forward with further data collection and/or data analysis and risk assessment.

- Interim Action. Sites may be considered for interim action if all of the following are true:

- sufficient information about contaminants and the environmental setting are known, but the site fails one or more specific accelerated action criteria;

- near-term opportunities exist for significant risk reduction, prevention of further contamination, and/or long-term cost savings;

- appropriate technologies are available to deal with the known contaminants;

- proposed action will not impede or be inconsistent with the expected approach for the final remedy;

- interim action is not worse than the problem for the ecosystem, worker safety, or public health; and

- if waste is generated, adequate waste treatment, storage, or disposal capacity is available (including mixed waste if applicable).

3.2.2.2 Risk-Based Decisions

Further decisions about a site (i.e., beyond screening decisions for which NFA, interim measures, or accelerated cleanup may be proposed) must take into account risks to human health and the environment posed by contamination at the site. Decisions based on comparison of individual observations with a SAL are not risk-based decisions because the exposure assumptions underlying the SAL calculation are not site-specific and because risk depends both on the extent and level of contamination.

Estimation of risks to human health and the environment must be based on reasonable site-specific land use and exposure assumptions. The ER Project considers stakeholder input when proposing cleanup levels and exposure assumptions. Risks associated with the use of alluvial aquifers and surface waters (e.g., canyon bottoms with perennial stream flow, permanent alluvial aquifers, and outfalls to canyons) are considered for sites when these waters may be impacted and potential exposures may occur.

The groundwater exposure pathway is not considered for most mesa-top sites because the depth to the main aquifer is about 800-1,100 ft. Potential contaminant migration to groundwater, however, may be modeled at those mesa-top sites where deep subsurface contamination is detected and where the potential for transport to groundwater exists. The decision to evaluate groundwater contamination will be determined on a case-by-case basis.

Baseline risk assessment may provide a basis for NFA at sites where COPCs have been identified. Superfund's risk assessment guidance documents provide the basic guidance for performing baseline risk assessments. For example,

- If the total carcinogenic risk and noncarcinogenic risk thresholds are not exceeded, the Laboratory may propose the site for NFA. Carcinogenic risk thresholds are established on a case-by-case basis within the range of 10^{-4} to 10^{-6} excess cancers per lifetime.

- If the dose is expected to be less than 15 mrem/yr above background (for unrestricted release of residential sites) or 30 mrem/yr above background (for sites retained under DOE control), DOE/ University of California (UC) may propose the site for NFA. Guidelines in 10 CFR 834 (DOE 1993, 1270) and proposed EPA Radiation Site Cleanup Level Regulations (EPA 1993, 1272) establish rationale for adoption of these target dose levels.

Exposure estimates are based on the distribution of contamination throughout areas or volumes of contaminated media and over periods that are consistent with land use assumptions. The 95% upper confidence level will be used for the mean concentration in such areas or in such volumes that the reasonable maximum exposure might take place. Alternative statistics, if proposed, could provide estimates of reasonable maximum exposure. In general, the areas or volumes should be consistent with the selected exposure scenario; that is, the smallest area or volume to which a receptor might be exposed over the entire exposure period determined by that scenario should be used.

3.3 RCRA Corrective Action Process

The corrective action process for the ER Project has three main phases: the RFI, CMS, and CMI. The ER Project also considers accelerated cleanup, when appropriate. The requirements for each of these phases are described briefly below.

3.3.1 Requirements for the RFI

The RFI entails preparing a work plan, which must be completed and approved by the regulators before sampling begins (unless DOE/UC decide to proceed at risk), to determine whether a release to the environment has occurred. The specific requirements are described in detail in Table 1-1 of the HSWA Module, and EPA has provided specific guidance in Volume I of the interim final RFI guidance (EPA 1989, 0088).

Each RFI work plan includes a description of the overall approach, technical and analytical approaches and methods, quality assurance (QA) procedures, and data management procedures. In addition, the HSWA Module specifically requires the concurrent development of five companion plans as part of the RFI work plan (the Project Management Plan, the Quality Assurance Project Plan, the Records Management Project Plan, the Health and Safety Project Plan, and the Public Involvement Project Plan); however, it does allow the Laboratory to deviate from the specific guidance as long as the work plan covers the essential elements discussed above.

It is the policy of the ER Project to adhere to Section 2, Volume I, of EPA's RFI guidance document (EPA 1989, 0088) to the extent practicable. DOE/UC RFIs also comply with the substantive requirements of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). During the RFI, the ER Project's strategy is to assess sites, using a logical and efficient sampling program that moves from analyzing existing data, to identifying data gaps in conceptual models, to finally proposing scientifically and technically sound sampling and analysis plans that accurately characterize Laboratory waste sites. The Laboratory's ER Project has written, or will write, sampling and analysis plans for each PRS or PRS aggregate.

RFI Reports will be submitted either prior to developing a CMS plan or after an NFA determination has been made. This NFA recommendation can be a result of an approved investigation, a modified investigation, or a VCA. A modified investigation may be performed without regulatory approval if the fundamental scope of the investigation has not changed. This is considered an insignificant modification. If the conceptual planning and modeling drive the development of new data quality objectives, regulatory approval of the modified investigation must be obtained. This is considered a significant modification to the initial SAP.

In some cases where the nature and extent of contamination are found to be unacceptable during any investigation, a CMS can be proposed in the RFI report. The regulator reviews each RFI report, and the proposal may be negotiated with the regulator, depending on the action(s) proposed and the regulator's willingness to accept the proposal. Ultimately, the project will request a permit modification to remove from the permit those sites proposed and approved for NFA.

The ER Project, in conjunction with the EPA and NMED, has generated a list of NFA criteria. Each PRS must meet at least one of these criteria before the ER Project can propose it for no further action. Although only those SWMUs listed in the HSWA Module are officially removed from the HSWA Module by means of an NFA proposal and ultimately a permit modification, every PRS at the Laboratory will undergo the same level of investigation to be removed from further consideration.

The NFA criteria are briefly discussed below. Additional information regarding the NFA process is contained in Appendix B of the Environmental Restoration Document of Understanding (NMED et al., 1995, 1328). A site is considered to satisfy NFA criteria if

- "the site cannot be located or has been found not to exist, is a duplicate PRS, or is located within and, therefore, investigated as part of another PRS";
- "the site has never been used for the management (i.e., generation, treatment, storage, or disposal) of RCRA solid or hazardous wastes and/or constituents, or other CERCLA hazardous substances";
- "no release to the environment has actually occurred, nor is likely to occur in the future";
- "there was a release, but the site was characterized and/or remediated under a different authority which adequately addresses corrective action, and documentation, such as a closure letter, is available"; or
- "the PRS has been characterized or remediated in accordance with current applicable state or federal regulations, and the available data indicate that contaminants of concern pose an acceptable level of risk under current and projected future land use."

3.3.2 Accelerated Cleanup

The ER Project is currently working with the NMED to develop an approach that will allow the accelerated cleanup of certain sites. The ER Project intends to use the accelerated cleanup approach when conditions are discovered that either warrant early action or for those sites that can be remediated rapidly and cost effectively. The criteria used to evaluate candidate sites for the accelerated cleanup process are

- the potential remedy is obvious and can be readily applied;
- the remedy will be a final solution to prevent potential releases or migration of contaminants from the site in the future;
- previous sampling data and/or archival data are available to adequately identify chemicals of concern; and
- adequate treatment, storage, and disposal capacity is available for all expected waste types, including mixed (hazardous and radioactive) wastes.

Cleanups will fall into two catagories, those that require minimal review and involvement from the regulator prior to initiation and those that, because of their complexity, location, or site type, the NMED would be more involved in, e.g., to review and approve the accelerated cleanup plan and/or to be present to observe the cleanup or to split samples. The NMED and the ER Project will jointly identify those sites that NMED will be involved in, prior to any activity being initiated. Both types of accelerated cleanups will include public involvement.

3.3.3 Requirements for Corrective Measures Studies

The CMS process is implemented in accordance with EPA guidance (EPA 1988, 0295) when further action is specified in an RFI report. When required by NMED, DOE/UC must submit for review and approval a CMS plan that lays out the activities to be conducted during the CMS. The draft CMS plan is due at NMED within 90 days of notification of the requirement to conduct a CMS. NMED then reviews and approves the CMS plan or suggests revisions to DOE/UC.

DOE/UC begin to implement the study within 15 days after receiving written notice that NMED has approved the CMS plan and then conducts the CMS in accordance with the approved CMS plan, which must include discussions of the processes for

- evaluating performance of the remedy(ies),
- assessing effectiveness,
- assessing the time required for implementation,
- estimating costs of implementation, and
- assessing institutional requirements.

A draft CMS report will be prepared after the CMS has been completed. The draft report is based on the results of the study, evaluating corrective measures and recommending a final corrective measure for a particular release site or groups of sites. NMED will approve the remedy proposed by DOE/UC based on how well the remedy satisfies the criteria used to select it during implementation of the CMS process. At a minimum, these criteria should address

- standards for remedies,
- criteria for selecting the remedy,
- schedules for implementing the remedy,
- media cleanup levels, and
- compliance with media cleanup levels.

A wide variety of PRSs exists at the Laboratory. Each study is tailored to the needs of each site. In many cases, site conditions may not require extensive evaluation of several alternatives, and, when the number of possible remedies is limited, the process is as focused and as streamlined as possible to expedite the corrective action process.

3.3.3.1 Corrective Measures Study Plan

The first step in the process of selecting alternatives to remedial action is to prepare a CMS plan. The plan will be specific to a PRS or PRS aggregate. CMS plans must be consistent with the scope of work for a CMS, Section Q, Task VI, of the HSWA Module and with proposed Subpart S (EPA 1990, 0432), as applicable.

The CMS is used to identify and develop a scheme for evaluating alternatives for final remediation of the PRSs. The CMS plan must provide sufficient information for the regulators to adequately review the methods proposed for evaluating potential cleanup alternatives. Each PRS-specific CMS is unique to the environmental setting and nature of contamination at the site.

At a minimum, CMS plans must contain

- a description of the general approach to investigating and evaluating potential alternatives;
- 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 EPA guidance;
- a schedule for conducting the CMS; and
- a proposed format for presenting the results (CMS report).

In addition to the requirements discussed above, DOE/UC integrate RCRA and National Environmental Policy Act compliance through the CMS process. CMS plans can be used to trigger a determination of whether an environmental assessment (EA) is required, and, if so, CMS reports can serve that function. In the event that a full environmental impact statement (EIS) is required, the CMS report serves as a support document for that effort.

After CMS plans have been approved and revised as necessary, DOE/UC will initiate the studies within 15 days. The scope and level of technical detail in each study will be adequate to allow DOE/UC to propose a remedy based on the results of the study and to allow NMED to review and approve that choice. The evaluation of the alternative(s) will be based on technical, environmental, human health, and institutional concerns.

It may be technically impractical to meet the requirements of a remedy. DOE/UC expect to minimize such situations through the use of new and innovative remedial technologies developed by the Laboratory and by others. However, if meeting the requirements of a remedy is impossible for technical reasons, DOE/UC will propose that NMED modify the permit so that additional or alternate methods may be used. This approach will be developed further.

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

- extent and nature of contamination,
- DOE/UC's ability to implement the 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 recognize the need for innovative and cost-effective remedial technologies. New technologies developed at the Laboratory could offer distinct advantages over currently available technologies (e.g., downhole monitors and stabilization techniques) not fully developed at the time the remedy is selected. In such cases, DOE/UC may propose that NMED postpone selecting a remedy until these technologies are functional if there is a distinct technical, time, or cost advantage.

3.3.3.2 Corrective Measures Study

In order for DOE/UC to propose and for NMED to select a remedy for a PRS, the NMED will evaluate the proposed alternative to determine whether the alternative meets EPA guidance (EPA 1988, 0295). Because conditions vary from PRS to PRS, decision factors for each proposed remedy may be weighed differently at different PRSs.

3.3.3.2.1 Standards for Remedies

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

- protection of human health and the environment,
- attainment of established cleanup levels,
- control of the source of release, and
- compliance with waste management requirements.

These standards are broad and include the major technical requirements for controlling sources, conducting waste management activities, and cleaning up the environment. The Laboratory will comply with media cleanup levels to the extent practicable. In all cases, the overriding concern in selecting remedies is protecting human health and the environment.

3.3.3.2.2 Media Cleanup Levels

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

Risk-based determinations must be consistent with EPA's risk assessment guidance (EPA 1991, 0302; EPA 1990, 0559), which states that "cleanup standards for carcinogens shall be established at levels which represent an excess upper-bound lifetime individual risk between 1×10^{-4} and 1×10^{-6}." Cleanup levels 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, that higher concentrations will be permitted because background levels are elevated, or that groundwater that is neither a potential source of drinking water nor hydraulically connected to a drinking water source need not meet drinking water standards. Other circumstances include determinations that the measures taken to meet specific cleanup levels would themselves cause more harm to the ecosystem than taking no action. In addition, the technical feasibility of remediation at each site will be taken into account.

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

Some sites at the Laboratory may require cleanup to action levels (e.g., soil excavation or some other method that physically removes the contaminant from the environment). However, there are sites at the Laboratory from which it would be impractical to physically remove all contaminants. Thus, the definition of cleanup must include other remedies that involve controlling migration of contaminants from a source.

Cleanup is considered to be any measure taken to ensure protection of human health and the environment, not necessarily the total removal of a contaminant. It may not be necessary to clean up areas of widespread, very-low-level contamination. The low levels of risk to human health and the environment resulting from low-level contamination would not be significantly reduced by cleanup because contaminant concentrations may be so close to background levels. Thus, cleanup is approached on a case-by-case basis, and it is the responsibility of DOE/UC to demonstrate to NMED that remediation would provide no significant reduction in risk.

3.3.3.2.3 Demonstration of Compliance with Media Cleanup Levels

DOE/UC will propose that NMED approve several conditions for demonstrating that implementing a remedy complies with the cleanup levels. These conditions include identifying

- the location where compliance levels must be achieved,
- the sampling and analysis plan that will be used to determine compliance,
- the statistic that will be used to compare to cleanup levels, and
- the length of time that DOE/UC must monitor a site to demonstrate that levels of contamination after cleanup do not exceed standards.

The primary limiting cleanup levels for the Laboratory will be those for soils and sediments. In general, the point of human exposure will be the likely location for demonstrating compliance. However, it may be that the point of compliance for some sites will have to be determined on a case-by-case basis. The project may provide, subject to NMED approval, 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. Those methods specific to particular PRSs will be proposed in the CMS reports for the individual units.

3.3.3.2.4 Conditional Remedies

When NMED cannot select a final remedy or when DOE/UC and NMED agree that it is in the interest of the environment to delay implementation of the final remedy (e.g., to await completion of a promising development or additional disposal capacity), conditional remedies may be proposed and approved. Such remedies include prompt corrective measures that reduce risk and/or partial cleanup when 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 can be certified as complete before the specified schedule of compliance is terminated. Several criteria must be met before implementation. These criteria include

- protecting human health and the environment,

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

DOE/UC may propose site stabilization and institutional controls as a conditional remedy for some of the large material disposal areas (MDAs), which are similar to municipal landfills. Remediating these landfills could be a complex and risky undertaking. Furthermore, the concentrations of contaminants in the MDAs that qualify for conditional remedies do not currently threaten human health, and institutional controls, which provide long-term control of access and prevent potential exposure of Laboratory workers, could be viable options at these sites. For these reasons, DOE/UC believe that a conditional remedy for these sites may optimally protect human health. Long-term monitoring will be conducted as necessary.

When the results of the RFI support a single obvious remedy, which could include extensive pilot testing, a formal CMS need not be conducted; however, the proposed remedy must be presented to NMED either as part of an RFI report or in a separate plan. Based on the results of the RFI, DOE/UC request that the permit be modified to allow a conditional remedy. Upon NMED approval, DOE/UC will prepare a CMI plan that contains information adequate to design and implement the remedy, maintenance plans, schedule, QA program, progress reports, and a proposal for determining a complete and final remedy.

DOE/UC intend to propose in-place stabilization with long-term monitoring and institutional control as a remedial alternative for some PRSs. To ensure compliance, sensitive and dependable instruments will be required for long-term monitoring, and 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 also realize that conditional remedies may not be final remedies. The remedy decision will 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 NMED may require further corrective action to supplement or replace the conditional remedy. Final selection of the remedy and termination of the permit must comply with the procedures described below.

3.3.3.3 Corrective Measures Study Report

Within 60 days of completing a CMS, a CMS report will be prepared and provided to NMED. At a minimum, this report must present the evaluation of alternatives consistent with the scope of work required for CMS reports as described in the HSWA Module.

The primary purpose of the CMS report is to enable DOE/UC to justify and recommend a corrective measure alternative for NMED approval. The report must include a detailed description of the remedies assessed and must describe how the proposed remedy meets the standards for remedies specified in the CMS plan. The primary criteria for developing and selecting remedy standards are

- long-term reliability and effectiveness;
- reduction of toxicity, mobility, or volume of contaminants;

- short-term effectiveness;
- implementability; and
- cost.

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

3.3.3.4 Permit Modification for Selection of Remedies

The preliminary selection of remedies based on NMED's response to CMS reports is finalized by a major modification of the schedule of compliance given in the HWSA Module. The NMED can modify the permit to specify remedies selected through the CMS process. The permit modification must be conducted according to the procedure established in Section N of the HSWA Module. The modification process includes a formal public comment and revision period before written notice of the permit modification is issued.

The remedy specified may be separated into phases, but the proposed modification must include

- a description of the technical features of the remedy;
- the media cleanup levels established through the CMS process;
- requirements for achieving compliance with media cleanup levels;
- 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.

3.3.4 Requirements for Corrective Measures Implementation

DOE/UC will prepare CMI plans after approval of the permit modification and upon NMED request. The standard outline for DOE/UC CMI plans has not yet been developed but will be submitted for approval in the future. In general, CMI plans will include

- remedy designs (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 NMED reviews of implementation;

- requirements for completion of the remedy;
- determination of technical practicability; and
- verification plans.

3.3.4.1 Remedy Designs

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

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

NMED will approve or revise CMI plans, and DOE/UC will implement the remedies as approved. The approved plans will be placed in the Laboratory's Outreach Center and Reading Room. DOE/UC will provide written notice of the availability of the approved plan to all individuals on the ER Project mailing list. In addition, the cost estimate provided in the CMS report will be revised as necessary.

3.3.4.2 Corrective Measures Progress Reports

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 remedies. Data for these reports will be maintained in the Records-Processing Facility and will be available for public review.

The schedule and content of the progress reports will be developed in CMI plans and will thus be tailored to each PRS. 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.

3.3.4.3 Review of Remedy Implementation

NMED will periodically review the progress of remedies 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 NMED oversight, CMI plans will be tailored to each site according to the level of review and progress evaluation required.

3.3.4.4 Completion of Remedies

CMI plans will contain criteria to be used to demonstrate completion of remedies. Upon completion of a 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 NMED will include verification that

- all media cleanup levels 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.

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

3.3.5 Special Situations in the Corrective Action Process

3.3.5.1 Interim Remedial Measures

Section I of the HSWA Module provides for interim remedial measures. If NMED determines that a release or potential release of hazardous waste or its constituents poses a threat to human health or the environment, it can mandate that DOE/UC implement interim remedial measures to mitigate the risk. NMED can also specify a schedule (by modifying the HSWA Module) for implementing the interim measure and can require the Laboratory to prepare and submit a plan to be approved before action is initiated. No interim remedial measures have been taken to date because no imminent threats to human health or the environment have been identified. However, in the event that NMED requires an interim measure in the future, DOE/UC will modify any plan already in place accordingly. DOE/UC may at that time request NMED to modify the schedule of compliance for the corrective action.

In determining the need for interim remedial measures based on health risks, at least the following factors should be considered:

- 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 wastes or constituents in soil that have the potential to migrate to groundwater or surface water,
- weather conditions, and
- risks of fire, explosion, or accident.

Other kinds of interim remedial measures 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." DOE/UC will conduct interim measures based on institutional needs consistent with the provisions of proposed Subpart S.

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

Several SWMUs 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 a manner consistent with the management of all of the other PRSs listed in the ER Project's PRS data base. As a result, the corrective action process occurs concurrently with the closure process, thereby satisfying both sets of regulations. It is understood that the NMED will maintain its role as the lead regulatory agency for these sites.

DOE/UC use 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 PRSs are subject only to RCRA corrective action and some are subject to both corrective action and closure). (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.

3.4 Waste Minimization and Management

The ER Project and the Waste Management Group are continuously defining the overall waste management strategy and procedures for the ER Project. Key issues in the overall waste management strategy involve planning, understanding requirements, and identifying contingency actions. Key components of the waste management strategy include

- an understanding of roles and responsibilities by the ER Project and Waste Management Group;
- accurate and consistent waste volume estimates;
- clear waste characterization requirements;
- a full complement of waste storage, waste analysis, and waste treatment capabilities for all expected waste types; and
- effective actions to significantly reduce the waste volumes generated by ER activities (assessment, remediation, and decommissioning).

The approach to managing ER wastes in a cost-effective manner requires a strategy that combines onsite and offsite options for treatment, storage, disposal, and accelerated and simplified waste characterization procedures.

3.4.1 Guidelines and Procedures for Waste Characterization and Classification

The ER Project's standard operating procedure (SOP), LANL-ER-SOP-01.06, provides guidance for the disposition of different types of wastes generated by field investigations to ensure that all wastes are properly handled in full compliance with regulations.

The ER Project's SOP, LANL-ER-SOP-01.10, provides guidance that defines the data and sampling requirements needed from a site investigation to characterize waste, obtain approval for, and properly dispose of waste generated by the ER Project. Waste characterization strategy forms are reviewed by the Environment, Safety, and Health (ESH) Division and reviewed and approved by the Chemical Science and Technology (CST) Division before any wastes are generated.

The Project recognizes the need to minimize the overall volume of ER wastes and to accurately differentiate between low-level radioactive waste (which is more costly to dispose) and nonhazardous solid waste. Toward those ends, the project has developed an approach to systematically defining the radiation level at which a soil material is deemed to exceed background.

3.4.2 Use of Available Onsite Disposal Capacity

When cost/benefit studies show that the costs of onsite disposal are equivalent to or lower than those for offsite disposal, the project is using the available onsite capacity to the extent possible to minimize the potential liabilities related to offsite disposal. However, even when studies indicate that new onsite disposal facilities are more cost-effective in the long term than offsite disposal, the near-term policy is to use offsite disposal facilities. To ensure availability of needed waste management capacity and capability, the ER Project will annually provide plans and projections of anticipated volumes by waste types to the Waste Management Group. In addition, as field activities are conducted, information on the waste volumes generated will be captured and used to more accurately project waste volumes at similar sites.

3.4.3 Technical Approach to Waste Disposal

The investigation and remediation of PRSs will generate four types of waste: hazardous, low-level mixed, low-level radioactive, and solid wastes. The ER Project's waste management strategy for handling these is described below.

3.4.3.1 Hazardous Wastes

The Laboratory has arranged for offsite disposal of hazardous wastes (listed or characteristic) at permitted commercial facilities in the past and plans to continue to do the same for near-term generation of hazardous wastes from the ER Project. Site-specific cost/benefit studies of onsite vs. offsite disposal may be necessary to determine the best approach. The quantity of hazardous waste that will be generated by the ER Project is currently estimated to be 8,500 yd^3.

3.4.3.2 Low-Level Mixed Wastes

The ER Project is also evaluating the merits of disposing of low-level mixed waste onsite or offsite in the long term. These cost/benefit analyses include careful consideration of the use of corrective action management units and temporary units. The quantity of low-level mixed wastes that will be generated by the ER Project is currently estimated to be 4,200 yd^3; however, this quantity is expected to change as new data and new assumptions are applied to this estimate.

3.4.3.3 Low-level Radioactive Wastes

An estimated 20,000 yd^3 of excavated soils will be radioactive (above background level). Additional disposal facilities may be required beyond those now planned for low-level radioactive wastes resulting from Laboratory operations. The project is working with the Waste Management Group at the Laboratory to develop new, onsite, low-level-waste-disposal capacity specifically for ER Project wastes. However, a decision on this project cannot be made until completion of the Laboratory's sitewide environmental impact statement.

3.4.3.4 Solid Waste Soils

Some excavated soil will be nonradioactive and nonhazardous. It is likely to be a portion of the volumes already estimated as mixed or low-level radioactive waste, not an additional volume of waste. These soils must be excavated because they have organics or metals above levels determined to be acceptable or consistent with the future use of a particular area. Although the soils may contain some contaminants, they need not be disposed either in a mixed-waste disposal facility or in a landfill for low-level radioactive waste, if alternatives are available. In the past, such materials were disposed in the Los Alamos County landfill or in onsite Laboratory disposal areas. Because the volumes of these wastes may be large, alternate disposal practices will be developed. In the short term, the ER Project will arrange for offsite disposal in landfills that are permitted to accept nonhazardous industrial residual wastes, such as the Conservation Services, Inc., facility in Colorado and other such facilities in New Mexico. In the longer term, the project will pursue a least-cost strategy for disposal by determining the cost of permitted solid waste landfill capacity; by developing a concept design and concept-level cost estimate for an onsite, variable-volume, solid waste landfill; and by comparing the costs of on- and offsite disposal on a net-present-value basis. If offsite disposal is less costly it will be used. If onsite disposal is more prudent, offsite disposal will be used on an interim (3- to 4-year) basis until an onsite landfill can be permitted and built.

3.4.3.5 Approach to Waste Minimization, Recycling, and Reuse

In conjunction with the Laboratory's waste minimization and pollution prevention program, the ER Project is developing a systematic approach to address how waste minimization and pollution prevention can be most effectively applied during the RFI/CMS process and in decommissioning projects. Initially, these issues will be addressed in waste management plans developed for site investigations in which the potential for waste segregation and/or recycling and reuse is emphasized.

As the ER Project matures, it will expand the waste minimization and pollution prevention component of the waste management plan and develop a systematic process for incorporating these components in site characterization, remediation, and decommissioning to produce checklist/decision trees for use before beginning field work. Additionally, the ER Project will document successes.

Examples of waste minimization include recycling contaminated metal, using portable compactors to minimize volumes, and decontaminating contaminated reinforced concrete. The concrete is crushed and recycled as backfill or used for other useful purposes. The rebar is recycled as scrap metal.

3.5 Public Involvement

Both the DOE and EPA have issued guidance documents that apply to public participation in the ER Project. This guidance is derived from the requirements of RCRA as amended by HSWA, CERCLA, and EPA's guidance on corrective action (DOE 1991, 0798; EPA 1987, 0816; EPA 1988, 0294). This plan meets those criteria and includes the general requirements of the HSWA Module. The full public involvement plan for the ER Project is described in Chapter 7.

References for Chapter 3

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Quality Assurance Project Plan Requirements for Sampling and Analysis

Environmental Restoration Project

December 1996

A Department of Energy Environmental Cleanup Program

Los Alamos
NATIONAL LABORATORY

1.0 DOCUMENT PURPOSE AND CONTEXT

This Environmental Restoration (ER) Quality Assurance Project Plan (QAPP) requirements document supersedes the Generic Quality Assurance Project Plan prepared by the Los Alamos National Laboratory (LANL) ER Project in 1991 (LANL 1991, 2360). This document is tiered to the US Environmental Protection Agency's (EPA's) Region 6 "Interim Draft Requirements for Quality Assurance Project Plans" (EPA QA/R-5, 1994, 52288).

This document is part of the ER Project Quality Assurance (QA) Program hierarchy of documents (Figure P-1). This document details quality requirements that must be addressed in ER Project sampling and analysis plans (SAPs), accelerated cleanup plans, decontamination and decommissioning (D & D) plans, etc. Use of this document in conjunction with the ER "Sampling and Analysis Plan Outline and Crosswalk" (Lewis et al., 1996, 52242) will facilitate the development of SAPs. It is intended that compliance with this document will allow for site-specific flexibility in planning and implementing environmental activities and will cause quality and consistency to be designed into ER Project environmental data collection activities. Note also that all elements of this document may not be relevant as progress is made toward a final solution (e.g., removal, decommissioning). When an element is considered not needed, it is best addressed as "not applicable" (NA).

The requirements presented in this document apply to all ER SAPs whether they are stand alone documents or part of other documents. Those other documents may include Resource Conservation and Recovery Act (RCRA) facility investigation (RFI) plans and reports, accelerated cleanup plans, voluntary corrective action (VCA) plans, closure plans, etc.

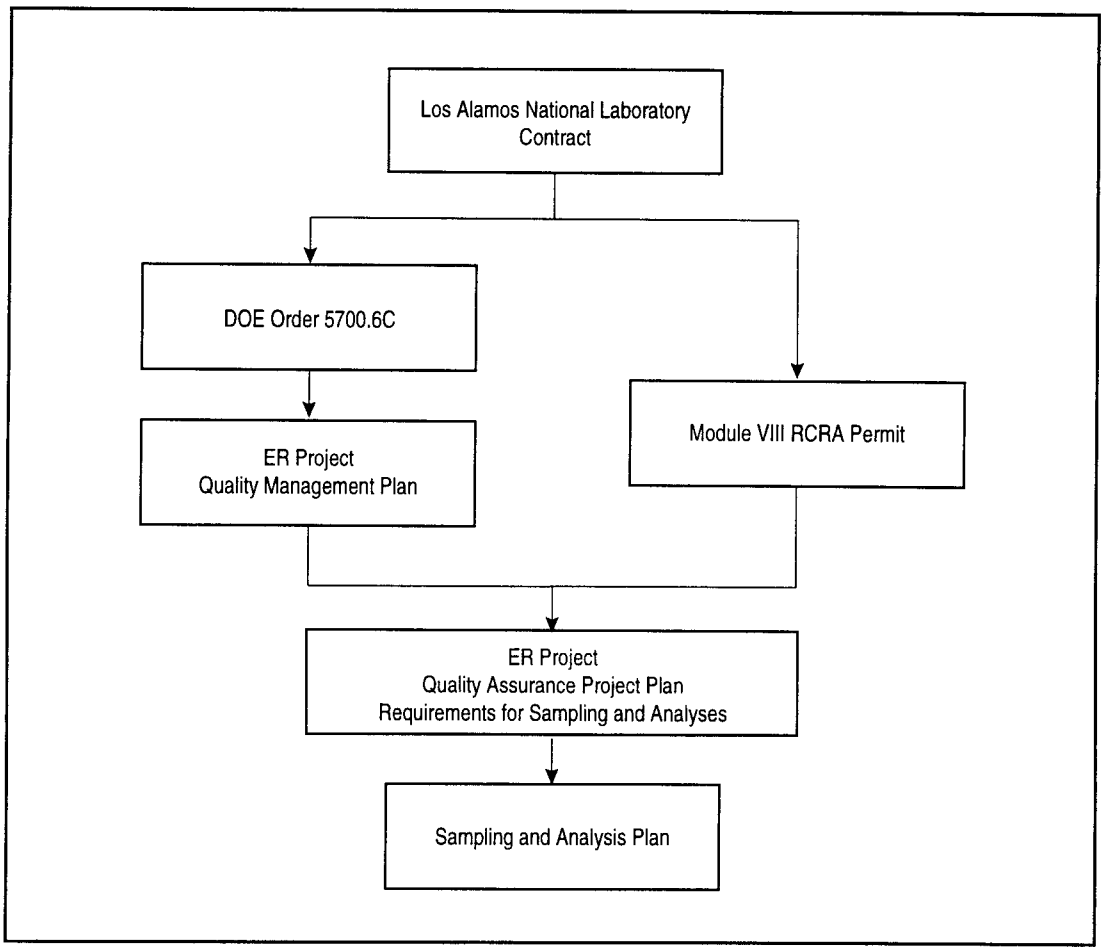

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Figure P-1. Document hierarchy.

2.0 DOCUMENT STRUCTURE

In accordance with the EPA Region 6 QAPP guidance (EPA 1994, 52288), this document is divided into four major sections: Section A-Project Management, Section B-Measurement/Data Acquisition, Section C-Assessment/Oversight, and Section D-Validation and Usability. Its contents have been bulletized to aid in identifying site-specific requirements.

Section A introduces requirements for defining the environmental problem to be solved, developing the general approach to solving the problem and documenting the related activities. Section B expands on Section A by defining more detailed requirements concerning problem definition, problem solution and documentation. Section C presents requirements for evaluating the planning, problem resolution, and documentation processes. Section D presents requirements for data review and evaluation. Appendix I through Appendix V provide supporting information to facilitate compliance with Section A through Section D.

A1 APPROVALS

1. NAME: J. Jansen

TITLE: Environmental Restoration Project Manager

SIGNATURE: _____ DATE _____

2. NAME: L. Souza

TITLE: Environmental Restoration Quality Assurance Officer

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3. NAME: B. Garcia

TITLE: New Mexico Environment Department, Hazardous and Radioactive Materials Bureau, Bureau Chief

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A1.1 Concurrence

1. NAME: G. Allen

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2. NAME: T. Glatzmaier

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3. NAME: G. Gould

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4. NAME: R. Michelotti

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5. NAME: D. McInroy

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6. NAME: A. Pratt

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7. NAME: D. Krier

TITLE: Field Unit Five Project Leader

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8. NAME: M. Salazar

TITLE: Field Unit Six Project Leader

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9. NAME: S. Bolivar

TITLE: Field Support Facility Project Leader

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A3 DISTRIBUTION LIST

No.	Name	Title
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4.	G. Allen	Field Unit One Project Leader
5.	T. Glatzmaier	Project Consistency Manager
6.	G. Gould	Field Unit Two Project Leader
7.	R. Michelotti	Field Unit Three Project Leader
8.	D. McInroy	Regulatory Compliance Manager
9.	A. Pratt	Field Unit Four Project Leader
10.	D. Krier	Field Unit Five Project Leader
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12.	S. Bolivar	Field Support Facility Project Leader
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14.	S. Dinwiddie	New Mexico Environment Department, Hazardous and Radioactive Material Bureau, Program Manager
15.	D. Neleigh	Environmental Protection Agency, Region 6

A4 PROJECT/TASK ORGANIZATION

SAPs must specify or reference the functional roles and responsibilities for the task or tasks for which they are developed. Names and telephone numbers for the identified roles and responsibilities should be provided during the readiness review.

In addition to the functional roles and responsibilities, a concise SAP organizational chart showing relationships and lines of communication among project participants must be provided. It is important to include the principal data users and decision-makers as part of the SAP. If the SAP is written to address multiple tasks or potential release sites (PRSs), including having multiple field organizations with common support groups, then the functional roles and responsibilities and organizational chart must reflect this situation.

Appendix I of this document provides the functional roles and responsibilities and an organizational chart for the ER Project to the field project leader (FPL) level. If necessary, Appendix I can be referenced as part of the SAP organization.

A5 PROBLEM DEFINITION

The ER Project undertakes many environmental data collection activities, including

- investigations described by the RFI Work Plans prepared by the ER Project, as well as any supplementary RFI sampling and analysis for which the need is identified after the initial work plan has been carried out;
- field observations to support intermediate field decisions, such as biasing selection of samples for laboratory analysis by field radiation measurements;
- data collection prior to and during corrective actions, such as accelerated cleanups and corrective measures implementation (CMIs), to delineate the extent of areas requiring remediation;
- verification sampling to demonstrate that corrective actions are complete, including decommissioning; and
- monitoring required as part of interim actions or final remedies.

As the first step toward ensuring environmental data quality, clear problem descriptions must be established for all environmental data collection activities. A systematic planning process must be used to develop specific, problem-related questions to be answered, and the associated environmental decisions to be made must be expressed.

For regulatory decisions, the ultimate decision-makers for the ER Project include the New Mexico Environment Department (NMED) and EPA. However, it is the responsibility of the ER Project to provide plans, reports, and other documentation needed to support the decision-making process. In those plans and reports, the ER Project will propose and defend the decisions that it believes are appropriate.

Key planning participants responsible for defining the problems and developing the problem-solving approach should be identified early in the planning process. This core planning team typically includes

- FPLs or their designees;
- field team leaders (FTLs) and selected field personnel;
- Earth Sciences Council (ESC) personnel (geologists, hydrologists, geochemists); and
- Decision Support Council (DSC) personnel (chemists, ecological and human health risk assessment specialists, statisticians).

The core team will contact others, as necessary, to provide historical, technical, and regulatory information.

The results of the planning process shall be documented in a SAP. SAPs may be prepared as stand-alone documents or as addenda to existing work plans, or they may be incorporated into corrective action plans. Problem definitions will be documented in the SAP by providing

- a clear statement of the question or questions to be answered by the data to be collected; and
- a clear statement of the decision or decisions for which these answers are required, including anticipated alternative courses of action.

The scope of activities and documentation that address the requirements of this document will be commensurate with the importance of the decisions to be based on the data supporting those decisions. The SAP or the document to which it is attached must provide enough information so that a technically trained reader can understand the activity's historical and regulatory context as well as its objectives. In all cases, the SAP must present either explicitly or by reference the following:

- a physical/historical description of the site and the problem including, as appropriate, a summary of existing information such as
  - engineering drawings and site process histories;
  - a site conceptual model describing known and potential releases and existing or potential exposure scenarios;
  - a list of potential or known contaminants; and
  - a list or summary of existing data (and the implications of those data).
- identification of practical constraints, such as physical limitations on sample collection, scheduling constraints imposed by the need to coordinate with corrective actions, limitations of available measurement technology, and budgetary constraints; and
- applicable technical, regulatory or program-specific drivers that will impact the problem-solving approach, including the approach (or reference thereto) used to calculate risk-based contaminant thresholds.

Additional guidance for generating appropriate problem descriptions and decision statements for each phase of a study is provided in the EPA data quality objective (DQO) guidance (EPA 1994, 50288). More detailed requirements concerning SAP development are presented in Section B1 of this document.

A6 PROJECT/TASK DESCRIPTION

The SAP must summarize the approach that is selected to address problem-related questions and decisions that are identified. This project/task description will describe:

- measurements expected during the project, which will provide the data inputs necessary to answer the question(s);
- a general schedule for project completion, typically the ER Project Baseline Schedule, which must also identify other activities with which these measurements need to be coordinated;
- special personnel and equipment requirements, such as field screening methods that require trained operators;
- specific reporting requirements, including field observations, results of field audits, data validation reports, and electronic deliverables;
- quality assurance (QA) activities, including technical reviews, surveillances, and audits to be implemented during the course of the work.

A7 QUALITY OBJECTIVES AND CRITERIA FOR MEASUREMENT DATA

Potential data quality concerns will be identified by the planning team for each type of measurement to be made, based on the proposed use of the data and the foreseeable consequences of errors resulting from incorrect interpretation of the measurements. Potential data quality concerns include, but are not limited to

- collecting a number of samples adequate to support the decision (the number of samples could be inadequate, for example, if measurement or sampling variability exceeds expectations);
- choosing measurement techniques and methods that are selective, sensitive, and precise enough to allow target analyte concentrations to be distinguished from prespecified threshold levels;
- limiting contamination of samples to insignificant levels; and
- maintaining the desired degree of data comparability to allow for statistically valid evaluation or pooling of the data.

The planning process will result in a list of criteria that are expected to increase the likelihood that data of the right type, quantity, and quality are collected to support the decision(s). In addition to the SAP requirements identified in Section A5 (Problem Definition) of this document, the list should include the following types of descriptors:

- identification of a focused list of environmental variables that must be measured or collected (e.g., analytes, concentrations/radioactivities, physicochemical parameters, risk exposure model parameters);
- specification of the data reporting units;
- specification of decision or action levels, e.g., screening action levels (SALs) or basis for deriving them (e.g., risk-based criteria);

- geographical boundaries of each PRS or PRS aggregate;
- subpopulations (e.g., geologic strata or risk-based exposure units);
- temporal considerations that affect the time during which data can be collected; and
- sample matrices of interest.

The SAP must document in detail the ways in which the collected data will be summarized and used to make the decisions. Possible uses of measurements include, but are not limited to

- comparison of individual observations with prespecified thresholds, such as background upper tolerance level (UTLs), SALs, or PRGs; and
- calculation of 95% upper confidence bounds for the mean of a measured parameter within a prespecified area or volume, for comparison with thresholds such as PRGs.

The consequences of making an incorrect decision should also be considered. When appropriate, quantitative limits on acceptable decision errors should be specified. The scientific and statistical assumptions that form the basis of the SAP may include contaminant transport models, exposure models, and statistical models to support hypothesis testing or estimation (based on components of variance from sampling and measurement). The planning process will ultimately result in selection of a cost-effective sampling and analysis plan that meets the applicable quality criteria. See Section B1 of this document for more specifics on SAP design and selection.

A8 PROJECT NARRATIVE

A project narrative is not required for ER Project data collection efforts as stated in Interim Draft EPA Requirements for Quality Assurance Project Plan (EPA 1994, 52288).

A9 TRAINING/CERTIFICATION

A9.1 Training

The FPL is responsible for determining specific training and certification needs and to document required training in accordance with LANL-ER-AP-O5.2. The review of worker training and qualifications shall be conducted before workers are assigned to ER Project activities. Individuals developing and implementing SAPs for the ER Project must 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:

- LANL ER quality management plan (QMP);
- this document;
- applicable SAP; and
- standard operating procedure (SOPs), administrative procedures, site-specific health and safety plans, and work plans.

Training consists of a reading list, classroom and video presentations, and other methods of instruction. In addition to the above, the responsible FPL shall determine any special training needs such as for use of special sample collection devices, cleanup systems, or other training not described in LANL-ER-AP-5.2. The FPL shall also define the associated training needs in the site SAP or referenced.

A9.2 Certification

Certification of training in such areas as radiation worker and hazardous waste operator and emergency response (HAZWOPER) is required for many ER Project activities. In addition, certification might be needed for special techniques used in sampling and analysis. These certifications shall be documented in the site-specific SAPs or health and safety plans as applicable. The FPL is responsible for identifying worker certification needs for the field unit and site.

A10 DOCUMENTATION AND RECORDS

The ER Project-wide requirements for documentation and records are described in Chapter 5 of the ER Project Installation Work Plan (IWP) (LANL 1995, 52009). These requirements are detailed further in the ER Project Administrative and Quality Procedures (LANL 1995, 49708) and the SOPs for the ER Project (LANL 1991, 21556). Additional data management requirements needed to meet project-specific goals must be specified in the SAP or referenced.

Figure A-1 illustrates the flow of data generated for the ER Project as defined by the data management and records requirements for the ER Project. Following this flow, results obtained from field instruments, field measurements, and field laboratories are verified and validated in the field to support rapid decision-making. Section D of this document provides the criteria and process for these reviews. Any nonroutine data gathering techniques must have the data management and records requirements documented in the SAP, either through direct insertion (mainly for one-time use of a technology) or by citation of an SOP.

Results of radiological screening conducted in the field or mobile radiological van (e.g., for sample shipping purposes) must be documented and sent to the Sample Management Office (SMO) prior to sample shipment to laboratories. The screening data are sent to the laboratories with the samples. All logs, field data reports, instrument calibration records, check sample analyses, and raw data must be submitted to the Records-Processing Facility (RPF) and all final results and electronic data needed to support decision-making must be submitted to the Facility for Information Management, Analysis, and Display (FIMAD).

Data generated from internal or contract analytical laboratories shall be submitted to the SMO following the requirements of the statement of work (SOW) (LANL 1995, 49738) for the analytical laboratories. The SOW provides the data-reporting requirements for all routine analytical services, analytical cost (Section II.B of the SOW), and a minimum list of the data reporting requirements for nonroutine analyses in Section V of the SOW. Any nonroutine analyses must have the actual site-specific data reporting requirements included in the SAP. This might include field logs, raw data, results of calibration and quality control (QC) checks and other data generated by the measurement system such as "case narratives." Nonroutine data turnaround time requirements and record retention requirements must also be specified in the SAP.

Once baseline data validation efforts are completed as described in Section D1 of this document, data become accessible through FIMAD to the field unit personnel (for data analyses such as comparisons to site contaminant background levels, SALs, and risk assessment), and other potential data users including regulators and the public. Field data and other hardcopy data packets, as appropriate, shall be sent to the RPF by appropriate field unit or SMO personnel following the procedures specified in Chapter 5 of the IWP (LANL 1995, 52009). Once data packages are delivered to the RPF, they will be available to data users to follow the procedures for accessing data in the RPF.

FPLs shall direct the field unit technical team data evaluation activities that follow verification and baseline validation. Those activities may include data quality assessment (DQA) and focused validation efforts as described in Section D of this document. All of the outputs of the DQA and focused validation efforts must be documented following the ER Project requirements or site-specific requirements included in the approved SAP.

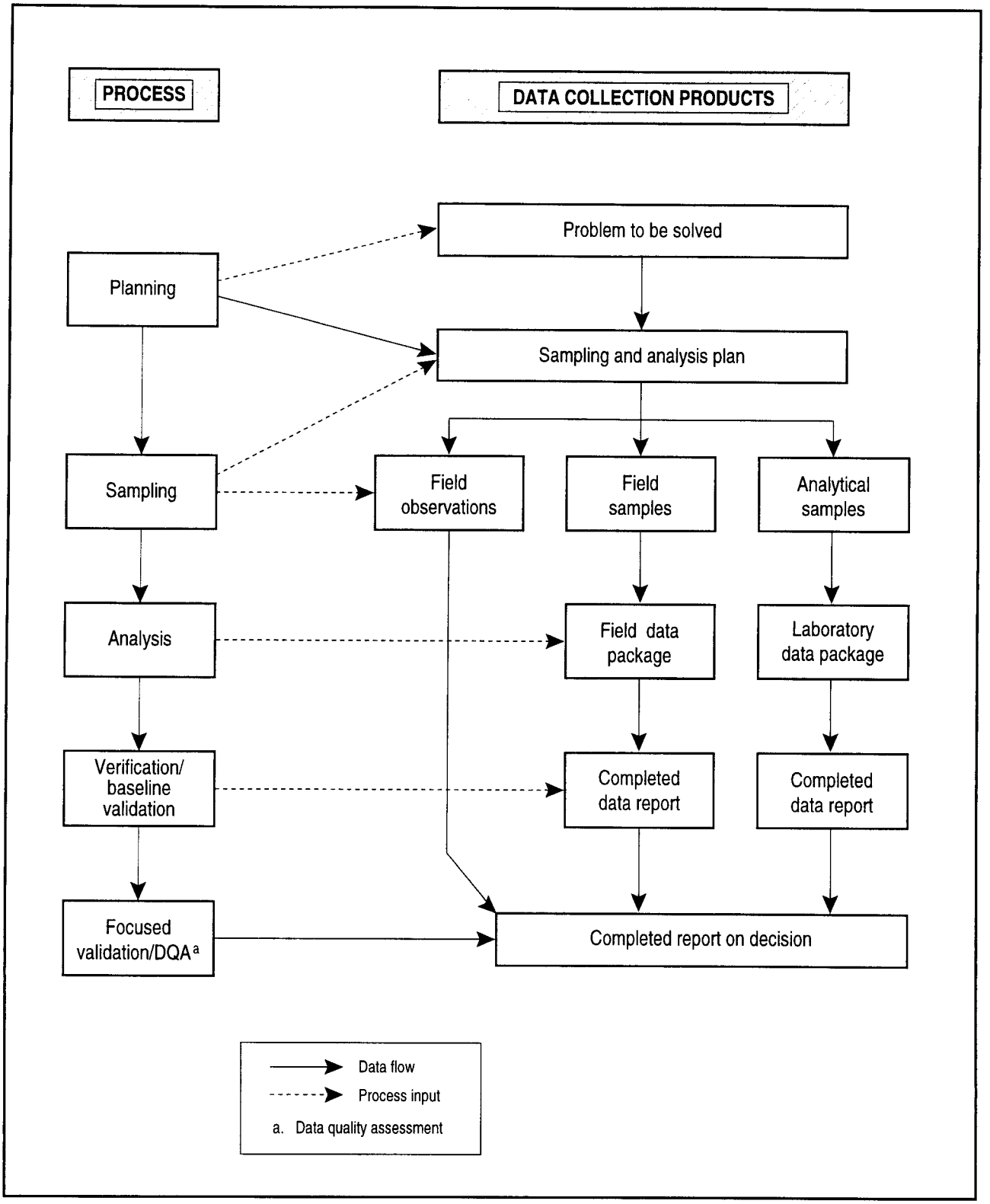

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Figure A-1. Project data flow for the Environmental Restoration Project.

As necessary, corrections identified in data verification or validation shall be incorporated into FIMAD. Only those data qualifiers based on the baseline validation criteria as described in Section D1 of this document will be used. Typically, the responsible data generator (e.g., laboratory) will be required to correct identified measurement problems and submit a revised report with the necessary corrections. Any changes resulting from the focused validation efforts must be sent to the RPF in addition to FIMAD, so that all records are current and consistent.

B1 SAMPLING PROCESS DESIGN

Alternative sampling and analysis options will be evaluated during planning and the most cost-effective design that is expected to meet the planning specifications will be selected. Cost-effectiveness may be determined through professional judgment or through a cost-benefit analysis. By selecting a particular sampling design, the type and number of samples, and the means of allocating samples, is defined. Specific sampling locations (and/ or frequency of sample collection) are selected along with sample acquisition methods, measurement methods, and other procedures that will be used to collect and analyze the samples. The type and number of quality assessment/quality control samples to be collected in the field must also be determined, and the frequency and/ or location for these samples documented.

SAP documentation requirements are specified in the following sections. The SAP design must be recorded in the appropriate document (i.e., RFI work plan, RFI report, accelerated cleanup plan, etc.), according to ER policy.

B1.1 Environmental Sampling Plan Design

All of the information listed below, as appropriate to the design, must be documented or referenced in enough detail to make the SAP third-party implementable. Provision for modification of SAP must be addressed.

- the number, or frequency of collection, for each type of sample (e.g., composite, grab, integrated) to be collected;
- the sampling network design (e.g., rectangular or triangular grid, stratification) and the assumptions underlying the design;
- the locations of the sampling points (preferably marked on a map);
- when field measurement methods are used, the techniques and/or guidelines to be followed in selecting sampling points, a description of or reference to the measurement technique/method to be used, and a description of how field screening results are to be used;
- if sample point selection will be made during field activities, the method(s) to be used to locate sampling points in the field, including specifics on how locational data are to be collected, stored, and transmitted;
- a description of the portion of each medium that will be collected for analysis;
- specification of nonmeasurement data required as inputs to solving the problem;
- references to all administrative procedures and SOPs used to carry out the work under the SAP;
- specific criteria, process, and schedule used to determine if methods with unknown performance characteristics will meet project goals; and
- design for well installation, as needed.

B1.2 Assessment and QC Sampling Plan

In addition to specifying the type, frequencies, and number of field samples and/or measurements to be made, SAPs must include

- a description of the selected number and type of assessment/quality control samples required to support the SAP; and
- a reference to, or description of, the process used to arrive at the number and type of assessment/quality control samples, when applicable.

Assessment samples are intended to provide information about variance (regardless of source) and/or bias after the fact during data assessment. Examples are field blanks, field duplicates or collocated samples, and equipment rinsates.

B2 SAMPLING METHODS REQUIREMENTS

Selecting methods appropriate for collecting samples of each environmental medium of interest is an important part of the planning process used to prepare the SAP. The sample collection methods must preserve sample integrity to ensure that the samples adequately represent the environmental media from which they are taken.

Technical issues considered in selecting sampling methods must be documented in the SAP or referenced. Therefore, the SAP must document the following:

- environmental medium to be sampled (e.g., air, sludge, soil, sediment, rock, water, etc.);
- type of samples needed by the SAP design (e.g., grab, composite, core, etc.);
- portion of the environmental medium (i.e., the target population) the data user wishes to represent (e.g., 0" to 12" depth of entire PRS or PRS aggregate) with the samples;
- types of analyses to be performed on the samples (e.g., volatiles, semivolatiles, metals) and any special sampling tool or method demanded by the analytical methods (e.g., SUMMA canisters);
- volume of each sample necessary to satisfy all analysis requirements (e.g., there are special considerations for using hydro-punch sampling or for collecting samples for volatile organics in the different media, because each medium could require different volumes and containers);
- size and type of sampling equipment appropriate for collecting the desired samples. This is especially important for analytical methods that require special containers such as air sampling, certain volatile organics analytical methods, and certain on-site measurements;
- decontamination (see LANL-ER-SOP-1.08) that must be performed on nondisposable sampling equipment prior to and between uses. Wash water and other wastes generated during the sampling operation must be managed and disposed of in accordance with LANL-ER-AP-05.3;

- waste minimization (including the minimization of decontamination wastes) when it is cost effective (LANL-AR-10.8); and
- constraints on the sampling events that might significantly affect the projected time or costs (e.g., inclement weather or threats to endangered species).

These requirements should be summarized to include references to the procedures that will be used to conduct the sampling. Where existing SOPs or other official guidance provide adequate documentation of any of these required criteria, those documents shall be cited in the SAP. For example, LANL-ER-SOP-1.02 addresses the requirements for sample containers, preservatives, sample volumes, and holding times; routine sampling procedures are documented in the ER Project SOPs, Chapter 6, "Sampling Techniques." Additional guidance is presented in Appendix II for selecting sampling methods and equipment.

If all site-specific requirements are not adequately addressed by reference, then the requirements shall be documented in the SAP by developing and referencing new SOPs or revised SOPs. Otherwise the requirements must be included in the SAP by incorporating the equivalent SOP requirements. Where site-specific performance requirements are necessary for sampling operations, those requirements should be written into the SAP. For those tasks that might be useful to more than one field unit, developing new SOPs is encouraged in lieu of writing instructions into the SAP.

Ultimate authority and responsibility for field operations lies with the responsible FPL. However, responsibility for corrective actions in the field that address deviations from SAPs and other field-work-related contingencies may rest with the cognizant field team leaders who report to the FPL. When possible, corrective actions should be anticipated and delineated in the SAP.

B3 SAMPLE HANDLING AND CUSTODY REQUIREMENTS

All personnel must follow the SOPs addressing sample handling and custody (ER Project SOPs, Chapter 1, "General Instructions"). Those SOPs must be referenced in the SAP. In cases where deviations from an SOP are planned, the deviations must be fully described in the SAP. In addition, the requirements in the following paragraphs must be met for all SAPs.

All samples must be identified in accordance with LANL-ER-SOP-01.04, which establishes the requirements for identifying each boring location, monitoring well, and sample collected during surface water, groundwater, sediment, waste stream, soil, and air sampling programs. The numbering system, which satisfies EPA requirements for sample identification (EPA 1987, 11654), provides a tracking capability to facilitate data retrieval. It ensures that all information required to identify and track samples is readily accessible and unique to a particular sample.

Chain-of-custody requirements satisfying EPA guidance (EPA 1991, 52287) must be implemented as delineated in LANL-ER-SOP-01.04 to provide legal and technical defensibility of ER Project sample data. Chain-of-custody records must be initiated at the time of sample collection and remain active until final disposition of the sample.

B3.1 Sample Management Office

The SMO must be alerted by the field units as to the types and quantities of environmental and QA/QC sample containers, as well as preservatives, needed for a particular sampling operation. This alert should come as early as possible, preferably at least four weeks prior to any sampling that requires SMO services. All special considerations, such as availability of analytical laboratory services or return of unused sample materials, must be coordinated with the SMO.

If archiving of samples or sample derivatives (e.g., extracts, digestates) is required, arrangements must be made with the SMO before sampling. These arrangements must be referenced or documented in the SAP.

B3.2 Field Packaging and On-Site Measurements

All analytical services, including field laboratory services (radiological van, chemistry van, etc.), must be coordinated through the Field Support Facility. However, if a field unit elects to package samples in the field or to use a field laboratory, the instructions for doing so must be written into the SAP or in SOPs referenced by the SAP. In those cases, at a minimum, the following sample collection and analysis activities must be addressed in the SAP:

- provision of sample containers, preservatives, coolers, labels, etc.;
- chain of custody and sample tracking (beginning when the samples are collected and sent to the analytical laboratory and ending with returned results);
- sample packaging and shipment to analytical laboratories;
- identification of available laboratory services (includes radiological van, chemistry van, and other on-site measurements) by reference to the applicable SOW for analytical services as designated by the SMO; and
- final disposition of sample materials.

Responsibilities for the above activities as well as schedules for completing the activities (when appropriate) must be delineated in the SAP or referenced. Additional guidance for using on-site measurement methods is included in the Department of Energy (DOE) document "Guidance for Planning On-Site Measurements" (DOE 1995, 52240).

In addition to the above requirements, all ER Project samples must be classified prior to shipment as hazardous or nonhazardous pursuant to International Air Transportation Association, Department of Transportation regulations (see 49 CFR 171-173) and EPA guidance (EPA 1987, 11654). LANL-ER-SOP-1.03 addresses the issues of determining the hazard status, packaging, and shipping of ER Project samples and provides more specific direction on sample packaging and transport.

B3.3 Sample Volumes, Containers, Holding Times, and Preservatives

Requirements for selecting sample volumes, containers, holding times, and preservatives for samples subjected to routine analyses are presented in LANL-ER-SOP-1.02. Routine analyses are addressed in detail in Section B4 and Appendices III and IV of this document. Sample preservation and holding time requirements for nonroutine analytical measurements must be specified directly in the SAP.

B4 ANALYTICAL METHODS REQUIREMENTS

The SAP must include or reference the following information:

- analytical and other measurement methods to be used. This includes sample preparation techniques (e.g., extraction, cleanup, digestion, etc.) and special equipment (e.g., instrument sample preparation equipment critical to the analyses);
- any decontamination procedures needed to prevent compromising the representativeness of the sample and analyses; and
- specific performance criteria for the above bulleted items.

The analytical services contracts, which include SOWs (LANL 1995, 49738) for analytical services, were developed for the ER Project to meet most users' needs in a cost-effective manner. Those SOWs can be especially appropriate for screening assessments and other types of investigations requiring broad-scan methods or very rigorous QC. They include lists of the analytes grouped into standard ER Project analyte suites such as volatile organics and

metals (see also Appendix III). It is unnecessary to specify in a SAP any routine analytical requirements that are addressed in the analytical laboratory SOWs (LANL 1995, 49738). The preferred method of specifying which analytical methods will be used is by summarizing them in a table by analytical method number or, when SOW-related analytical services are used, by reference to the analytical laboratory SOWs (LANL 1995, 49738).

Analytical method selection must be based on the requirements of the decision to be made. These decisions are established during the planning process (see Sections A5–A7 of this document). The SAP requirements for analytical methods must reflect the following considerations:

- required analytical information (e.g., analyte list, including whether determinations will be made for total, soluble, extractable, isotopic, volatile species, etc., and how the data will be used);
- sensitivity;
- selectivity;
- precision and bias;
- sample preparation;
- sample holding times;
- turnaround time;
- waste minimization;
- cost; and
- data comparability.

Consideration of the above elements, along with historical performance information on the available methods, is used to determine which of the following options provides the most cost-effective and timely approach to meet needs:

- routine analytical methods provided by the analytical services contracts;
- methods optimized for site-specific use (e.g., *in-situ* methods);
- nonroutine, off-site analytical services; or
- any combination of the above that provides the most cost-effective and timely approach to meet site-specific needs.

Detailed information and guidance for analytical method selection is included in Appendix IV. To facilitate the selection of sample preparation and chemical analysis methods, experienced analytical chemists are available from the Decision Support Council Chemistry Team.

When NRS are selected for a project, it is necessary to identify the critical aspects of the analytical methods. Those critical aspects are

- target analytes or variables and associated quantitation limit requirements;
- descriptions of, or citations of, sample preparation and analysis methods;

- standardization/calibration procedures that are related to individual sample analytical data and equipment;
- analytical raw data required, such as mass spectra, chromatograms, and graphite furnace atomic absorption outputs;
- all manual calculations used to generate results;
- analytical QC raw data including, for example
  - blanks
  - spikes (matrix, surrogate, tracers/carriers, etc.)
  - QC samples (laboratory control sample, site-specific performance evaluation materials, etc.); and
- special analytical conditions that require different sample handling, preparation, or analytical procedures.

If standard analytical methods are to be followed, the methods may be cited in the SAP; otherwise the specifications in the SAP must be detailed enough to allow any qualified analyst to repeat the specified work using similar equipment.

Each FPL is ultimately responsible for data quality in his/her respective field unit. Additional information defining the options that need to be considered when selecting nonroutine analytical methods is available in the guidance for analytical method selection in Appendix IV. These options are specific to the type of analytical method needed. The selected options must be specified in the SAP.

B5 QUALITY CONTROL REQUIREMENTS

This section provides the quality control requirements for sampling, analyses, data management/assessment, and other measurements (e.g., land surveys and biological assessments) that must be performed routinely. The approach at LANL is to tailor QC activities to site-specific needs through planning and eliminating unnecessary QC checks.

SAPs should be designed to assess the major components of total study error to enable the final evaluation of whether environmental data are of sufficient quality to support the related decisions. The QC requirements must be designed to provide measurement error information that can be used to initiate corrective actions that limit the total measurement error. Consequently, SAPs must reference or

- describe the QC samples and procedures associated with sampling and measurement,
- list specific QC checks that are required for each type of sampling and measurement, including data management/assessment data to be collected. The list must include
  - the frequencies of the control checks, and
  - the required acceptance criteria for each QC check.

The SAP must also provide or reference

4.0 QUALITY ASSURANCE PROJECT PLAN

The Quality Assurance Project Plan is included here as part of the Installation Work Plan but is formatted as a stand-alone document to be used in the field.

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- as necessary, procedures for calculating QC statistics; a reference to this document's glossary (see Precision and Bias) might suffice,
- anticipated corrective actions associated with failure of sampling or measurement systems to meet acceptance criteria.

If established SOPs or standard methods are used for sampling and measurement, and those documents specify the applicable QC checks, frequencies, acceptance criteria, and corrective actions, those documents may be cited. Otherwise, the appropriate QC activities must be described explicitly in the SAP.

For sample collection activities, the QC procedures specified in LANL-ER-SOP-1.05 must be followed or specific QC procedures must be provided in the SAP or in the SOP used for the sampling.

B5.1 Sampling

QC for sampling must be part of a comprehensive QA approach that includes quality oversight of field teams and analytical laboratories.

B5.2 Analyses/Measurements

For the routine analytical services provided through the analytical services contracts, a default set of QC procedures and criteria are specified in the analytical laboratory SOW (LANL 1995, 49738). Provided that these defaults are adequate and routine analyses are selected, additional QC procedures for the sample analyses need not be spelled out in the SAP.

For nonroutine analyses (such as on-site measurements, specialized analyses, or land surveys), the project-specific QC procedures and limits must be specified in the SAP or in SOPs. Many on-site measurements are capable of providing data adequate for decision-making in the field if the QC activities are designed to support a quantitative assessment of the measurement performance. For nonroutine services that are conducted in the field or are unique to the field situation, the QC procedures must be specified in the SAP or an SOP that provides for adequate QC review in the field.

B5.3 Data Management/Assessment

Data management(paper flow; data tracking, data entry, etc.) and data assessment (verification, validation, and DQA) activities require adequate QC procedures to ensure that the SOPs are being followed and result in records/reports that are accurate and appropriate. QC procedures include peer review of each step or management review of a certain percentage of the data. The SAP should describe or reference project QC for data management and assessment. (See also Section B10 of this document.)

B6 INSTRUMENT/EQUIPMENT PURCHASING, TESTING, INSPECTION, AND MAINTENANCE REQUIREMENTS

Items and services procured by the ER Project shall be approved by the responsible FPL or shall be acquired under the FPL's direction. As necessary, an FPL or designee will develop the purchase specifications for goods and services that are designed to satisfy the needs of the field unit. Once the FPL or designee has approved the specifications, the goods or services will be purchased through the field unit's contractors or the LANL purchasing group (e.g., BUS-5).

Goods and services received that do not meet purchase or performance specifications shall be identified. The FPL or designee shall control nonconforming items or services to prevent use until compliance with the original or modified specifications has been demonstrated, or until the item is retired from potential use.

Only equipment that is maintained and calibrated in accordance with the manufacturer's recommendations or in accordance with equal or more stringent standards shall be used for data collection. Support organizations must maintain equipment as specified in SOPs and SAPs. The ER Project will monitor support organizations' performance through periodic audits and use of performance evaluation samples.

When equipment maintenance, inspection, and calibration requirements are delineated in SOPs, it is sufficient to cite the applicable SOP. When requirements are not delineated in SOPs, the SAP must define the requirements or cite manufacturers' maintenance and calibration schedules. When maintenance and calibration requirements that exceed those recommended by the manufacturer are deemed appropriate, and such requirements are not delineated in an SOP, they must be stated explicitly in the SAP.

Service contracts may provide a vehicle for routine preventive maintenance and emergency repair service. In such cases, actions taken by an instrument service representative shall be documented in the records for that instrument.

B7 INSTRUMENT CALIBRATION AND FREQUENCY

Equipment designated for use in ER Project work plans shall be specified to meet site-specific planning specifications. Measuring and testing equipment used in the field or an analytical laboratory must be controlled by formal calibration procedures, which are required for proper operation of equipment and instruments. If available and applicable, instrument manufacturer directions for calibration may be cited instead of repeating them in ER Project documents. All calibration standards shall be traceable to nationally recognized standards such as those from the National Institute of Standards and Technology, unless such traceability is inappropriate or not possible. If traceability is inappropriate or not possible, the manner in which the suitability of calibration standards is determined must be stated or referenced in the SAP.

B7.1 Field Equipment

Field equipment must be properly calibrated and charged, as appropriate, and must be in good general working condition before the beginning of each day of use. ER Project SOPs and SAPs specify the required checks and calibration for each type of field equipment. These requirements include the frequencies of checks and calibrations necessary to ensure that operability is acceptable. Field equipment that does not meet calibration requirements shall be taken out of service until acceptable performance can be verified. Nonoperational field equipment shall also be removed from service and may be returned to the supplier for replacement. Maintenance records must be maintained for each field instrument according to a unique number affixed to the instrument used to facilitate tracking of instrument records. The unique serial number for each instrument shall be used on all related documentation concerning that instrument. These records should be reviewed before equipment use to ensure that maintenance and calibration are current.

All instruments used for environmental investigations must be properly protected against inclement weather as needed.

Logbooks specific to individual equipment items shall be used to record the

- equipment identifier;
- inspection, maintenance, and calibration action(s) performed;
- trigger(s) for the maintenance, calibration, or inspection action(s);

- identity of each person performing the work;
- date on which the work was performed; and
- condition of the equipment upon completion of the action(s).

Use of tabulated maintenance, inspection, and calibration requirements and actions is recommended for convenience.

B7.2 Laboratory Equipment

For the services provided through the analytical services contracts (LANL 1995, 49738), all laboratories are expected to meet or exceed manufacturers' recommendations for maintaining and calibrating equipment. Contracts may be used to require implementation of certain calibration and maintenance procedures.

Before enlisting analytical services outside of the analytical services contracts, ER Project QA personnel or designees shall review the laboratory's operations to ensure that an adequate equipment maintenance and calibration program is in place.

Oversight of analytical laboratories is addressed in Section C1.2 of this document.

B8 INSPECTION/ACCEPTANCE REQUIREMENTS FOR SUPPLIES AND CONSUMABLES

Supplies and consumables will be inspected and accepted for use in the ER Project by the appropriate FPL or designee. Supplies and consumables are those items necessary to support the sampling and analysis operations. Field supplies will normally be inspected and accepted by the field team leader. Laboratory supplies will normally be inspected and accepted by the appropriate laboratory personnel. Acceptance criteria for specific supplies and consumables will be listed in the SAP or field-unit-specific SOP.

To the extent practicable, spare parts for field and laboratory equipment must be kept readily available to minimize downtime. However, to control costs, the responsible supervisor shall determine the numbers and types of spare parts to be stocked for each type of equipment. The FPL or designee shall identify those pieces of equipment for which a record of spare parts availability must be maintained.

After a defective part has been replaced, it shall be returned to the manufacturer for repair, stored for future inspection, or discarded. If a defective part is stored temporarily, it shall be labeled as defective and the label shall indicate when the part was taken out of service and the nature of the deficiency. If a defective part or equipment item was used to collect data and such use may have compromised the integrity of the data, a note in the data record shall be made. The SAP must

- identify by name, during the final readiness review, individuals who will inspect and accept supplies and consumables for the task, and
- list acceptance criteria for critical supplies and consumables in order to satisfy the technical and quality objectives of the task.

B9 DATA ACQUISITION REQUIREMENTS (NONDIRECT MEASUREMENTS; REQUIREMENTS FOR USING ARCHIVED DATA AND NONMEASUREMENT DATA)

If archived data or nonmeasurement data (e.g., interviews, maps, spreadsheets, computer data bases, calculations) are to be used in decision-making, the acceptability of the data shall be assessed on a case-by-case basis. The data acceptability may be confirmed by comparing data from more than one source or by corroborating the data through additional data collection. Information received through interviews shall be documented with written concurrence by the interviewee. For numerical data, prior validations shall be reviewed to assess the technical validity of the data as well as their suitability for use in making decision(s).

The responsible FPL shall determine the level of effort to be used in the data review. The effort will be commensurate with the amount of information available and the importance of the data relative to decision(s).

It could be important to prepare a pedigree for data of interest that describes the procedures used to collect the data and the qualifications of personnel who collected the data. The FPL or designee shall determine the need for, and method of, documenting a data pedigree.

B10 DATA MANAGEMENT

Chapter 5 of the IWP (LANL 1995, 52009) presents LANL's approach to data and records management. Following this approach, electronic data are stored in FIMAD and all other records are stored in the RPF. Data and records management requirements not specified in Chapter 5 of the IWP, applicable SOPs, or applicable SOWs must be specified in the SAP or referenced. (See also Section A10 of this document.)

Figure A-1 illustrates the flow of data generated for the ER Project. Results obtained from field instruments, field measurements, and field laboratories are verified and validated in the field to permit decisions to be made rapidly. The criteria and process for these reviews are discussed in Section D of this document. The results of radiological screening conducted in the field or in a mobile radiological van should be documented and sent along with the samples to the SMO.

Manually recorded data are recorded in accordance with LANL-ER-SOPs-1.04 and 3.12. They are reviewed by the field team as required by LANL-ER-SOPs 1.01, 1.04, and 3.12. Data that are transferred electronically are not subject to this review. However, the portion of the data that will be manually entered into the database (e.g., some nonroutine and field analytical methods, field notes, and other data recorded on forms in the field and then entered into FIMAD) must be reviewed for data entry errors. Field records, even if rendered illegible, must be kept as permanent records and may not be discarded.

Data generated as a result of analytical services by internal or contract laboratories must be submitted to the SMO, which is responsible for routine data verification and baseline validation as defined in Section D1 of this document. Nonroutine data verification/validation is the responsibility of the field unit team. Upon completion of the data verification/baseline validation process (see Section D1 of this document), the data must be transferred to accessible FIMAD files. Data entries include any qualifying flags assigned during baseline validation.

C1 ASSESSMENTS AND RESPONSE ACTIONS

The following sections provide a summary of the assessment activities required by the ER Project. The FPLs and quality assurance officer (QAO) are responsible for tracking the results of assessments and response actions to ensure that deficiencies are corrected in a timely manner. The QAO is responsible for identifying the personnel who participate in planned assessments, surveillances, etc., and ensuring that they are qualified to implement those evaluations.

Assessments planning includes delineation of responsibilities and reporting authorities. The manner in which evaluation results will be reported, and to whom they will be reported, are determined during planning for the evaluation. Schedules for preliminary and follow-up interviews, meetings, etc., are decided in advance of the evaluation and designed to adversely affect work schedules as little as possible.

C1.1 Internal Assessment

The process by which the ER Project assesses systems (programmatic assessments) and performance is described in LANL-ER-QP-01.5Q. System assessments provide an effectiveness evaluation of systems established to ensure the quality of project activities. Performance assessments provide feedback on the effectiveness of activities in meeting ER Project objectives.

C1.1.1 Field Unit Assessments

The ER Project uses self-assessments and formal, independent field assessments to assess compliance with the SOPs identified in work plans, RFI reports, site characterization analyses (SCAs), accelerated cleanups, closure plans, SAPs, etc., and associated QA documents (including this document). The FPLs in conjunction with the QAO are responsible for determining the number and types of assessments to be conducted and for arranging for their implementation. The number, frequency, and purpose of each assessment must be specified in the SAP. At a minimum, assessments should review the processes used in the field to record information about each sample taken, control the chain of custody, determine the locations of sampling points, implement the specified sample collection methods, and implement the specified procedures for sample handling.

C1.1.2 Corrective Action

Deficiencies identified during assessments are documented in accordance with LANL-ER-QP-1.04Q. Corrective action requests are issued to the FPL/DPL to identify, document, and implement the necessary corrective actions.

C1.2 Oversight of Analytical Laboratories

C1.2.1 Analytical Laboratory Assessments

The performance of LANL's analytical chemistry and contract laboratories, including mobile analytical laboratories, is assessed prior to their acceptance for use. These assessments are performed on an as needed basis by QA personnel from LANL's ER Project unless audits by other organizations (DOE, EPA, and other DOE management and operations contractors) have occurred within the current year and reports to QA personnel demonstrate adequacy for meeting ER Project defined needs.

Checklists for audits specific to the kind of analytical services to be audited are developed by (or equivalent to) the Albuquerque DOE FSMP checklists are used in these assessments. When assessments by other organizations are used, they are compared to the Albuquerque FSMP checklists and accepted, either partially or completely, depending on how they match the FSMP criteria.

C1.2.2 Analytical Laboratory Performance Measurement

The ER Project is implementing a program to evaluate and track the performance of its analytical laboratories. Results from blind performance evaluation samples obtained by the ER Project and/or quality assessment/ quality control samples included in individual SAPs will be used, as necessary, to assess matrix- and analyte-specific precision and bias across the ER Project. These assessments will be performed on a continuing basis to provide the ER Project with laboratory and site performance data. Other approaches may also be used, as needed, to assess performance, including approaches to track the performance of laboratories generating data within a field season or field unit. This information will be used to design future SAPs and to assign acceptance criteria to QC data parameters.

C1.2.3 Data Package Assessment

In addition to the baseline and focused validation processes described in Section D2 of this document, a percentage of each laboratory's data packages is assessed to monitor performance of individual laboratories. These assessments include a review of raw data and the calculations that support the reported results. A statistical and performance-based frequency for conducting these assessments is developed for each laboratory. The required data package assessment of laboratory frequencies are reported as they are developed.

C1.2.4 Verification/Validation Assessments

The data verification/baseline validation/data entry processes are audited by ER QA personnel on an as-needed basis.

C1.2.5 Monitoring and Tracking Administrative Indicators

Indicators that include turnaround times, holding times, and responses to problems (problem resolution) are used to identify trends in performance-related and administrative functions. This information is made available throughout the ER Project for planning purposes.

C1.2.6 Problem Resolution

The problem resolution process includes the following:

- problem identification,
- problem analysis,
- corrective action, and
- resolution tracking system.

The problem resolution information is forwarded to the responsible FPL and QAO.

C1.3 ER Project Peer Reviews

ER Project plans and reports are peer-reviewed in accordance with LANL-ER-AP-01.3. This procedure provides for selecting appropriate personnel to conduct reviews and for formal comment resolution.

C1.4 Readiness Reviews

Before performing selected field activities, a readiness review is conducted in accordance with LANL-ER-AP-5.1. Implementing this procedure ensures that field work complies with applicable directives, guidance, SOPs, administrative requirements, and applicable regulations.

C2 REPORTS TO MANAGEMENT

C2.1 Project Status

Periodic reports are generated to describe ER Project status and to satisfy the requirements of Hazardous and Solid Waste Amendments (HSWA) Module VIII of the RCRA permit. The FPL is responsible for identifying the types of reports and frequencies in their respective SAPs or project plans. More detailed descriptions of RFI, corrective measures study/corrective measures implementation (CMS/CMI), and accelerated cleanup plans and reports are provided in Chapter 3 of the December 1996 IWP.

C2.2 Quality Assurance Reports

The results of QA assessment activities identified in Sections C1.1 and C1.2 of this document are assembled, summarized, and distributed to the ER Project management team. These reports describe significant quality problems, recommend solutions, and identify personnel responsible for resolving the problems.

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D1 DATA REVIEW: VERIFICATION AND BASELINE VALIDATION

Most data generated by ER Project data collection activities, excluding some data that will not be used for final decision-making, will undergo a data review process that accomplishes two goals. First, "data verification" assures that needed data are available for further evaluation, assures that contract, or other, specifications have been met (or noted where not met), and provides the information needed for prompt and appropriate payment for analytical services. Second, "baseline validation" attaches qualifiers to data that do not meet specifications and provides information on potential deficiencies of that data. Reason codes for the qualifiers are also assigned to data to help users understand why a qualifier was added and the potential impacts of the data deficiency. The product of this first process is a report in FIMAD that can be used, as is, for data quality assessment (DQA) (see Section D3 of this document) and, as necessary, to focus further validation efforts. See Figure D-1 for a portrayal of the data verification/baseline validation process and Figure D-2 for a flow diagram that shows where the process fits into the entire data collection process.

For routine analytical services (RAS), the verification and baseline validation processes are carried out simultaneously. Those processes make use of a checklist for data completeness and compliance that is based on the routine analytical contracts, and that use standard validation qualifiers based on the commonly accepted contract laboratory program (CLP), "CLP Functional Guidelines" for review of analytical data. During this process, missing items are obtained from the laboratory that generated the data and any required corrections to erroneous data are made. These error corrections include both problems with compliance and problems with data entry into FIMAD.

For routine analytical services, the SAP must state that the "LANL ER Checklist and Criteria for Verification and Baseline Validation" (LANL 1995, 52241), including data qualifiers and reason codes, will be used for verification and baseline validation. Forms and checklists may be provided for clarification, based on the analytical services used, e.g., organics, inorganics, high explosive (HE), radiochemistry, or commonly used mobile laboratory SOWs.

If known, the SAP should identify anticipated needs for focused validation (see Section D2 of this document). For example, when petroleum hydrocarbons are anticipated to be an interference in semivolatile analyses, the SAP should specify that the chromatograms will be reviewed to assess the effect or potential effect of interferences on the reported data.

For nonroutine analytical services (NRAS), which include off-site analytical services, field analyses, and field measurements, verification criteria must be stated in the SAP or SOP. These verification, or acceptance, criteria are most efficiently used when they are provided as a checklist or data review SOP. The qualifiers that have been stipulated for the routine analytical services should be used to provide consistent data qualifiers within FIMAD. The SOP must also provide reason codes that are appropriate for the specific analyses. In the case of NRAS, the verification and baseline validation criteria should be combined when possible. This will create a single set of requirements that must be met. Data failing these requirements will be qualified and reason codes will be attached.

For NRAS, the SAP must provide the following:

- the problem-specific verification and baseline validation criteria (the analytical data generator must be made aware of these criteria). Note that if the nonroutine service closely resembles a routine service, the routine verification/baseline validation procedures may be cited, with appropriate deviations identified;
- the payment implications if measurement criteria are not met;
- the process for corrective action (e.g., completion and correction of data package); and
- if known, any need for additional focused validation (see Section D2 of this document).

These items can be provided by reference to appropriate SOPs and SOWs or by incorporating the requirements into the SAP.

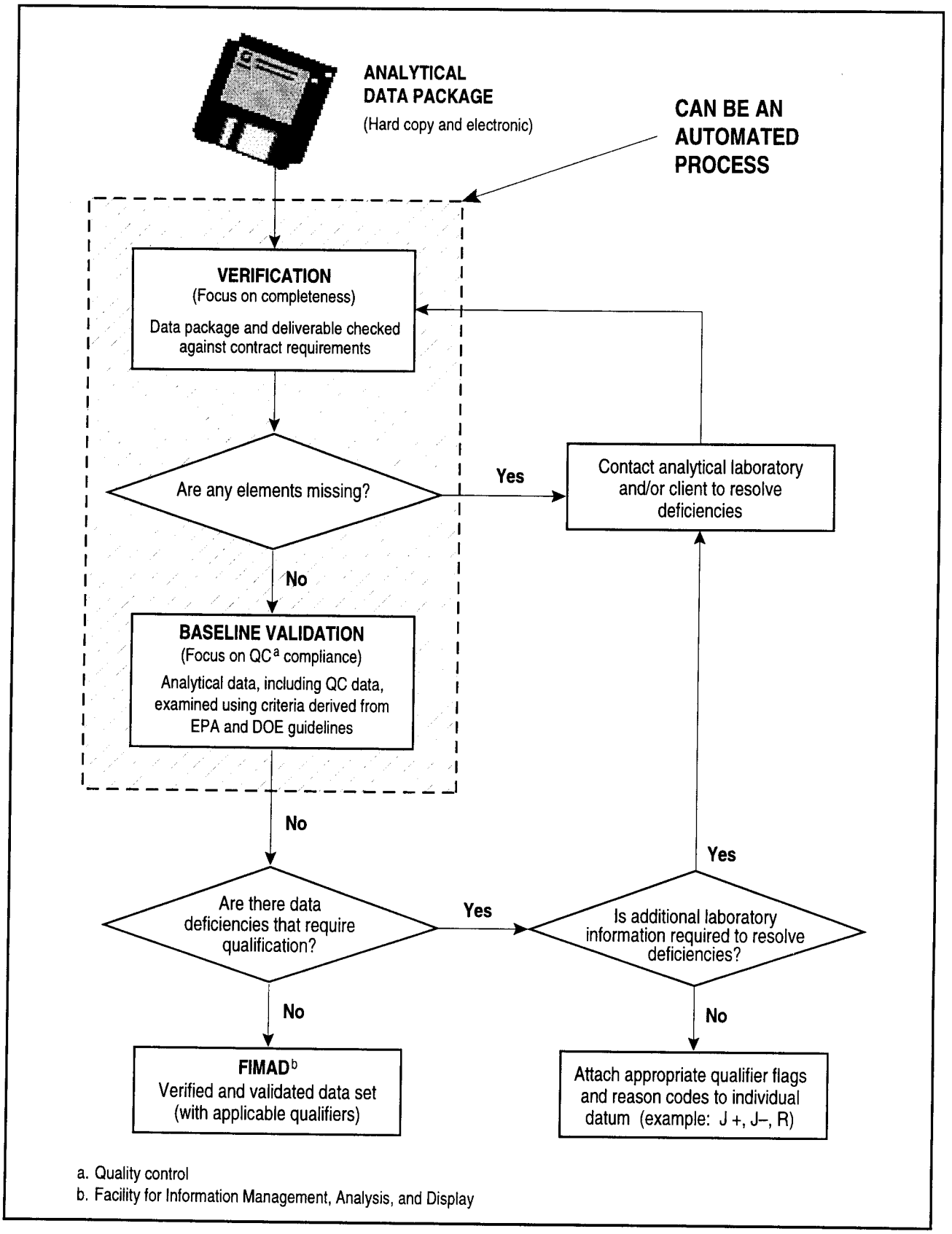

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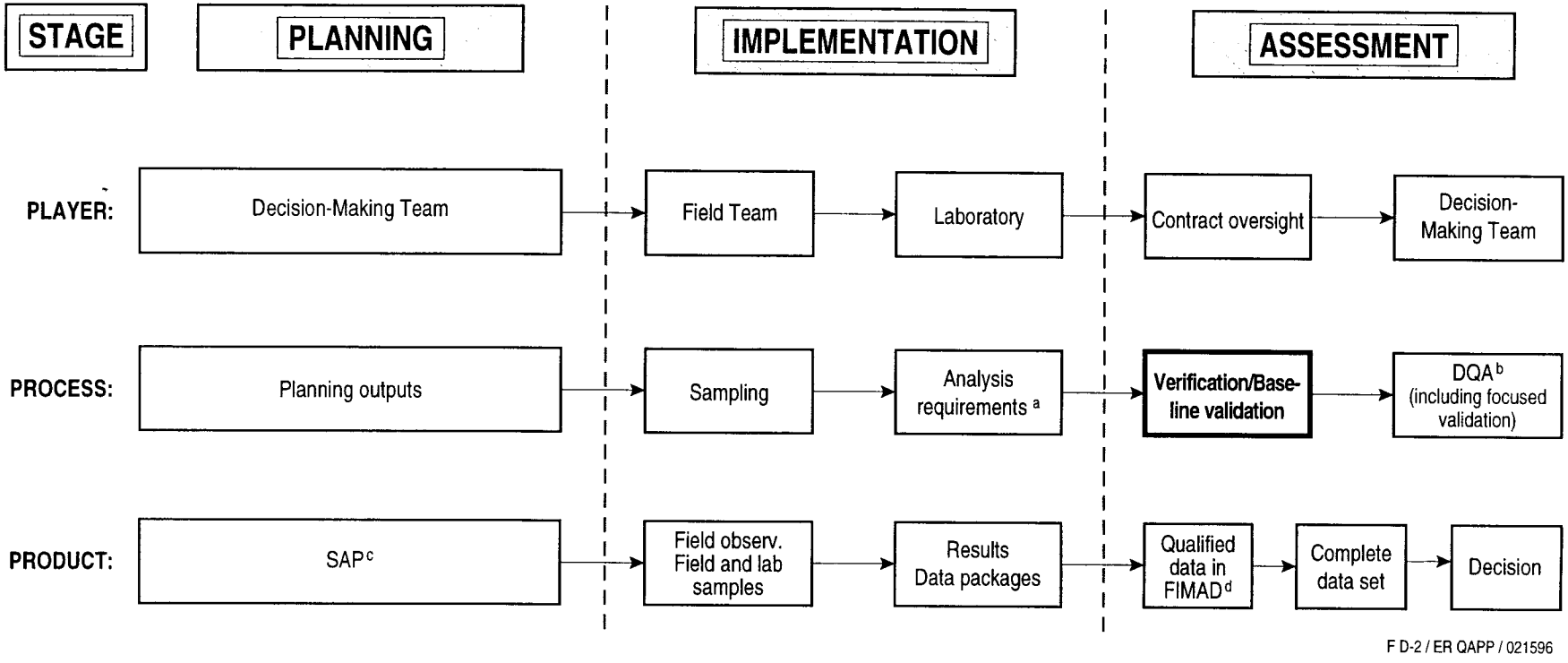
Figure D-1. The data verification/baseline validation process.



a. Analysis requirements are specified in a formal statement of work or contract.
b. Data quality assessment
c. Sampling and analysis plan
d. Facility for Information Management, Analysis, and Display

Figure D-2. Data flow diagram for the Environmental Restoration Project.

The baseline validation process focuses on the measurement data. The variability associated with the measurement process often represents only a minor component of the overall variability in the environmental data collection process. Other components of variability in a data set include, but are not limited to, spatial variability of environmental contaminants, variability in the sampling processes, and uncertainty in all other processes that occur during planning, sample collection, field data recording, and reporting. Consequently, data validation should not be overemphasized at the expense of other elements of the data collection process. To better match the cost of data validation with its comparable value, the ER Project requires only this streamlined verification/baseline validation process.

D2 FOCUSED DATA VALIDATION

The purpose of focused data validation is to determine the technical adequacy of measurement data when

- the data are qualified as deficient during the verification/baseline validation process. For example, when holding times are exceeded, interferences are present, artifacts are detected in the laboratory blank, poor sample recovery is indicated, or multiple deficiencies are noted, a focused validation may be required to assist in the determination of data adequacy for the intended use;
- the DQA process requires additional information about the variability or uncertainty of the reported data; or
- the DQA process requires additional information about the data quality prior to making a data use decision because of anomalies detected in a data set.

Figure D-3 depicts where focused validation usually occurs in the DQA process. Focused data validation usually occurs as a result of specific data use questions that arise during the DQA process, which is described in Section D3 of this document. However, unusual, excessive, or potentially fatal deficiencies noted in the report for data verification/baseline validation may trigger focused validation as an initial step in the DQA process. If this appears to be the case, the field unit technical team is notified through appropriate qualifiers and reason codes in FIMAD and must make a decision as to whether the focused validation should be initiated during DQA.

Focused validation for the LANL ER Project does not result in any adjustment of data (e.g., for bias), because PRS-specific data will usually be insufficient for such a purpose. However, it might be possible, based on historical ER Project-wide QA/QC data, used in conjunction with the site-specific data, to support a conclusion of a bias that can be quantitated and taken into consideration in a decision. Bias considerations must be addressed on a case-by-case basis by the DSC.

Factors which may be used to focus validation are

- qualitative QC measures,
- quantitative QC measures,
- degree of importance of the detection/quantitation limit,
- concern with detectable concentrations,
- analytical false negatives,
- analytical false positives,

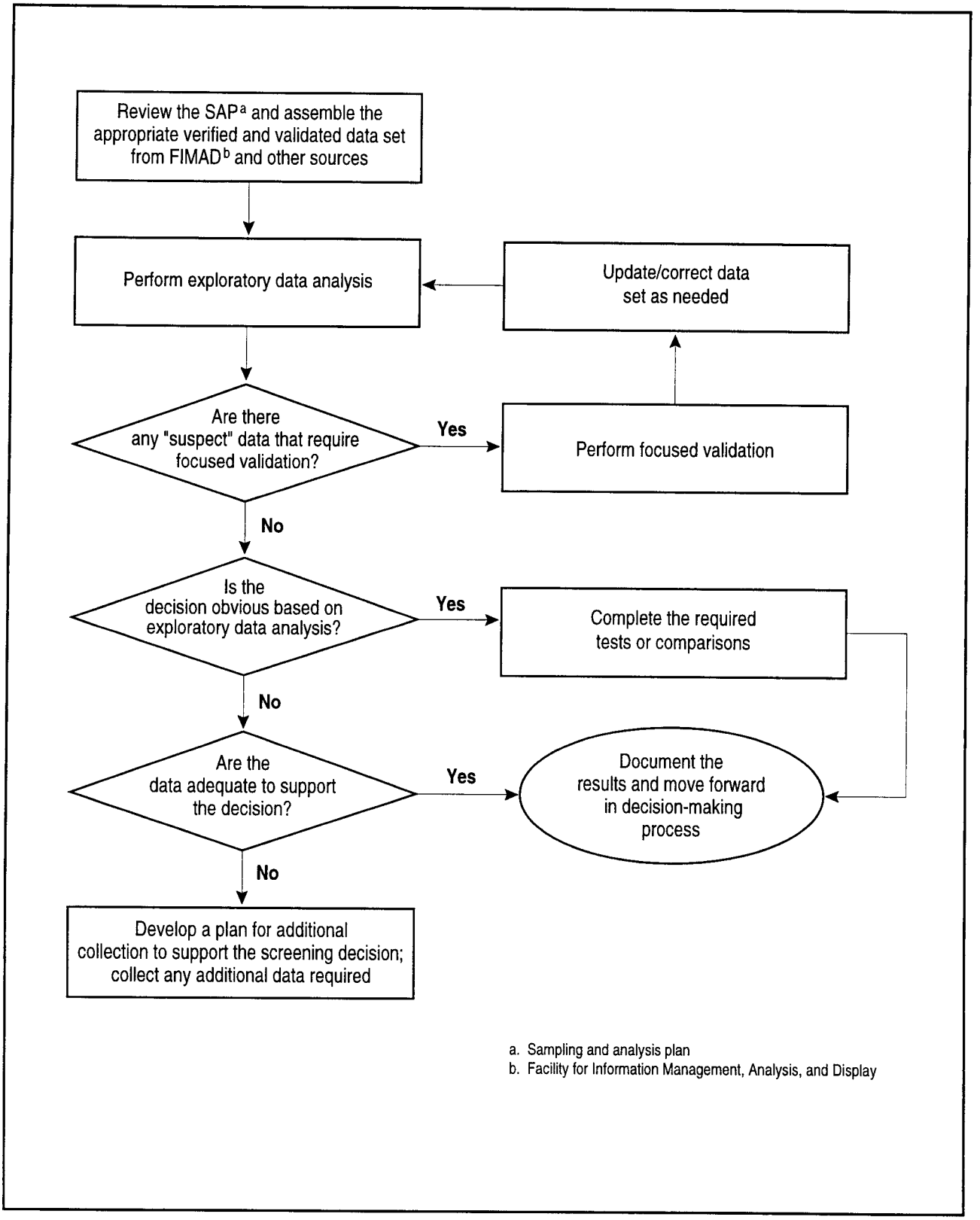


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Figure D-3. The data quality assessment process.

- potential use of data not meeting defined performance criteria, or
- analytical uncertainly/variability, especially when results are close to action thresholds and/or detection/quantitation limits.

D3 DATA QUALITY ASSESSMENT: RECONCILIATION WITH PLANNING (SAP) OBJECTIVES

Data quality assessment (DQA) is a data analysis and interpretation process involving scientific and statistical evaluation of data sets to determine if they are sufficient to support specific decisions. To implement the DQA process, the data analyst will work closely with a multidisciplinary team, potentially including the field team leader, data manager, chemist, statistician, risk assessor, and earth scientists. Figure D-3 provides an overview of the approach the ER project uses to implement the DQA process to determine adequacy to support a decision.

The DQA process includes a review of the SAP objectives, data quality requirements, sampling design, and exploratory and confirmatory statistical analyses of the data. Initially the data analyst will assemble the data set, including field information such as sample coordinates and descriptions and associated field measurements, and review any additional reports (e.g., a data validation report).

DQA usually begins with exploratory data analysis, including a significant graphical component. An interactive statistical graphics computer program is very useful for this purpose. Because this process evaluates individual data points within the context of entire data sets, it can quickly identify both "suspect" data and critical observations that could affect decisions based on these data. If necessary, "suspect" data can be submitted for focused validation (see Section D2 of this document) to determine whether they resulted from errors in the data generation process. "Suspect" and other unusual observations may also be reviewed by experts on the natural environment and the measurement process to determine if they have scientific explanations. A third possibility is that such observations simply represent the true variability inherent in the measurement process or the environment.

Following exploratory data analyses and any required focused validation, the DQA process will determine the validity of

- removing questionable results from the data set,
- correcting incorrect data, or
- leaving the data set unaltered.

Any changes made to the data set must be fully documented.

The remainder of the DQA process is intended to reconcile the data with the requirements specified in the SAP, and to assess the adequacy of the data to support the SAP objectives. The DQA process addresses the questions "Did we get what we asked for?" and "Did we ask for what we need?" How this is done depends in part on how quantitatively the original requirements were formulated.

To assess the adequacy of the sampling design to support a decision (e.g. "Did we ask for what we need?"), the data analyst must work with other members of the DQA team to determine if the number and types of samples, as specified in the SAP and as actually collected, were appropriate. This includes

- determining if the number and location of samples required by the SAP were taken;
- determining if the appropriate media were sampled;

- judging the adequacy of the sample number and locations, given the updated understanding of the problem; and
- determining if the understanding of the problem changed since the SAP was prepared because of observations made by the field team.

While problems on one or more of the above do not automatically rule out using the data as planned, they can suggest that supplemental data must be collected before proceeding.

In some cases, the correct decision will be obvious by inspection of the data set; for example, when reported values are far above or are uniformly below SALs. Provided that the sampling design was adequate to support this obvious decision, the evaluation of data adequacy for that decision may terminate after the initial exploratory analysis, and the site should move forward in the decision-making process.

If the decision is not obvious, either because the data do not all point in the same direction, or because of some minor problem with the design, or if the SAP specifies that the decision will be based on the results of certain statistical tests or calculations (e.g., on upper confidence bounds for certain population parameters), further examination of the analytical data is required. Qualitative evaluation of the analytical and field data will determine if

- analytical measurements for all variables specified in the SAP were generated;
- the appropriate suite(s) of analytes were requested, given the updated understanding of the problem;
- the analytical methods used were appropriate for the analytes of interest (e.g., inductively coupled plasma atomic emission spectrometry (ICPAES) is typically considered inappropriate for measuring thallium concentrations in soil);
- the detection or quantitation limits reported for "nondetects" were less than or equal to the decision levels specified in the SAP;
- measurement performance requirements (precision and bias) specified in the SAP were met; and
- data collected at different times are consistent between sampling events and between sample request/report numbers.

Beyond these qualitative evaluations, the ER Project will use the elements of the DQA process defined by EPA (EPA 1995, 52289) that are relevant to data use, or its equivalent, to assess data adequacy to support a statistically based decision. This process focuses on the adequacy of the data set for decision-making, rather than the integrity of individual measurements. The EPA DQA process assumes that a statistical approach to sampling and analysis was taken, and that the basis for this design (such as the outputs of EPA's DQO process (EPA 1994, 50288) was either recorded in the SAP or can be developed retrospectively. The first two steps of this formal DQA process, review of the sampling design and preliminary data review, are as described above. The remaining three steps are summarized below.

- The data analyst will work with the DQA team to ensure that the most appropriate statistical test will be used. (If the DQO process was followed, then a statistical test was specified in the SAP. However, additional or alternate tests may be considered at this time, particularly if the understanding of the problem has been updated.) Then the underlying assumptions that must hold for the proposed statistical procedures will be evaluated for this data set. In addition, the data analyst will consult with the appropriate scientists and site experts to make sure that the comparisons implied by the statistical test are appropriate from a scientific standpoint.

- In general, the data analyst will use the site data to generate estimates of total study error and to perform the appropriate statistical tests at a significance level consistent with the decision-makers' desire to control decision errors. (Again, if the DQO process was followed, then these limits on decision errors were among its outputs.) In cases where the data set will be used to support a no further action (NFA) proposal or some other specified decision outcome, the data analyst should evaluate the confidence associated with this decision outcome and determine if the data are sufficient to support the decision in that case.

- If an adequate level of confidence was achieved at the contaminant concentrations actually observed, this observation supports the case that data are sufficient to support the proposed decision.

Results of DQA will be documented in adequate detail for the decision-maker and peer reviewers to evaluate the effect of these results on decision-making. If a decision can be made based on the data, the documentation will include both the decision outcome and also the level of confidence that can be ascribed to the decision. The data analyst and other members of the DQA team will develop recommendations in cases where the data are not deemed sufficient to support a decision, which may be included in the documentation or presented to the decision-makers in a less formal manner. If further investigations appear to be required, the data analyst will summarize information contained in the existing data as it applies to the design of subsequent SAPs for this site. As appropriate, the DQA team may recommend that limitations be placed on current or future uses of the data.

1.0 OVERVIEW

The ER Project is part of the LANL Environmental Management Program. The ER Project is led by a project management team consisting of the ER Project Manager, a Regulatory Compliance Manager, a Project Consistency Manager, six FPLs, and a Field Support Facility Leader. A Project Planning and Control (PP&C) Manager, Project Documentation Leader, and a QAO also support the ER Project (Figure I-1). Project-wide responsibilities, lines of communication, and the organizational structure are divided into functional areas as described below.

1.1 ER Project Manager

The ER Project Manager has overall responsibility for organizing, controlling, coordinating, and directing all ER Project operations. He is the final authority for

- identifying overall project objectives such as identifying which sites require investigation/ remediation and decommissioning,
- ensuring that all operations are conducted in a safe manner and in accordance with applicable requirements as set forth in the LANL ER QMP,
- reviewing and approving site investigation reports, and
- allocating funding for ER Project operations.

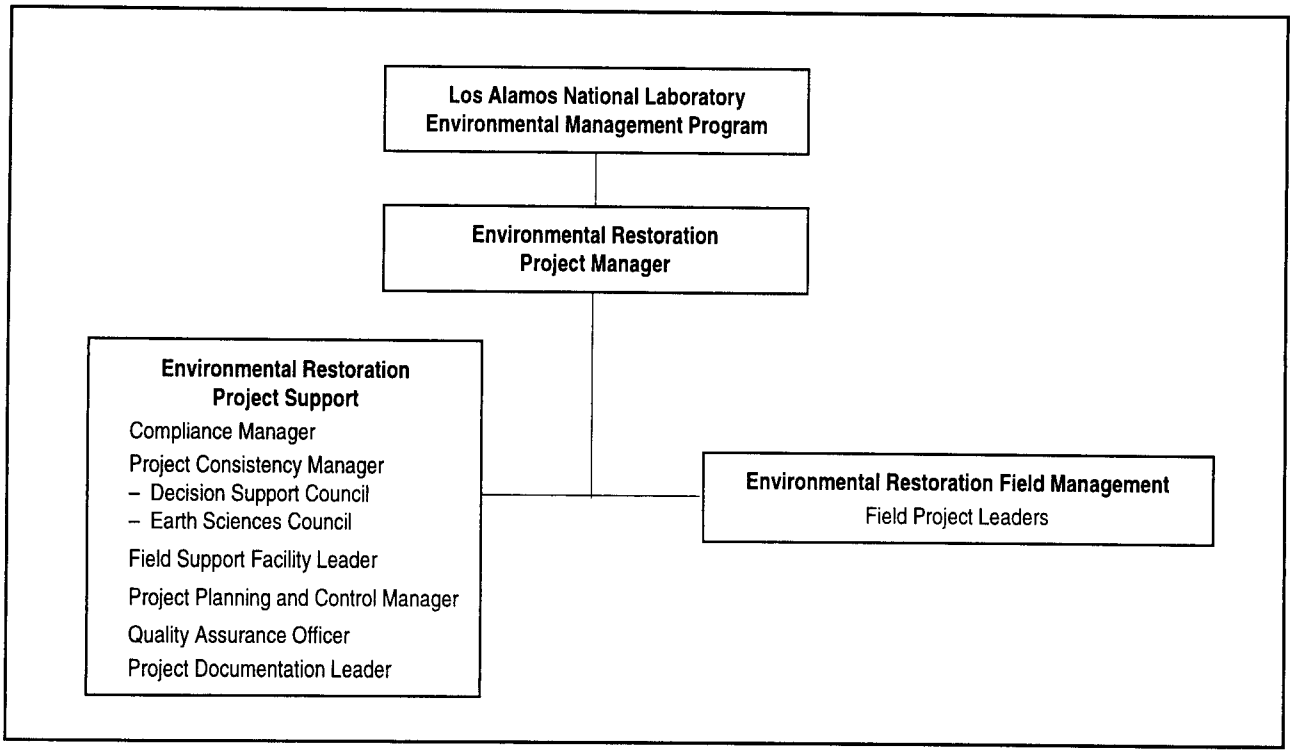

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Figure I-1. Project organizational structure for the Environmental Restoration Project.

1.2 ER Project Field Management

The six FPLs and their teams make up the ER Project field management functional area. The project leaders report directly to the ER Project Manager. They are responsible for

- identifying ER Project team members for their respective field units;
- identifying and defining site-specific ER Project objectives and project quality objectives, e.g., data quality objectives (DQOs);
- scheduling project activities;
- coordinating with ER Project and contractor personnel to ensure availability of resources;
- developing and implementing site-specific planning documents such as SAPs, RFI work plans, accelerated cleanup plans, CMS/CMI plans, and decommissioning plans to achieve project objectives, developing RFI reports, develop decommissioning reports, responding to any notices of deficiency; and preparing and reviewing reports on the implementation of the above activities;
- communicating with regulators on SAP issues to gain acceptance of the regulator regarding the approach to problem solving and the outcome of the problem solving process;
- organizing, coordinating, controlling, and directing contractors and ER Project team members to meet ER Project objectives;
- defining/specifying quality requirements for materials and services purchased for field unit operations;
- implementing corrective actions to reconcile identified deficiencies with ER Project and regulatory requirements;
- identifying training opportunities and requirements for ER Project and contractor personnel; and
- implementing this document and other applicable documents, policies, orders, etc., as set forth in the LANL ER QMP.

Each of these project leaders have teams (contractor and LANL employees) that assist them in developing appropriate work plans, implementing the work plans, reviewing data, making decisions, and reporting on the results of their activities.

1.3 ER Project Support

The ER Project Compliance Manager, Project Consistency Manager, Field Support Facility Leader, PPC Manager, Project Documentation Leader, and their teams make up the ER Project support functional area. These managers and leaders report directly to the ER Project Manager. They are responsible for providing technical and administrative support to the ER Project leaders and each other, and for implementing the LANL ER QMP and this document.

1.3.1 Regulatory Compliance Manager

This manager is the primary interface with the State of New Mexico, the EPA, and regulatory agencies, as appropriate. The Compliance Manager

- provides technical support to the FPLs on regulatory issues;
- is responsible for initiating permit modifications based on results of ER Project activities;
- provides technical support to the Field Support Facility and FPLs concerning waste management issues;
- is responsible for managing site closure activities for the ER Project; and
- is responsible for implementing this document and other applicable documents, policies, orders, etc., as set forth in the LANL ER QMP.

1.3.2 Project Consistency Manager

The Project Consistency Manager

- has primary responsibility for promoting consistency throughout ER Project activities;
- is responsible for the development and revisions of ER Project procedures, policies, etc.;
- is assisted in the above task by the DSC, ESC, and the resources available to the ER Project through LANL, DOE, and contractor personnel; and
- is responsible for implementing this document and other applicable documents, policies, orders, etc., as set forth in the LANL ER QMP.

1.3.3 Field Support Facility Project Leader

The Field Support Facility Project Leader

- is responsible for operating the ER Field Support Facility and supporting ER Project activities;
- manages the packaging, shipping, and tracking of samples to analytical laboratories;
- establishes and administrates contracts with analytical laboratories for performing analysis of ER Project samples;
- manages the ER Project's electronic data management system;
- manages contracts drilling and coring activities;
- manages the mobile analytical facilities (radiological and chemistry vans);
- identifies the costs of these field support functions for use by the FPLs in their budgeting and planning functions; and
- implements this document and other applicable documents, policies, orders, etc., as set forth in the LANL ER QMP.

1.3.4 Project Planning and Control Manager

The PP&C Manager

- provides planning and control system support to the ER Project;
- integrates information from the field units on an ER Project-wide basis to support the development of the ER Project baseline schedule and budget activity data sheets (ADSs), and reports to the ER Project Manager and DOE;
- provides critical path analyses, what-if scenarios and operational load leveling to ER Project management; and
- maintains a master index of records generated by the ER Project.

Each field unit team includes a PP&C specialist. These specialists coordinate through the PP&C Manager to ensure consistency in level of detail, unit costs, etc.

1.3.5 ER Project Documentation Leader

The ER Project Documentation Leader supports the ER Project by managing the RPF and functions. This task includes

- processing hardcopy records of ER Project activities to the LANL central records facility,
- making records available to the public as part of the ER Project administrative record,
- distributing documents (including controlled documents), and
- preparing documents and retrieving documents in support of ER Project activities.

1.4 ER Project Quality Assurance Officer

The ER Project QAO reports to the ER Project Manager and provides support to the ER Project management team. The QAO is responsible for

- identifying ER Project QA requirements;
- advising ER Project management on QA matters;
- developing, reviewing, and approving the ER Project QMP and other applicable quality assurance/control/assessment documents; and
- assessing the effectiveness of the ER Project's implementation of applicable governing documents and regulations such as the HSWA Permit, the LANL ER QMP, and the LANL ER QAPP, by
  - performing assessment and oversight of ER Project activities,
  - implementing the analytical laboratory oversight functions (including laboratory qualification and performance monitoring),
  - reporting quality problems to the appropriate level manager and requesting the implementation of corrective actions, and
  - tracking corrective actions to completion.

1.0 INTRODUCTION

The objective of environmental sampling is to obtain samples of material that represent a particular population about which information is needed. The population could be a geographical area, the collection of waste material in one or more containers, a stream of fluid, etc. Decisions concerning the possibility of taking NFA or of having to remediate a site will be based on the data derived from analysis of the collected samples. If the samples do not reflect the true contaminant distribution of the site, environmental problems could go unaddressed or a great deal of effort might be expended in unnecessary site remediation.

Contaminants of potential concern (COPCs) must be identified, and sampling locations and depths must be identified, prior to selecting the devices or methods for collecting the samples. The sample collection methods and tools are then selected to satisfy the investigation's quality objectives.

2.0 FACTORS AFFECTING SAMPLING TOOL SELECTION AND SAMPLE HANDLING

Most of the environmental samples collected at LANL are soils. However, liquids are sampled occasionally, and when it is necessary to establish the presence or distribution of permeable layers, or to establish stratigraphic control, continuous coring may be necessary. Those items that must be identified before sampling methodology can be selected are addressed below.

1. *The Intended Use of the Data, i.e., Objectives of the SAP.* These might include

    - providing input such as contaminant location, variability, and site contaminant concentration profiles for future SAP design;
    - determining whether contaminants are present above predetermined action levels such as SALs;
    - providing information for selecting remediation alternatives;
    - determining the volume and location of media that must be removed or treated to achieve cleanup levels; and
    - verifying attainment of cleanup levels.

    Involving the correct personnel to develop SAPs is essential to success of the investigation. This selection will usually mean that at least one statistician will be involved at the outset of planning. Where soils are to be collected and analyzed, subject matter experts representing the disciplines of soil science, geology, geochemistry, hydrology, risk assessment, and analytical chemistry should also be involved, as necessary. The responsible FPL should be involved; the public and the regulators should be included as necessary.

    When evaluating the problem to be resolved and identifying associated contaminants, not only should the primary LANL process at the site be considered but also those processes that are related. For example, HE casting and milling operations would leave a potential legacy of HE contaminants. However, the milling machines must have been lubricated periodically, and spilled lubricants might have been cleaned up with degreasing (i.e., chlorinated organic) solvents, thus creating a potential legacy of petroleum hydrocarbons and chlorinated organics as well as the HE. Outputs of the planning process should include estimates of the tolerable decision errors. Factoring into the decision error are limits that should be established for tolerable sampling and measurement error.

2. *The Types of Samples to be Collected.* Grab samples are discrete samples taken at a single location and depth or single point in time. Grab samples may be collected to establish the distribution of contaminants over a site. They are also useful for monitoring changes in contaminant concentrations over time and pinpointing single spots of high contaminant concentration (i.e., hot spots).

Composite samples, which are mixtures of individual grab samples or portions of samples, are useful for obtaining an estimate of average contaminant concentrations over a given space and time at relatively low cost. However, compositing has a tendency to effect dilution of contaminants by mixing samples of higher concentration with samples of lower concentration. As a result, composite sampling is not appropriate for identifying hot spots or when concentrations approach the detection limit of the analytical method.

Integrated samples are collected by accumulating, either continuously or discretely, portions of the medium being sampled. They provide average concentration values over a discrete time interval and the sampling devices can often be programmed for automatic sample acquisition. Integrated samples are typically collected from liquid and air media only.

3. *The Geographical Locations (Flat Area, Hillside, Stream Bed, etc.) of the sampling points.* These will be affected by the intent of the SAP and the ability to collect samples in the desired locations.

4. *The Sampling Point Coordinates.* Each sample collected must be linked to four coordinates: the three spatial coordinates (*x, y* and *z*), and the time of collection.

5. *The Nature of the Material to be Sampled (Tuff, Soil, Sediment, Sludge, Water, Air, Stack Gases, etc.).* The material to be sampled will be determined by expectations associated with contaminant deposition and transport mechanisms and will influence the choice of sample collection tools and methods. For example, collection of sandy (i.e., noncohesive) soils requires methodology that prevents sample losses from the collection tool between the point of collection until it is safely containerized. Guidance on the selection of sample collection tools for various types of samples and types/conditions of media to be sampled are presented in Section 3.0 of this appendix. An experienced field team member should be consulted when selecting sampling tools and a thorough inspection of the site should be made before or during SAP development so the nature of the media being sampled can be appropriately identified. This might require the input of a geologist, hydrologist, etc., to accurately characterize the media to be sampled.

6. *The Analyses to be Performed on the Collected Samples (Determined by SAP Objective(s)).* Sample handling, storage, and transport can significantly affect the integrity of the samples. Collection of samples for volatile analyses requires that the sample be agitated as little as possible and the sample containers be filled as much as possible to minimize the headspace volume. Grab samples are the preferred sample type when determining volatile analytes or radionuclides, because volatiles can be lost through compositing or integration, and radionuclides (e.g., Pu) are often distributed as particulates. Semivolatiles, pesticides, polychlorinated biphenyl (PCBs), TPH, metals, and radionuclides are generally not subject to loss through volatilization, and therefore are not subject to the gentle handling constraints associated with the volatiles.

   Enough sample must be collected to provide sufficient material for completing all of the required analyses. This amount can be determined easily by consulting the chosen analytical methods, reviewing past experiences, consulting the appropriate LANL ER SOP, or consulting a member of the SMO or DSC Chemistry Team. Coordination with the SMO can be especially important if a particular sample type is being collected for the first time or a particular suite of analytes is to be determined for the first time. It is usually best to collect more sample than necessary for the required analyses in the event that an analysis of the sample must be repeated.

   If a sample requires special handling, it is advisable to record on the chain-of-custody form accompanying the sample, and on the analytical order, all special handling requirements. For example, if stones, vegetable matter, other debris, etc., should be excluded from the analyses, a note to that effect should accompany the sample.

7. *The Preservatives and Containers Used to Store the Samples (Dictated by the Analytes to be Determined and the Analytical Protocol).* Many analytes tend to adsorb to the inside walls of their containers. This causes an apparent loss of analyte because the adsorbed analytes may not be transferred during sample

preparation with the rest of the sample. Even worse, the loss of analyte may not be apparent at all. Conversely, contaminants can leach into the sample from the containers, especially if liquid is present in the sample. Thus, the choice of container can be critical to obtaining accurate analytical results. Chemical preservatives can retard or prevent the plating of contaminants onto container walls. The choice of container closure (i.e., lid, cap, etc.) is also important, as the glues used to fasten liners into the closures can release contaminants into the sample. When standard analytical protocols are used, containers and preservatives are generally dictated by the analytical protocols. In cases where sample preservation conditions are not specified for a particular analysis, an experienced chemist should be consulted for advice. LANL-ER-SOP-01.02 also provides guidance for the preservation and containerization of samples.

8. *Sample Holding Times, Storage, and Shipping.* Because loss of analytes from sample degradation is a common problem, it is important not to store a sample for too long a period before it is analyzed. The acceptable storage period (i.e., holding time) is a function of the analytes of interest, the sample matrix, and the storage conditions. Most degradation rates are greatest soon after sample collection and decrease over time. However, biodegradation rates can increase with time as microorganisms increase in number.

   If a sacrifice in sensitivity is acceptable for volatile organic contaminants/compounds (VOCs), the methanol extraction (NMED circa 1994, ER ID number 52243) may be used to extract the analytes from the sample matrix on-site. The advantage of this on-site extraction technique is that the extract submitted for analysis is more stable than the original sample with regard to analyte loss. Water samples to be submitted for VOC analyses must be preserved with acid (e.g., sodium bisulfate or hydrochloric acid) upon collection.

   Light-sensitive analytes must be stored in dark-colored containers or in the dark to prevent photodegradation. Volatile organic compounds are easily lost through agitation or mixing of samples and can be lost readily when the seal between the sample container and its closure is not air-tight. It is therefore extremely important to ensure that the screw threads on sample containers and corresponding caps are free of debris before the samples are sealed in the containers. All soil samples collected for HE analyses should be frozen to prevent degradation. Freezing can be effected by adding dry ice to the sample cooler. Chemical oxidation/reduction of analytes in a sample can be minimized by protection from atmospheric oxygen and by adding chemical preservatives. While sample preservation protocols typically require adding a predetermined amount of preservative to a sample, it is not the *amount* of added preservative that is important so much as the *condition* that the added preservative is expected to create and sustain within the sample until the sample is analyzed. If insufficient preservative is added, the preservative might be consumed before the sample is analyzed.

   Standard analytical methods typically specify sample preservation and storage conditions and will serve as guidance for sample preservation and storage for other analytical methods. If using analytical methods that do not specify sample preservation and storage conditions, it is important to ensure that the selected preservatives do not interfere with the analysis. Consult LANL-ER-SOP-1.02 for specific holding times related to various analyses. Where storage conditions are not specified, the DSC Chemistry Team should be consulted.

9. *Sample Collection Costs and Time.* Estimates of sampling costs will be affected by the time projected for sampling, the number of personnel involved in the sampling effort, the number of samples to be collected, the costs of training the sampling personnel, costs for equipment rental/purchase (e.g., drill rigs), and costs devoted to packaging and shipping samples. Time schedules can be affected significantly by the availability of equipment and weather. Equipment availability may be a more significant issue for large items such as drill rigs, for which availability could be limited during peak sampling season. Failure to achieve quality standards or to satisfy DQOs is not an acceptable consequence of reducing costs.

10. *Waste Minimization.* Sampling plan implementation results in the generation of sampling waste such as discarded environmental materials, decontamination fluids, and used disposable sampling equipment. These and other wastes generated during sampling must be managed in accordance with LANL-ER-AP-5.3, and minimized in accordance with LANL-AR-10-8.

3.0 THE SAMPLE COLLECTION METHOD SELECTION PROCESS

After considering the above aspects of sample collection/storage and shipping, the sampling equipment and sampling methodology may be selected, consistent with SAP objectives, etc. This selection requires that the collected samples are representative of the medium being sampled and that they be collected and handled in a manner that preserves their integrity. The sample collection methods must be chosen to obtain those samples that best represent the media of interest.

The selection of sample collection methods and sampling apparatus will depend primarily on the nature of the medium to be sampled, the analyses to be performed on the sample, the type of sample to be collected (i.e., grab or composite), the sampling depth, the sampling costs, and availability of sampling equipment. LANL-ER-SOPs 01.01 through 01.04 present requirements and guidance for sample collection, preservation, packaging, transportation, and storage. The discussions below provide a summary of the conditions for which selected sampling tools are most appropriate.

1. *Soil and Sediment Sampling.* Table II-1 presents those sampling tools most useful for collecting environmental soil and sediment samples. For ephemeral streams these methods are suitable for sampling stream beds in the absence of water; when the stream bed is under water, refer to Table II-2 or II-3.

   Augers are especially suited to collecting composite samples because the augering action homogenizes the soil, whereas they are not useful for collecting samples for volatile analyses because the augering action causes loss of volatiles. Augers are not recommended for collecting cohesionless soil samples as the sample may not be retained when the auger is removed from the ground. The open tube sampler is recommended for collecting samples that are to be characterized lithologically. Scoops are useful only for collecting surface grab samples, which may then be composited either at the sampling site or in a laboratory. They are not recommended for collecting volatiles because the act of scooping and pouring the samples into a container can cause loss of volatiles. Thin-walled tube samplers can be used with or without sample liners to collect core samples. When used with a stainless steel or brass liner, the liner can be easily sealed with end caps after sample collection and submitted for volatiles analyses. If a clear plastic liner is used, lithologic descriptions of the core can be obtained. The thin walled tube sampler, because it is pushed into the ground hydraulically rather than being tamped or hammered into the ground, does not compact the soil. It is thus well suited to the determination of geotechnical parameters such as porosity, hydraulic conductivity, grain size distributions, and Atterberg limits. For soil sampling at depths greater than 5 ft., mechanical drivers such as auger drill rigs are typically used to push the sampling tool into the ground.

   Table II-2 presents sampling tools useful for sampling drainage sediment from flowing rivers, streams, and surface water drainage. If the flowing water source is dry at the time of sampling, the sampler should refer to Table I-1 for soil sampling methods.

   Sediment sampling may be used to determine if contaminants are migrating downstream of the potential contaminant source. Samples should be taken from those areas such as ponds and low-lying ponding areas in which contaminants can accumulate during periods of flow. If background samples are needed, they should generally be taken from upstream of the potential contaminant source.

   Use of dippers and scoops should be confined to shallow waters of low flow rates. The dipper may be more effective than the scoop at retrieving fine grained sediments, but due to the lack of a good cutting edge its use is generally limited to soft sediment.

   The methods most appropriate for sampling sediments in standing water include the scoop, dipper, and box and dredge samplers. All of these except the dredge sampler are most useful in shallow water. The box and dredge samplers used with a wire line can be used in deep water. Table II-3 is a tabulation of likely applications of these sampling tools.

TABLE II-1

RECOMMENDED USES FOR SOIL SAMPLING TOOLS

	Analyses				
Sampling Tool	**Volatiles**	**Non-volatiles[1]**	**Sample Type[2]**	**Approximate Sampling Depth**	**Applicable ER SOP**
Hand Auger	No	All except geotechnical	AC,VC	0 to 5.0 ft.	06.10 06.18
Open Tube (Trier)	No	No	Lithology	0 to 5.0 ft.	06.17
Ring Sampler	Yes[3]	Yes	Gra, AC	0 to 0.7 ft.	06.11
Scoop (Spade and Scoop)	Yes[3]	All except geotechnical	Grab, AC	0 to 0.5 ft.	06.09
Split Spoon	Yes	Yes	Grab, AC, VC,	0 to 2 ft.	06.24
Split Tube (Core Barrel)	No	All except geotechnical	Grab, VC, Lithology	0.5 to 5.0 ft.; >5 ft. with mechanical driver	06.26
Split Tube with SS[4] liner (Core Barrel)	Yes	All except geotechnical	Grab, VC,	0.5 to 5.0 ft.; >5 ft. with mechanical driver	06.26
Thin-Walled Tube[5]	Yes	All	Grab	0.5 to 5.0 ft.; >5 ft. with mechanical driver	06.10

1 Includes geotechnical parameters, herbicides, metals, PCBs, pesticides, radionuclides, semivolatile organics, and total petroleum hydrocarbons.
2 Grab = grab sample; AC = areal composite sample; VC = vertical composite sample; Lithology = lithology description
3 Can be used to collect samples for volatiles analyses, but is not recommended for this use.
4 SS = stainless steel
5 SS sampler recommended for collecting samples to be analyzed for chemical or radiological contaminants.

TABLE II-2

SOIL SAMPLING TOOLS USEFUL FOR SAMPLING IN FLOWING WATER

	Analyses				
Sampling Tool	**Volatiles**	**Non-volatiles[1]**	**Sample Type[2]**	**Approximate Sampling Depth**	**Applicable ER SOP**
Dredge Sampler (Ponar Grab)	Yes[3]	All except geotechnical	Grab, AC, Lithology	0 to 0.5 ft.	06.14
Gravity Corer	Yes	Yes	Grab, AC, VC, Lithology	0 to 3 ft.	06.14
Hand Corer	Yes	Yes	Grab, AC, VC, Lithology	0 to 3 ft.	06.14
Scoop/Trowel	Yes[3]	Yes[3]	Grab, AC	0 to 0.5 ft.	06.14

1 Includes geotechnical parameters, herbicides, metals, PCBs, pesticides, radionuclides, semivolatile organics, and total petroleum hydrocarbons.
2 Grab = grab sample; AC = areal composite sample; VC = vertical composite sample; Lithology = lithology description
3 Can be used to collect samples for these analyses, but is not recommended for this use.

TABLE II-3

SOIL SAMPLING TOOLS USEFUL FOR SAMPLING IN STANDING WATER

	Analyses				
Sampling Tool	**Volatiles**	**Non-volatiles [1]**	**Sample Type[2]**	**Approximate Sampling Depth**	**Applicable ER SOP**
Dredge Sampler (Ponar Grab)	Yes[3]	All except geotechnical	Grab; AC; Lithology	0 to 0.5 ft.	06.14
Gravity Corer	Yes	Yes	Grab; AC; VC; Lithology	0 to 3 ft.	06.14
Hand Corer	Yes	Yes	Grab; AC; VC; Lithology	0 to 3 ft.	06.14
Scoop/Trowel	Yes[3]	Yes[3]	Grab; AC	0 to 0.5 ft.	06.14

1 Includes geotechnical parameters, herbicides, metals, PCBs, pesticides, radionuclides, semivolatile organics, and total petroleum hydrocarbons.
2 Grab = grab sample; AC = areal composite sample; VC = vertical composite sample; Lithology = lithology description
3 Can be used to collect samples for these analyses, but is not recommended for this use.

2. *Water Sampling.* Table II-4 presents sampling methods useful for collecting samples from streams, rivers, and drainage flows. The bottle submersion approach is the simplest, requiring that a bottle attached to an extendible arm be submerged below the water surface until it is full. The subsurface filling of the bottle prevents the loss of volatiles. If samples are to be composited after collection, volatiles analyses should not be performed on the composited sample because of the great potential for loss of analytes during compositing. All but the dipper method are useful for collecting composite samples. The dipper method should only be used for collecting samples that will not have volatile organic analyses performed on them.

   Sampling of standing surface water (see Table II-5) should be conducted based on the SAP requirements which should include a consideration of suspected contaminant concentrations and natures of the COPCs. For example, if dense organics that are immiscible with water are to be sampled, those contaminants are most likely to be found at the bottom of the body of water. However, water-immiscible COPCs that are less dense than water are most likely to be found at the surface.

   Groundwater might be sampled using a pump to bring the water to the surface and into a sample collection container or it might be sampled using a container that is lowered into a groundwater monitoring well. In the case of vacuum lysimeters which are useful for collecting soil water in the vadose zone, a porous cup is buried beneath the ground surface and the surrounding water is pushed into the cup under a pressure differential. Table II-6 presents various sampling tools used at LANL that are appropriate for groundwater.

3. *Container Sampling.* This section addresses sample collection from drums, tanks, and bags. Sampling of closed drums can be dangerous, depending on the drum contents. When the contents are unknown, remote mechanical devices made of "nonsparking" materials can be used to pierce the top of the drum prior to sampling to allow combustible vapors to escape safely. See Table II-7.

   The hand auger is recommended for sampling soils from drums when toxicity characteristic leaching procedures (TCLP) or radionuclide testing will be performed. Compositing is also recommended except when collecting samples for volatile organic analytes. The auger is especially effective for collecting composite samples because the augering action tends to homogenize the samples.

4. *Air Sampling.* Air canisters such as SUMMA canisters can be used to collect relatively large volumes of gases for subsequent analyses. Air and exhaust gases can be trapped on a sorbent and later released from the sorbent material for analysis. The volatile organic sampling train (VOST) can be used to collect volatile organic contaminants with boiling points less than 100 °C. See Table II-8.

TABLE II-4

TOOLS USEFUL FOR SAMPLING FLOWING SURFACE WATER

	Analyses				
Sampling Tool	**Volatiles**	**Non-volatiles [1]**	**Sample Type[2]**	**Approximate Sampling Depth**	**Applicable ER SOP**
Bottle Submersion	Yes	Yes	Grab, AC, I	0 to 0.5 ft.	06.13
Dipper	No	Yes	Grab, AC, I	0 to 0.5 ft.	06.13
Extendible Bottle Sampler	Yes[3]	Yes	Grab, AC, I, VC	0.5 to 5.0 ft.	06.13
Extendible Tube Sampler	Yes[3]	Yes	Grab, AC; I; VC	0.5 to 5.0 ft.	06.13
Single Stage Sampler	No	Yes	Grab	Surface	06.29
Peristaltic Pump	Yes	Yes	Grab, AC; I; V	0.5 to 5.0 ft.	06.13

1 Includes herbicides, metals, PCBs, pesticides, radionuclides, semivolatile organics, and total petroleum hydrocarbons.
2 Grab = grab sample; AC = areal composite sample; I = integrated sample; VC = vertical composite sample
3 Can be used to collect samples for these analyses, but is not recommended for this use.

TABLE II-5

SAMPLING TOOLS USEFUL FOR SAMPLING STANDING SURFACE WATER

	Analyses				
Sampling Tool	**Volatiles**	**Non-volatiles [1]**	**Sample Type[2]**	**Approximate Sampling Depth**	**Applicable ER SOP**
Bottle Submersion	Yes	Yes	Grab, AC, I	0 to 0.5 ft.	06.13
Dipper	No	Yes	Grab, AC, I	0 to 0.5 ft.	06.13
Extendible Bottle Sampler	Yes[3]	Yes	Grab, AC, I, VC	0.5 to 5.0 ft.	06.13
Extendible Tube Sampler	Yes[3]	Yes	Grab, AC, I, VC	0.5 to 5.0 ft.	06.13
Kemmerer Bottle Sampler	Yes[3]	Yes	Grab, AC, I, VC	0.5 to >5 ft.[4]	06.13
Peristaltic Pump	Yes[3]	Yes	Grab, AC, I, V	0.5 to 5.0 ft.	06.13

1 Includes herbicides, metals, PCBs, pesticides, radionuclides, semivolatile organics, and total petroleum hydrocarbons.
2 Grab = grab sample; AC = areal composite sample; I = integrated sample; VC = vertical composite sample
3 Can be used to collect samples for these analyses, but is not recommended for this use.
4 Most appropriate at depths greater than 5 ft.

TABLE II-6

TOOLS USEFUL FOR SAMPLING GROUNDWATER AND SOIL WATER

	Analyses				
Sampling Tool	**Volatiles**	**Non-volatiles [1]**	**Sample Type[2]**	**Approximate Sampling Depth**	**Applicable ER SOP**
Bailer	Yes[3]	Yes	Grab, I[4]	0 to 30 ft.[5]	06.03
Bladder Pump	Yes	Yes	Grab, I, VC[4]	0 to >30 ft.	06.03
Vacuum Lysimeter[6]	Yes	Yes	Grab, I	0 to 6 ft.	06.05
Pressure-Vacuum[6] Lysimeter	Yes	Yes	Grab, I	0 to 50 ft.	06.05
High Pressure-Vacuum Lysimeter[6]	Yes	Yes	Grab, I	0 to >50 ft.	06.05
Piston Pump	Yes[3]	Yes	Grab, I, VC[4]	0 to >30 ft.	06.03
Submersible Pump	Yes[3]	Yes	Grab, I, VC[4]	0 to >30 ft.	06.03
Syringe Sampler	Yes	Yes	Grab	0 to >30 ft.	06.03

1 Includes herbicides, metals, PCBs, pesticides, radionuclides, semivolatile organics, and total petroleum hydrocarbons.
2 Grab = grab sample; AC = areal composite sample; I = integrated sample; VC = vertical composite sample
3 Can be used to collect samples for these analyses, but is not recommended for this use.
4 Acceptable, but not the preferred application.
5 Can be used at depths greater than 30 ft., though the preferred depth is less than 30 ft.
6 Not recommended for clay soils.

TABLE II-7

TOOLS USEFUL FOR SAMPLING CONTAINER CONTENTS

		Analyses			
Sampling Tool	**Nature of Sample**	**Volatiles**	**Non-volatiles [1]**	**Sample Type[2]**	**Applicable ER SOP**
Coliwasa Sampler	Sludges, Liquids, Slurries	Yes[3]	Yes	Grab, I[4]	06.15
Hand Auger	Soils	No	Yes	AC, VC	06.18
Open Tube (Trier)	No	No	Lithology	0 to 5.0 ft.	06.17
Thin-walled Tube Sampler with SS[5] liner	Soils	Yes	Yes	Grab	06.10
Thief Sampler	Dry Powders or Granules	No	Yes	Grab	06.16
Weighted Bottle	Liquids and Slurries in Tanks	Yes[3]	Yes	Grab, VC	06.19

1 Includes herbicides metals, PCBs, pesticides, radionuclides, semivolatile organics, and total petroleum hydrocarbons.
2 Grab = grab sample; AC = areal composite sample; I = integrated sample; VC = vertical composite sample.
3 Contents of sampler should be transferred carefully to sample container to minimize loss of volatiles.
4 Acceptable, but not the preferred application.
5 SS = stainless steel.

TABLE II-8

TOOLS USEFUL FOR SAMPLING AMBIENT AIR AND EXHAUST STACKS

		Analyses			
Sampling Tool	**Nature of Sample**	**Volatiles**	**Non-volatiles [1]**	**Sample Type[2]**	**Applicable ER SOP**
Canister	Air or exhaust	Yes[3]	No	Grab, I	06.22
Filter	Air or Exhaust	No	Yes	I	06.25
Volatile Organic Sampling Train	Air or Exhaust	Yes	No	I	06.21

1 Includes herbicides, metals, PCBs, pesticides, radionuclides, semivolatile organics, and total petroleum hydrocarbons.
2 Grab = grab sample; I = integrated sample
3 Not recommended for polar, highly water-soluble compounds such as alcohols, ketones, and acetonitrile.

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1.0 INTRODUCTION

Tabulated in this appendix are the analyses and related information provided through the LANL analytical laboratory contracts Statement of Work (LANL 1995, 49738). Section 2 lists, for RAS, estimated detection limits (EDLs) for inorganic analytes, and estimated quantitation limits (EQLs) for organic, HE and radiochemical analytes. Section 3 lists data for NRAS.

EDLs are based on the Contract Laboratory Program "Contract Required Detection Limits (CRDLs)," which are not necessarily achievable in real world samples. EQLs listed for soil/sediment are based on wet sample weight but, normally, data are reported on a dry weight basis, thus causing EQLs higher than those cited for dry weight.

In parts of this appendix, references are made to analytical methods that are approved for quantifying specific analytes or analyte suites, by citing the associated method numbers. Method numbers in this appendix that are preceded by "SW" indicate methods belonging to the SW-846 analytical methods compendium (EPA 1986, 31732).

2.0 ROUTINE ANALYTICAL SERVICES

2.1 Inorganics (Metals and Inorganic Compounds)

2.1.1 Sample Preparation

Following are the sample preparation procedures that are appropriate for use in determining metals. Methods from the most recent version of SW-846 should be used, although CLP sample preparation procedures (from Statement of Work ILM03.0 or more recent) may be used, if appropriate for the matrix.

- SW-3005 Acid digestion of waters for total recoverable or dissolved metals for analysis by flame AAS or ICP;
- SW-3010 Acid digestion of aqueous samples and extracts for total metals for analysis by flame AAS or ICP;
- SW-3020 Acid digestion of aqueous samples and extracts for total metals for analysis by furnace AAS, with the exception of As and Se, which are to be prepared according to methods 7060 and 7740;
- SW-3040 Dissolution procedure for oils, greases or waxes (microwave digestion of these samples is preferred);
- SW-3050 Acid digestion of sediments, sludges, and soils.
- SW-1311 TCLP (note that changes made in the Federal Register, Volume 57, No. 227, p. 55114, must be incorporated); and
- SW-3015 and SW-3051 Microwave digestion procedures.

2.1.2 Target Analyte List and Detection Limits

EDLs are presented in Table III-1. For water samples, the EDLs are based on CLP CRDLs.

Mercury should be determined by the cold vapor technique with the EDL for water = 0.2 µg/L and the EDL for soils = 0.1 mg/kg. The cold vapor technique soil EDL is based upon a 1-gram sample taken to a final volume of 100 mL. This is a TCLP metal and may be requested as a separate determination.

In cases where the EDL for a metal cannot be met using ICPAES, or false positives are suspected to be a problem at a laboratory, the subcontractor must use the GFAA technique (e.g., method SW7841 for thallium and method SW7421 for lead) or ICP-MS technique (e.g. method SW6020).

TCLP metals (identified as footnote 3 in Table III-1) may be requested as a separate determination. Laboratories should consider EDLs for TCLP metals using the TCLP to be the regulatory limits. Method SW-1311 (7/92) is the method to be used for TCLP.

TABLE III-1

DETERMINATION OF METALS

	ICPAES[1]		GFAA or ICP-MS	
Analyte	**Water (µg/L)**	**Soils (mg/kg[2])**	**Water (µg/L)**	**Soils (mg/kg[2])**
Aluminum	200	40		
Antimony	60	12		
Arsenic[3]	NR[4]	NR[4]	10	2
Barium	200	40		
Beryllium	5	1		
Cadmium[3,5]	5	1		
Calcium	5000	1000		
Chromium[3,5]	10	2		
Cobalt	50	10		
Copper	25	5		
Iron	100	20		
Lead[3,5]	3	0.6	1	0.2
Magnesium	5000	1000		
Manganese	15	3		
Nickel	40	8		
Potassium	5000	1000		
Selenium[3]	NR[4]	NR[4]	5	1
Silver[3,5]	10	2		
Sodium	5000	1000		
Thallium	NR[4]	NR[4]	10	2
Vanadium	50	10		
Zinc	20	4		

1. Recommended method for ICPAES analysis is SW6010A.
2. Soil EDLs for ICPAES, GFAA, and ICP-MS analytes are based upon a 1-gram sample taken to a final volume of 200 mL.
3. This is a Toxicity Characteristic Leaching Procedure (TCLP) metal and may be requested as a separate determination. The TCLP regulatory limits are the EDLs for these analytes. Method SW-1311 (7/92) is the method to be used for TCLP.
4. NR = not recommended; analyte should not be determined using this method.
5. Atomic absorption (AA) methods or ICP-MS may also be used for these analytes.

Cyanide may be determined using methods SW9010, SW9010A, SW9012, or EPA 335.2. The EDLs for cyanide are 10 µg/L (water) and 0.05 mg/kg (soils). The soil EDL for CLP ILM03.0 method 335.2 is based upon a 5-gram sample taken to a final volume of 250 mL.

The contractor may vary weights and final volumes for metals and cyanide analyses; however, any allowable variance must still meet the EDL.

2.2 Volatiles

Table III-2 identifies the volatile target analytes and associated EQLs. The US EPA methods that are options for use are method SW8260 (11/90 or more recent) or the CLP method for volatiles (OLM02.0 or more recent, using capillary column). These methods are based on purge and trap sample extraction/concentration followed by gas chromatography/mass spectrometry analysis.

Tentatively identified compounds (TICs) may be requested. If requested, they should be identified and quantitated per the CLP method for volatiles, OLM02.0 (or more recent).

TABLE III-2

VOLATILE TARGET ANALYTES AND EQLs

Target Analyte	Water (µg/L)	Soil/Solids (µg/kg)
Chloromethane	10	10
Vinyl Chloride	10	10
Bromomethane	10	10
Chloroethane	10	10
Acetone	20	20
Dichlorodifluoromethane	10	10
Iodomethane	5	5
Trichlorotrifluoroethane	5	5
Trichlorofluoromethane	5	5
Methylene Chloride	5	5
1,1-Dichloroethene	5	5
Carbon Disulfide	5	5
1,1-Dichloroethane	5	5
1,2-Dichloroethene (total)	10	10
Bromochloromethane	5	5
Chloroform	5	5
1,2-Dichloroethane	5	5
1,1-Dichloropropene	5	5
2-Butanone	20	20
2,2-Dichloropropane	5	5
1,1,1-Trichloroethane	5	5

TABLE III-2 (continued)

VOLATILE TARGET ANALYTES AND EQLs

Target Analyte	Water (mg/L)	Soil/Solids (mg/kg)
Carbon Tetrachloride	5	5
Benzene	5	5
1,2-Dichloropropane	5	5
Trichloroethene	5	5
Dibromomethane	5	5
Bromodichloromethane	5	5
t-1,3-Dichloropropene	5	5
c-1,3-Dichloropropene	5	5
1,1,2-Trichloroethane	5	5
1,3-Dichloropropane	5	5
Chlorodibromomethane	5	5
4-Methyl-2-Pentanone	20	20
Toluene	5	5
2-Hexanone	20	20
1,2-Dibromoethane	5	5
Tetrachloroethene	5	5
Chlorobenzene	5	5
1,1,1,2-Tetrachloroethane	5	5
Ethylbenzene	5	5
o,m,p-Xylene (mixed)	5	5
Styrene	5	5
Bromoform	5	5
1,1,2,2-Tetrachloroethane	5	5
1,2,3-Trichloropropane	5	5
Isopropylbenzene	5	5
Bromobenzene	5	5
n-Propylbenzene	5	5
2-Chlorotoluene	5	5
4-Chlorotoluene	5	5
1,3,5-Trimethylbenzene	5	5
tert-Butlybenzene	5	5
1,2,4-Trimethylbenzene	5	5
sec-Butylbenzene	5	5
1,3-Dichlorobenzene	5	5
1,4-Dichlorobenzene	5	5
p-Isopropyltoluene	5	5
1,2-Dichlorobenzene	5	5
n-Butlybenzene	5	5
1,2-Dibromo-3-Chloropropane	10	10

2.3 Semivolatiles

Table III-3 identifies the semivolatile target analytes and associated EQLs. The US EPA methods that are options for use are method SW-8270 (11/90 or more recent) or the CLP method for semivolatiles (OLM02.0 or more recent). These methods are based on solvent extraction, concentration, and GC/MS detection and quantitation.

TICs may be requested. If requested, they should be identified and quantitated per the CLP method for semivolatiles, OLM02.0 (or more recent).

2.4 Pesticides and Aroclors

Table III-4a identifies the pesticide and aroclor target analytes and associated EQLs. The US EPA methods that are options for use are method SW-8081, *dual column option*, (11/92 or more recent) or the CLP method for pesticides/aroclors (OLM01.8 or more recent). These methods are based on solvent extraction, concentration, and GC/EC detection and quantitation.

Since the EQLs are sensitive to the nature of the sample matrix, Table III-4b presents factors by which the EQLs in Table III-4a are to be multiplied, depending on the matrix.

2.5 High Explosives

Table III-5a presents the HE target analytes for method SW8330 and associated EQLs. For water samples these analytes may be determined using either of the following methods:

- SW8330, or
- US Army Toxic & Hazardous Materials Agency (USATHAMA), 1990, "Improved Salting-Out Solvent Extraction Method for Determination of Low Levels of Nitroaromatics and Nitramines in Groundwater" coupled with the USATHAMA 6/30/88 "Determination of Explosives in Water by High Pressure Liquid Chromatography" (method no. UW14).

For soil samples, the analytes in Table III-5a may be determined using either of the following methods:

- SW8330, or
- USATHAMA, August 1989, "Reversed-Phase Method for the Determination of Explosive Residues in Soil."

Table III-5b lists additional HE analytes that may be determined using USATHAMA analytical methods.

TABLE III-3

SEMIVOLATILE TARGET ANALYTES AND ASSOCIATED EQLs

Target Analyte	Water (µg/L)	Soil/Solids (µg/kg[1])
Acenaphthene	10	330
Acenaphthylene	10	330
Aniline	20	660
Anthracene	10	330
Azobenzene	20	660
Benzo(a)anthracene	10	330
Benzoic acid	50	3300
Benzo(b)fluoranthene	10	330
Benzo(K)fluoranthene	10	330
Benzo(g,h,i)perylene	10	330
Benzo(a)pyrene	10	330
Benzyl alcohol	20	1300
Bis(2-chloroethoxy)methane	10	330
Bis(2-chloroethyl)ether	10	330
4-Bromophenyl phenylether	10	330
Butylbenzylphthalate	10	330
4-Chloroaniline	20	1300
4-Chloro-3-mehtylphenol	20	660
2-Chloronaphthalene	10	330
2-Chlorophenol	10	330
4-Chlorophenyl phenylether	10	330
Chrysene	10	330
Dibenz(a,h)anthracene	10	330
Dibenzofuran	10	330
1,2-Dichlorobenzene	10	330
1,3-Dichlorobenzene	10	330
1,4-Dichlorobenzene	10	330
3,3'-Dichlorobenzidine	20	660
2,4-Dichlorophenol	10	330
Diethylphthalate	10	330
Dimethyl phthalate	10	330
2,4-Dimethylphenol	10	330
2,4-Dinitrophenol	50	1600
Di-n-butylphthalate	10	330
4,6-Dinitro-2-methylphenol	50	1600
2,4-Dinitrotoluene	10	330
2,6-Dinitrotoluene	10	330
Di-n-octyl phthalate	10	330
Bis(2-ethylhexyl)phthalate	10	330

TABLE III-3 (continued)

SEMIVOLATILE TARGET ANALYTES AND ASSOCIATED EQLs

Target Analyte	Water (µg/L)	Soil/Solids (µg/kg[1])
Fluoranthene	10	330
Fluorene	10	330
Hexachlorobenzene	10	660
Hexachlorobutadiene	10	330
Hexachlorocyclopentadiene	10	330
Hexachloroethane	10	330
Indeno(1,2,3-cd)pyrene	10	330
Isophorone	10	330
2-Methylnaphthalene	10	330
2-Methylphenol	10	330
4-Methylphenol	10	330
Naphthalene	10	330
2-Nitroaniline	50	1600
3-Nitroaniline	50	1600
4-Nitroaniline	20	660
Nitrobenzene	10	330
2-Nitrophenol	10	330
4-Nitrophenol	50	1600
N-Nitrosodimethylamine	10	330
N-Nitrosodiphenylamine	10	330
N-Nitroso-di-n-propylamine	10	330
2,2'-oxybis(1-Chloropropane)	10	330
Pentachlorophenol	50	1600
Phenanthrene	10	330
Phenol	10	330
Pyrene	10	330
1,2,4-Trichlorobenzene	10	330
2,4,5-Trichlorophenol	50	1600
2,4,6-Trichlorophenol	10	330

1. EQLs for soil are based on no Gel Permeation Chromatography (GPC) clean-up being performed. The laboratories' GPC equipment will determine what the EQL is, based on the volume of extract the GPC equipment uses. However, if possible, the laboratories should concentrate the GPC extract to a volume that makes the EQL for a sample that underwent GPC clean-up no more than twice the listed EQL.

TABLE III-4a

PESTICIDE/AROCLOR TARGET ANALYTES AND EQLs

Analyte	Water (µg/L) (See also Table III-4b)
Aldrin	0.05
α-BHC	0.05
β-BHC	0.05
δ-BHC	0.05
γ-BHC (Lindane)	0.05
α-Chlordane	0.05
γ-Chlordane	0.05
4,4'-DDD	0.10
4,4'-DDE	0.10
4,4'-DDT	0.10
Dieldrin	0.10
Endosulfan I	0.05
Endosulfan II	0.10
Endosulfan sulfate	0.10
Endrin	0.10
Endrin Ketone	0.10
Endrin Aldehyde	0.10
Heptachlor	0.05
Heptachlor epoxide	0.05
Methoxychlor	0.50
Toxaphene	5.00
Aroclor-1016	1.00
Aroclor-1221	2.00
Aroclor-1232	1.00
Aroclor-1242	1.00
Aroclor-1248	1.00
Aroclor-1254	1.00
Aroclor-1260	1.00

TABLE III-4b

EQL ADJUSTMENT FACTORS FOR VARIOUS SAMPLE MATRICES

Matrix	Factor[1]
Ground Water	1
Low-concentration soil by sonication[2]	33
High-concentration soil and sludges by sonication[2]	1000
Non-water miscible waste	10,000

1. To obtain the matrix-dependent EQL, multiply the EQL in Table III-4a by this factor.
2. This factor is based on no GPC clean-up. The factor will vary for soil samples that undergo GPC, based on the GPC equipment used (volume of extract put through GPC). The laboratories should adjust the final volume of the GPC extract to make this factor no greater than 66, if possible.

TABLE III-5a

NITROAROMATIC AND NITRAMINE HE TARGET ANALYTES AND EQLs

		EQL[1]		
		Waters (µg/L)		Soils (mg/kg)
Target Analyte	Abbreviation	Low Level	High Level	
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine	(HMX)	ND	13.0	2.2
Hexahydro-1,3,5-trinitro-1,3,5-triazine	(RDX)	0.84	14.0	1.0
1,3,5-Trinitrobenzene	(1,3,5-TNB)	0.26	7.3	0.25
1,3-Dinitrobenzene	(1,3-DNB)	0.11	4.0	0.25
Methyl-2,4,6-trinitrophenylnitramine	(Tetryl)	ND	20.0	0.65
Nitrobenzene	(NB)	ND	6.4	0.26
2,4,6-Trinitrotoluene	(2,4,6-TNT)	0.11	6.9	0.25
4-Amino-2,6-dinitrotoluene	(4-Am-DNT)	0.06	ND	ND
2-Amino-4,6-dinitrotoluene	(2-Am-DNT)	0.035	ND	0.26
2,4-Dinitrotoluene	(2,4-DNT)	0.02	5.7	0.25
2,6-Dinitrotoluene	(2,6-DNT)	0.31	9.4	0.26
2-Nitrotoluene	(2-NT)	ND	12.0	0.25
3-Nitrotoluene	(3-NT)	ND	7.9	0.25
4-Nitrotoluene	(4-NT)	ND	8.5	0.25

1. These EQLs apply only to the SW-846 and USATHAMA methods listed above. If "ND" appears in a cell, the EQL has not been determined. In those cases, assume an EQL of 1.0 mg/L for the low level waters and an EQL of 10 mg/L for the high waters where values are missing.

TABLE III-5b

ADDITIONAL HE TARGET ANALYTES AND EQLs

Analyte	Water (µg/L[1])	Soil (mg/kg[1])	Analytical Method
Nitroglycerine	25	0.50	USATHAMA Aug., 1989, Reversed Phase HPLC Method for the Determination of NG and PETN in Water (or Soil, as applicable)
Pentaerythritol Tetranitrate	25	0.50	USATHAMA Aug., 1989, Reversed Phase HPLC Method for the Determination of NG and PETN in Water (or Soil, as applicable)
Nitroguanidine	5.0	0.51	USATHAMA Aug., 1989, Reversed Phase HPLC Method for the Determination of Nitroguanidine in Water (or Soil, as applicable)
Tetrazene	6.11	1.3	USATHAMA Reversed Phase HPLC Method for the Determination of Tetrazene in Water (or Soil, as applicable)
Nitrocellulose	70.0	ND	USATHAMA Reversed Phase HPLC Method for the Determination of Tetrazene in Water (or Soil, as applicable)

1. These are assumed EQLs based on the USATHAMA lower limit of the linear concentration range.

2.6 Radiochemical Analytes

Table III-6a presents EQLs for commonly determined individual radiochemical analytes as well as analyte suites. The gamma spectroscopy analyte suite (see "Multiple isotopes" in Table III-6a) is defined by Table III-6b.

TABLE III-6a

TARGET ANALYTE EQL BY MATRIX; pCi/g OR pCi/L UNLESS OTHERWISE INDICATED

Analyte	Soil	Water	Technique[1]
Gross alpha/beta	10.0	3.0	gas-proportional
Gross alpha/beta	10.0	NA	liquid scintillation
Strontium-90[2]	2.0	5.0	gas-proportional
Americium-241	0.1	0.1	alpha-spectroscopy
Plutonium-238, -239	0.1	0.1	alpha-spectroscopy
Thorium-228, -230, -232	0.1	0.1	alpha-spectroscopy
Thorium-230, -232	0.1	0.1	ICP-MS-FIA (commonly requested nonroutine analysis)
Uranium-234, -235, -238	0.1	0.1	alpha-spectroscopy
Uranium-234, -235, -238	0.1	0.1	ICP-MS-FIA (commonly requested nonroutine analysis)
Tritium	300pCi/L	300	liquid scintillation
Multiple isotopes (Table III-6b)	Am-241: 1 Cs-137: 1	Am-241: 20 Cs-137: 20	gamma spectroscopy
Gross gamma	2.0	100	NaI(Tl) or HPGE detection
Total uranium	0.5µg/g	1µg/L	KPA[3] (commonly requested nonroutine analysis)
Total uranium	0.5µg/g	1µg/L	ICP-MS (commonly requested nonroutine analysis)
Radium-226	1.0	1.0	assorted
Radium-228	0.5	0.5	assorted
Thorium-234	1.0	20	assorted
Lead-210	2.0	5.0	assorted

1. The Los Alamos National Laboratory methods for these analytes are contained in LA-10300-M, "Health and Environmental Chem Analytical Techniques, Data Management, and Quality Assurance."
2. It may be presumed that strontium-89 is not present.
3. Kinetic Phosphorescence analysis, also referred to as pulsed-laser phosphorimetry (ASTM method D5174-91) or kinetic laser phosphorescence.

TABLE III-6b

GAMMA SPECTROSCOPY SUITE DEFINITION

Nuclide Symbol	Nuclide Name	Nuclide Symbol	Nuclide Name
Ac-228	Actinium-228	Pa-231	Protactinium-231
Am-241	Americium-241	Pa-233	Protactinium-233
Ann Rad	Annihilation Radiation	Pa-234m	Protactinium-234m
Ba-140	Barium-140	Pb-210	Lead-210
Bi-211	Bismuth-211	Pb-211	Lead-211
Bi-212	Bismuth-212	Pb-212	Lead-212
Bi-214	Bismuth-214	Pb-214	Lead-214
Cd-109	Cadmium-109	Ra-223	Radium-223
Ce-139	Cerium-139	Ra-224	Radium-224
Ce-144	Cerium-144	Ra-226	Radium-226
Co-57	Cobalt-57	Ru-106	Ruthenium-106
Co-60	Cobalt-60	Rn-219	Radon-219
Cs-134	Cesium-134	Se-75	Selenium-75
Cs-137	Cesium-137	Sn-113	Tin-113
Eu-152	Europium-152	Sr-85	Strontium-85
Hg-203	Mercury-203	Th-227	Thorium-227
I-129	Iodine-129	Th-234	Thorium-234
K-40	Potassium-40	Tl-208	Thallium-208
La-140	Lanthanum-140	U-235	Uranium-235
Mn-54	Manganese-54	Y-88	Yttrium-88
Na-22	Sodium-22	Zn-65	Zinc-65
Np-237	Neptunium-237		

3.0 NONROUTINE ANALYTICAL SERVICES

Table III-7 presents individual analytes and analyte suites that comprise the NRAS included by the laboratory contracts SOW (LANL 1995, 49738). In some cases, references are made to the analytical methods that are approved or recommended for quantifying the listed parameter. Where analyte suites are listed but the analytes within the suite are not defined, the field unit is responsible for identifying which analytes are to be quantified, and for selecting the analytical method appropriate for quantifying the selected analytes at the desired concentration levels in the applicable sample matrices.

TABLE III-7

NONROUTINE ANALYTES, ANALYTE SUITES AND RELATED INFORMATION

Acrolein and Acrylonitrile (soil and water)
Method SW8240
Method SW8030
Method SW8260 or Method EPA 524
Agent Byproducts (soil and water)
Thioglycol
Organosulfurs
GB/VX Breakdown Products
DIMP/DMMP
IMPA, MPA, Fluoracetic acid
Anions (soil and water)
Fluoride
Nitrites/Nitrates
Sulfates
Herbicides
Method EPA 515
Method 1658
Method EPA 531
Method EPA 632
Method EPA 632
Method SW8150
Low Detection Level for Inorganics
SOW 10/91(CLP metals)
Low Detection Level for Organics
Volatile Organic Analysis (VOA), Method EPA 524.2
Volatile Organic Analysis (VOA), Method 1624
Volatile Organic Analysis (VOA), SOW 6/91 (CLP VOA)
Semivolatiles (SV), Method 1625
Organochlorine Pesticides
Organic Analyses
Method 8015M/CADHS TPH
Total Recoverable Petroleum Hydrocarbons, Method EPA 418.1
GC VOAs, Method SW8010/8020
Organophosphorus Pesticides
Polyaromatic hydrocarbons, Method SW8310
Picric Acid
Total PCBs - water and soil
PCBs by Congener
Alcohol-F lists
Phenols
VOA-F lists
Appendix IX
Volatile Organic Analyses (VOA)
Semivolatiles (SV)
Pesticides/PCBs

TABLE III-7 (continued)

NONROUTINE ANALYTES, ANALYTE SUITES AND RELATED INFORMATION

Chlorophenoxy Herbicides
Organophosphorus Pesticides
Dioxins/Furans
Metals
TCLP (extractions and associated analyses)
Zero Headspace Extraction
Tumbler Extraction
Volatiles
Semivolatiles
Herbicides
Pesticides
Metals
Reactive CN/Sulfide
Density
Flash Point
Ignitability
Free Liquids
Radiochemistry
Uranium by KPA
Carbon-14 (C-14)
Technetium-99 (Tc-99)
Air Analyses
Method TO-1
Method TO-2
Method TO-5 PAHs
Method TO-13 PAHs
Method TO-14
Volatile Organic Sampling Train (VOST)
Fixed Gases
Benzene, Ethylbenzene, Toluene, Xylene (BTEX)
Method EPA 504.1
Halogenated Volatiles, Method SW8010
Aromatic Volatiles, Method SW8020
Organophosphorus Pesticides, Method SW8140
Volatile Organics by GC/MS, Method SW8240
Total Petroleum Hydrocarbon, TPH-G
GFAA Metals, Al, Se, Pb, Tl, Cd, Sb, Ag
Unusual Matrices
Tissue/Vegetation:
Organochlorine Pesticedes and PCBs, Method SW8080
Metals by ICPAES, Method SW6010 (Each Metal for Kemron)
Mercury, Method SW7470
Non-soil Solids:
Volatiles
Semivolatiles
Target Analyte List (TAL) Metals and CN

TABLE III-7 (continued)

NONROUTINE ANALYTES, ANALYTE SUITES AND RELATED INFORMATION

Pesticides/PCGs
Biological Tests
Arsenic in Biota
Mercury in Biota
Selected Explosives in Biota
Selected Metals in Biota
Selected Pesticides in Biota
Water Quality Parameters
Anion(s) First Analyte
Acidity
Alkalinity
Ammonia
Anions 300.0 First Analyte
Bicarbonate/carbonate
Bromide
Biochemical Oxygen Demand (BOD)
Carbon - Total Organic Carbon (TOC)
Carbonate
Chloride
Chlorine - residual
Chlorophyll A
Chemical Oxygen Demand (COD)
Color
Corrosivity, Langelier
Cyanide - free (no distillation)
Cyanide - reactive
Cyanide - total
Cyanide - Amenable to Chlorination
Dissolved Inorganic Carbon (DX)
Flash point, Setaflash
Fluoride (distilled)
Fluoride (non-distilled)
Formaldehyde
Hardness (as CaCO3)
Hexavalent Chromium (Hex Chrome, Chromium-VI, Cr(VI))
Ion Chromatography (IC) Scan (Cl, NO2, NO3, PO4, SO4, Br)
Iodide
Infrared (IR) scan
Langlier Index
Metals, Safe Drinking Water Act (SDWA)
Nitrate/Nitrite (NO3/NO2)
Nitrogen, Total Kjeldahl
Nitrogen, Total Organic
Oil and Grease
Oil and Grease-Gravimetric
Petroleum Hydrocarbons

TABLE III-7 (continued)

NONROUTINE ANALYTES, ANALYTE SUITES AND RELATED INFORMATION

pH
Phenolics, Total
Phosphate-Ortho
Phosphate
Phosphate-Total
Phosphorus
SOC (soluble organic carbon)
Solids-Percent Ash
Solids-Percent Moisture
Solids-Percent Solids
Solids-Settleable
Solids-Total
Solids-Total Dissolved (TDS)
Solids-Total Suspended (TSS)
Solids-Total Volatile (TVS)
Specific Conductivity
Specific Gravity
Sulfate
Sulfide
Sulfite
Surfactants, Methylene Blue Active Substances (MBAS)
Temperature
TOX (total organic halides)
Turbidity
Geotechnical
1-Dimensional Consolidation
Atterburg Limits
Bulk Density
Cation Exchange
CU Triazial (3pt.) (Shelby Tube) - Triazial Shear
Dimensional Swell
Grain Size-Hydrometer
Grain Size-Sieve Analysis
Grain Size, Method ASTM0422
Hydraulic Conductivity
Hydraulic Extrusion/visual classification
Modified Proctor (4 inch diameter mold)
Modified Proctor (6 inch diameter mold)
Moisture Ash & Organic Matter
Moisture Content
Particle Size (% passing N 200 sieve)
Particle Size (combined)
Paste pH (rock)
Permeability (after 2 weeks)
Permeability (constant head)
Permeability (sample remolding)

TABLE III-7 (concluded)

NONROUTINE ANALYTES, ANALYTE SUITES AND RELATED INFORMATION

pH
Proctor Penetrometer
Soil Classification
Specific Gravity
Standard Proctor (4 inch diameter mold)
Standard Proctor (6 inch diameter mold)
Unconfined Compressive Strength
Unit Weight (density)
UU Triazial (3 pt)
Visual Classification
Void Ratio (porosity)

1.0 INTRODUCTION

Selection of analytical methods is complicated by the diversity of methods available and the tendency of individuals making method selections to use those with which they are familiar. Method selection may be further complicated by the belief that certain standard analytical protocols such as SW-846 are applicable beyond their intended purposes. The scientist sometimes feels forced to use standard methods because they are widely accepted as being robust, accurate, precise, etc., even though a more accurate, more precise, more robust, cheaper, or less time consuming method is available or can be readily developed. It is also frequently easier and more cost-effective for commercial laboratories to standardize their operations by selecting a few robust methods that are applicable to most routine samples.

Overshadowing all other considerations, the use of certain analytical methods might be governed by Federal, state, or other regulations, or ER Project representatives may enter into agreements with regulators to use specific analytical methods. For example, the RCRA mandates the use of solid waste methods, SW-846, in the following circumstances:

- determination of hazardous waste characteristics (SW-846 method 1311) followed by appropriate analytical method,
- determination of free liquid (SW-846 method 9095),
- analyses associated with submission of delisting petitions,
- analyses associated with a hazardous waste incinerator trial burn, or
- determination of air emissions from process equipment.

While the first two determinations listed above may occasionally be relevant for the LANL ER Project, the others are not likely to apply at all. It is imperative to notify the SMO when one of these five circumstances dictates strict use of an SW-846 method so that the laboratory can be informed.

2.0 CONSIDERATIONS IN SELECTING ANALYTICAL METHODS AND QC

Analytical method performance criteria derive from the site-specific planning requirements. Communicating with regulators in the early stages of planning is good practice and is an integral part of a thorough planning process, as it espouses full participation of *all* stakeholders. Since it is not always possible to have regulators actually present during scoping meetings, it is important to gain acceptance from them of the approach taken to identify the important performance criteria. The approach used could lead to selecting other-than-traditional (e.g., SW-846/CLP) methods. Negotiation of method selection with regulators is possible and is encouraged. The DSC Chemistry Team will be helpful in these negotiations.

Large-volume RAS contracts have been developed for the ER Project, including the laboratory-required QC procedures and criteria. In addition, these contracts include the ready capacity to allow for many NRAS. The list of RAS and allowed methods, with detection or quantitation limits identified for each analyte, is presented in the analytical laboratory Statement of Work (SOW for RAS [LANL 1995, 49738]) and Appendix III of this document. The services under NRAS are listed in that same appendix. Note that many of the NRAS have "standard" or commonly used and accepted methods available, and others may be more specialized. The analytical services contracts do identify required deliverables; however, more technical expertise is needed when selecting a more specialized or emerging method to determine what kinds of QC procedures are appropriate for the method and what criteria are appropriate for the specific data quality need. The DSC Chemistry Team is the best source of assistance for selecting NRAS and QC procedures and criteria.

Method selection must include consideration of the following factors:

Desired analytical information. The COPCs, chemicals of concern (COC), or other parameters of interest must be identified. If particular forms of the analytes (e.g., dissolved, extractable, suspended, leachable, isotopic, total, etc.) are of interest, those forms must be identified. The use of the analytical information in the context of the study should be identified and recorded. The role the analytical information will play in the decision-making process should be identified. For example, risk assessment decisions, screening decisions, waste characterization decisions, etc., may be required. How the data will be used to compute statistical parameters — i.e., how it will be compared to numerical limits such as SALs, etc., to support these decisions — should be included in the SAP.

Sensitivity. The needed measurement ranges must also be identified. The measurement ranges will be influenced by the expected contaminant concentrations and the decision levels such as SALs, risk-based cleanup levels, background levels used in place of SALs, and waste characterization regulatory limits. SALs and background levels for contaminants important at LANL can be found on-line in FIMAD. If contaminants are expected to be present at concentrations near the decision level, the selected method should be able to distinguish concentrations both less than and greater than the decision level. The relationship between the decision level and the lowest reasonably quantifiable concentration is frequently a limiting factor for method selection. The quantitation limit of the method must be low enough to support determination of the COPC and COC concentrations with the desired confidence. However, the ability of a particular method to achieve the reported quantitation limit depends on the concentrations of chemical and physical interferences in the sample matrix. There are some instances when the commonly used methods cannot detect or quantitate certain analytes at or below the SAL (e.g., vinyl chloride, benzo(a)pyrene). In these cases, it may not be possible to meet the SAL using any reasonable approach. If there is no reason to believe that any of these analytes could be a LANL ER problem, it is not likely an issue. However, if there is cause for concern, the DSC Chemistry Team can be consulted to identify potential analytical procedures that may be satisfactorily employed.

Selectivity. The degree to which an analytical method is adversely impacted by the presence of interferences is a function of its selectivity. If the method responds to more than one analyte, the presence of one analyte may affect the accuracy or precision with which another can be determined. Often, interferences arise from chemical analytes that are not target analytes, or by physical effects — the net effect being to lower the confidence in the quality of the result reported for the target analyte by increasing the dispersion of analytical results or by introducing a bias. Potential interferences should be identified during selection of analytical methods, and if a problem is possible, sample preparation/cleanup procedures to remove interferences or alternative methods can be identified by the DSC Chemistry Team.

Precision. Method selection should take into account the allowable precision error associated with the analytical measurement as determined through the DQO planning process. Ideally, the precision error is known prior to analytical method selection. However, method selection can be made without knowing the precision error and precision error may be determined later. In those cases, the project may be at risk of having selected inadequate methods.

Confidence in estimating certain statistical parameters, such as the arithmetic mean, can be increased by averaging many measurements. This may be especially useful when using on-site measurements (OM) or abbreviated routine measurements that cost less and require less time to implement than fixed laboratory methods. A good example is the use of OM, optimized, or focused methods for a known contaminant problem.

Stability and Robustness. Instrument stability is a function of precision and drift, which influences the measurement system stability. Stable instruments require relatively fewer recalibrations whereas unstable methods may require frequent recalibrations and may require averaging the results of several repeat analyses on the same sample to increase the confidence in the results. It is important to understand the stability of a measurement system on both short (hourly or daily) and long (weekly or monthly) time scales. Frequently, the stability of a system is not stated explicitly in a particular analytical protocol but can be inferred from the required calibration

frequency. If a measurement system is robust, it will be stable and will yield results that are comparable, even when used by different operators, on different instruments, in different laboratories, and on samples of varying matrix compositions.

Bias. The impact of bias on data quality should be evaluated in the SAP planning process. In some cases, use of the data without a consideration of the bias may be acceptable if the bias consideration does not change the decision (e.g., high bias on sample results less than the action limit or low bias on sample results greater than the action limit). This decision needs to be made during the evaluation of the data during DQA. When bias needs to be addressed, the data reviewers must be consulted to determine the direction and magnitude of the suspected bias as well as the significance of the bias. Without sufficient information to assure that the bias is real and significant, corrections for bias cannot be justified. Selection of methods with no bias (or a well characterized bias) relative to the methods used previously, generally facilitates planning, but it is not necessary as long as the degree of bias and its significance can be determined before making the required decision.

Sample Preparation. Prior to chemical analysis, a sample is usually treated chemically or physically to yield a derivative of the sample. It is the derivative of the sample (extract, digestate, electroplate, pulverized sample, etc.) that is actually analyzed. The sample preparation method must be compatable with the sample matrix and is usually specified as part of the analytical procedure, either explicitly or as a reference to another procedure. The sample preparation procedure may be followed with a sample cleanup procedure designed to remove the majority of the interferences, either without affecting the analytes of interest or by affecting them in a quantifiable manner. If interferences are known to exist at a particular site, methods should be selected that allow for mitigation of the interferences and this information should be conveyed to the analytical laboratory. Advice on method selection for mitigating interferences can be obtained from members of the DSC Chemistry Team. When special interferences and methods for mitigating them are known in advance, the analytical laboratory should be alerted to the situation. The conveyance of special instructions to analytical laboratories should be coordinated through the SMO.

Sample Holding Times. Because changes in analyte concentrations caused by sample degradation is a potential problem, it is important to not store a sample for too long a period before it is analyzed. The acceptable storage period, or holding time, for a given sample container is a function of the analytes of interest, the sample matrix and the storage conditions. The holding time clock begins upon sample collection and terminates upon initiation of sample preparation or analysis (either of original sample, such as a purge of the sample for volatiles analysis or the analysis of an extract or digestate). Thus, both the field unit and the analytical laboratory share responsibility for ensuring that holding time requirements are satisfied, since the ability of the analytical laboratory to meet regulatory holding times depends on the samples being shipped with adequate time remaining for timely analyses.

Both regulatory and technical issues can influence, or determine, acceptable holding times. The regulatory issue can often complicate the process, despite the fact that there is limited scientific basis[1] for regulatory holding times. Holding time effects can become significant long before a regulatory holding time is reached. Conversely, exceeding a holding time might have no detrimental effects on the sample, especially if the sample is preserved properly. For example, despite regulatory requirements, studies[1] have shown that most volatile target compounds are stable for at least 12 weeks. Significant losses were not seen until after 90 days and were noted for carbon disulfide, 2-hexanone, 2-butanone, 4-methyl-2-pentanone, carbon tetrachloride, styrene, and cis-1,3 -dichloropropene.[2]

1 "Holding Times of Volatile Organics in Water," Bottrell, D., Fisk, J., Robertson, G., Petty, J., Dempsey, C., and Bartling, ML, Fifth Annual Waste Testing and Quality Assurance Symposium, July 1989.
2 Ibid.

If samples are not analyzed within the applicable holding time, it might be necessary to collect additional samples, especially if regulations require adherence to the holding times. However, there are instances when resampling should not be required—even if holding times are mandated by regulation or regulators. For example, if an analyte of concern is found at a level above a SAL even after the holding time was exceeded, it could be that the analyte had an initially higher concentration than the determined value and the missed holding time would have no adverse impact on the ability to make a sound decision. In that case, resampling would be wasteful. When there is a concern related to holding time exigencies, the DSC Chemistry Team should be consulted for guidance. Regulators should also be informed of the situation prior to a decision to resample or prior to accepting results associated with missed holding times. The possible effects of the missed holding times on the integrity of the data and the impact on the decision to be made should be discussed, and the conclusions should be based on sound scientific knowledge and judgment. LANL-ER SOP-01.02 and standard analytical methods typically specify sample preservation and storage conditions and will serve as guidance for sample preservation and storage when applicable.

Holding times are not always mandated or specified in analytical procedures. In addition, there may be instances when a true determination of the holding time effects is warranted (e.g., when there is public concern or potential litigation and results are negative in a situation where holding times were exceeded). A determination can be made through the use of ASTM method D4515-85, which provides an analytical and statistical tool to model sample degradation on a site-specific basis.[3] If using analytical methods that do not specify sample preservation, holding times, or storage conditions, it is important to ensure that the selected preservative does not interfere with the analysis.

When regulatory holding times are exceeded, and the context for the sampling is not regulatory, there may be more room for flexibility in dealing with the potential problem of changes in the sample. However, for water samples this should never be the case as all water samples for volatiles analyses must be acidified (preferably as described below).

If adherence to holding time requirements is critical, it may be appropriate to analyze the samples in the field or to take direct field measurements at the sampling point. An example would be the determination of VOCs using GC or GC/MS analytical methods based on fixed laboratory methods. Holding times can sometimes be extended by limited sample preparation in the field. For example, water samples to be analyzed for VOCs can be, and *should be*, acidified to prevent microbial degradation (250 mg of sodium bisulfate per 40 ml sample has proved to be very effective). Methanol extraction of soils in the field (NMED 1994, 52243) is another way to extend holding times for volatile organics, although this will raise the detection limits. Immediate freezing of samples (using dry ice in the field) is a possibility for HE, and is recommended for soil samples to be analyzed for HE components.

Turnaround Time. The selected sample preparation and analysis methods must allow for the sample results to be generated in a timely manner. The required turnaround time could play a major role in the method selection and is often a primary factor in selecting field analyses over fixed laboratory analyses. Some of the reasons for requiring measurements on-site are

- a decision must be made in, for example, less than 24 hours to continue work efficiently, such as during a remediation;
- to direct work in real time, such as during an Expedited Site Characterization (a DOE-HQ initiative) and when there is a potential for a change in direction from the original design, and new knowledge gained from on-site measurements will allow for a speedy change;

3 Standard Practice for Estimation of Holding Time for Water Samples Containing Organic Constituents," ASTMD4515-85.

- when there are constraints such as sample degradation (addressed under "holding times") or temporal constraints that require instant analysis; and
- for gaining important health and safety information to protect the workers and the public.[4]

When time is a factor, it is important to assure that data quality needs can be met, even if abbreviated methods are used, because of the time constraints. An example of when it is important to make sure that "fast" analyses will not compromise data use is when counting times for radioisotopes will be inadequate to meet sensitivity needs if the time is constrained.

Cost. While cost is not a technical issue, it will factor into the selection of analytical methods. As budgets are reduced, the ability to generate sufficient data with adequate quality becomes more difficult. If the EPA- and DOE- mandated DQO process is used, the last step of the process, "Optimization of Design," will identify a reasonably cost-effective solution to sampling and analysis that is adequate for supporting the decision. Assistance from a statistician on the DSC Statistics Team, as well as the DSC Chemistry Team, should be solicited for this.

Data Comparability. Data collected in various phases of a project often must be compared or pooled into a single data set, or subgroup of data sets, before a decision can be made. To do this, the comparability of the data and the data quality must be acceptable. If the data from more than one phase of the project are directly comparable, pooling is easy. If the data are not directly comparable but the data quality (e.g., precision and bias) from each phase is known, it could be possible to combine them in a useful manner. If the data quality of a particular data set is unknown, the ability to compare data, or to pool the data with other data sets, to make decisions is hampered. Even worse, the ability to make a decision with the desired degree of confidence may be rendered impossible if the data qualities are indeterminate. For example, use of hydrofluoric acid digestion prior to determination of metals will yield analytical results that are incomparable to analyses based on nitric acid/ hydrochloric acid digestions. Attempts to compare results from the two different approaches could be futile. When strict comparability of data is required, all samples must be prepared and analyzed using the same methods over the duration of the study.

Availability of Adequate Analytical Methods. The primary consideration in selecting analytical methods/services should be the analytical method performance criteria derived from the data quality objectives developed for the site. However, because the use of RAS often provides the most cost-effective approach to chemical analyses, serious consideration should be given to using these services even when the resulting data quality may exceed the needs of the decision-makers.

When RAS methods are inadequate or there is a better way to meet analytical needs (e.g., faster and/or cheaper), other methods can be found through the same analytical contracts as NRAS which can make capacity for many additional methods immediately available. There may be other instances when the already-procured analytical methods do not meet needs, in which case special contracts/arrangements need to be made. Further discussion of RAS and NRAS will follow in Sections 3.0 and 4.0 of this Appendix.

Immunoassay test kits are an example of methods that might be non-SW-486 or non-CLP methods. These test kits can be used effectively if due consideration is given to their limitations. For example, some test kits provide actual concentration values while others only provide an indication of whether the analyte is present at a concentration above a certain cutoff value (i.e., "go/no go" tests). Because their utility is becoming more recognized, some immunoassay test kits have been approved as SW-846 methods with qualifications on their use.

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4 "Planning Guidance for Using Onsite Measurements," Fisk, J, Bath, R, and Klevano, C, draft, December 1995 - for DOE-EM26.

3.0 ROUTINE ANALYTICAL SERVICES (RAS) CAN BE PROVIDED THROUGH ANALYTICAL CONTRACTS DEVELOPED FOR THE ER PROJECT

The SOW for RAS (LANL 1995, 49738) is the source for the list in Appendix III of analytical services available through the RAS contracts, including target analytes, estimated quantitation limits EQLs, estimated detection limits EDLs, and methods that are acceptable. The following section (3.1) describes an approach one might use to arrive at needed analytical methods and to determine if the RAS methods are adequate.

3.1 Selection of SW-846, CLP, and AEC (formerly USATHAMA) Methods

When using CLP or Army Environmental Center (AEC) methods (CLP and SW-846 are comparable in performance, the differences being transparent to the data user), the appropriate SW-846 method should be identified, then the CLP or USATHAMA method equivalent to the selected SW-846 method substituted. The first step is to identify those methods that appear to serve the intended purpose (Table IV-1 can be helpful here). Table IV-1 shows the relationship among the analytical methods allowed by the analytical support subcontracts for routine services. In most cases, an SW-846 method is allowed and use of SW-846 methods will support most needs. However, especially with regard to radionuclides (techniques allowed are cited) and selected high explosives, laboratory-specific methods are allowed or specific USATHAMA methods are required. The user must then verify the applicability of the method by referring to the particular protocol and

- verify that the method is applicable to supporting the decision to be made based on results generated from the method either alone or in conjunction with other data;
- verify that the sensitivity, comparability to other analytical methods, detection limits, selectivity, stability bias, and precision of the protocol meet the needs of the SAP;
- verify that the protocol is not subject to interferences that are anticipated to be present in the sample at concentrations that will render the analyses invalid; and
- balance factors such as turnaround times, holding times, and analytical costs.

Selected AEC methods are available for high explosives analyses for which no equivalent CLP or SW-864 methods exist. Refer to Table IV-1 when selecting these high explosives routine analytical services. Because radiochemistry methods are not as standardized as other chemistry methods, the allowed techniques are cited, but the method numbers (nonexistent) are not.

4.0 NONROUTINE ANALYTICAL SERVICES

A large number of NRAS can be provided through the contract mentioned above. Appendix III provides the list of NRAS available through the RAS contracts. Many of the NRAS services involve use of standard or commonly accepted methods (though not routinely provided through these contracts). In addition, many of the NRAS methods are simple modifications of the RAS methods, in which case the deliverables are alike, the QC procedures can be cited, and criteria can be modified to meet needs (e.g., a lower detection limit may need to be demonstrated). However, for specialized or emerging methods some prescriptive narrative in the SAP is needed to make sure that project goals are met. The following information is required as a set of deliverables from the contractors when NRAS is requested;

- target analytes/measurement parameters and associated analytical results and quantitation or measurement limits,
- citation of sample preparation and analysis method used (when a "standard" method is used) or a description of the technology used when a standard method cannot be cited,

TABLE IV-1

RELATIONSHIPS AMONG SW-846, CLP AND AEC ANALYSIS METHODS[1]

SW-846 Method Allowed by Analytical Contracts [2]	Comparable CLP Method	Comparable AEC Method
6010, Metals by ICP-AES	SOW ILM03.0	None
6020, Metals by ICP-MS	SW-6020	None
7000 Series, Metals by AA/GFAA	EPA200 Series	None
9010, Total Cyanide	EPA335.2	None
9012, Total Cyanide	EPA335.2	None
8081, Organochlorine pesticides/PCBs by capillary GC	None	None
8151, Chlorinated herbicides by capillary GC	None	None
8260, VOCs by capillary GC/MS	OLM03.0 (capillary column)	None
8270, SVOCs by capillary GC/MS	OLM03.0 (capillary column)	None
8330, Nitroaromatics and nitramines by reversed phase HPLC with UV detection	None	1. Reversed Phase HPLC Method for Determination of Explosives Residues in Soil 2. UW14, Determination of Explosives in Water by HPLC 3. Improved Salting-Out Solvent Extraction Method for Determination of Low Levels of Nitroaromatics and Nitramines in Ground Water
8331, Tetrazene by reversed phase HPLC with UV detection	None	1. Reversed Phase HPLC Method for Determination of Tetrazene Water 2. Reversed Phase HPLC Method for Determination of Tetrazene Water in Soil
None	None	1. 1989 Reversed-Phase HPLC Method for the determination of NG and PETN in Water 2. 1989 Reversed-Phase HPLC Method for the determination of NG and PETN in Water
None	None	1. 1989 Reversed-Phase HPLC Method for the determination of Nitroguanidine in Water 2. 1989 Reversed-Phase HPLC Method for the determination of Nitroguanidine in Water
None	None	Reversed-Phase HPLC Method for the determination of Nitroguanidine in Water

1 The applicability of sample preparation methods should be verified by consulting the chosen analytical method. Radionuclide determination techniques are provided in Table IV-2.

2 Refers to the most recent version of SW-846 methods, e.g., 8081A, 9010A, etc.

TABLE IV-2

TARGET ANALYTE EQL[1] BY MATRIX; pCi/g OR pCi/L UNLESS INDICATED

Analyte	Soil	Water	Technique [2]
Gross alpha/beta	10.0	3.0	gas-proportional
Gross alpha/beta	10.0	NA	liquid scintillation
Strontium-90[3]	2.0	5.0	gas-proportional
Americium-241	0.1	0.1	alpha spectroscopy
Plutonium-238, -239	0.1	0.1	alpha spectroscopy
Thorium-228, -230, -232	0.1	0.1	alpha spectroscopy
Thorium-230, -232	0.1	0.1	ICP-MS-FIA (commonly requested nonroutine analysis)
Uranium-234, -235, -238	0.1	0.1	alpha spectroscopy
Uranium-234, -235, -238	0.1	0.1	ICP-MS-FIA (commonly requested nonroutine analysis)
Tritium	300 pCi/L	300	liquid scintillation
multiple isotopes (Table III6b).	Am-241: 1 Cs-137: 1	Am-241: 20 Cs-137: 20	gamma spectroscopy
Gross gamma	2.0	100	NaI(Tl) or HPGE detection
Total uranium	0.5 mg/g	1 mg/L	KPA[4] (commonly requested nonroutine analysis)
Total uranium	0.5 mg/g	1 mg/L	ICP-MS (commonly requested nonroutine analysis)
Radium-226	1.0	1.0	assorted
Radium-228	0.5	0.5	assorted
Thorium-234	1.0	20	assorted
Lead-210	2.0	5.0	assorted

1 EQL
2 The Los Alamos National Laboratory methods for these analytes are contained in LA-10300-M, "Health and Environmental Chemistry Analytical Techniques, Data Management, and Quality Assurance."
3 It may be presumed that strontium-89 is not present.
4 Kinetic phosphorescence analysis, also referred to as pulsed-laser phosphorimetry (ASTM D 5174-91) or kinetic laser phosphorescence.

- calibration data,
- raw analytical data (instrument outputs),
- manual calculations used for generating results (unless specified in cited method), and
- all QC documentation.

4.1 Selection of NRAS Methods

Whether choosing the NRAS method from the list available through the analytical contracts or citing alternate (including new, emerging, and innovative) technologies, there are performance criteria to be considered, just as in selecting "standard" methods.

A process similar to the RAS method selection process described in Section 3.0 of this appendix should be undertaken when choosing nonroutine analytical methods. However, that process cannot be flow charted in a detailed manner, as the number of possible method selections is so large. Instead, the user is required to evaluate the possible analytical methods with respect to the following performance criteria and additional features, as appropriate, to ensure that the selected method meets the needs of the SAP. These performance criteria and additional features are directly linked to the method selection factors listed in Section 2.0 of this appendix.

4.1.1 Nonroutine Analytical Performance Criteria

- Method Quantitation Limit
- Selectivity (degree to which method is free from interferences)
- Comparability to Existing Methods
- Linearity (determination of useful linear calibration range)
- Precision
- Short-Term/Long-Term Stability (analytical system stability/precision)
- Robustness (minimal adverse impact to data quality from changing analysts, laboratories, and other operational conditions)
- Bias (accuracy)

4.1.2 Nonroutine Additional Information

- Required Competency Level of Analyst (on-site measurements only)
- Training Requirements (on-site measurements only)
- Sample Preparation Requirements
- Method SOP (method number and title; method applicability and limitations; safety concerns; sample preservation, storage and preparation; calibration procedures; analysis procedure; data reporting requirements; QC requirements; routine equipment care and maintenance; references)
- QA requirements
- Quality Assessment requirements
- Cost per Analysis
- Turnaround Time

In some cases, a particular performance criterion or additional information item may not be readily quantifiable. For example, selectivity is inherently difficult to quantify, even for standard methods such as the CLP and SW-846 methods. In such cases, the applicability of the method should still be demonstrated through the analysis of reference materials or spiked samples, etc., before it is used for analysis of environmental samples under the SAP. If the method is used prior to this verification, the field unit is at risk and will be required to demonstrate

applicability at a later date. At times the best professional judgment of a competent analyst, such as a DSC Chemistry Team member, may be involved in the assessment of the items above. This is especially true in the case of difficult-to-measure parameters such as data comparability. In all cases, the evaluation of the nonroutine analytical method, including the bases for conclusion regarding the method's applicability to the intended data use, should be documented. This documentation may be included in the SAP either directly or by reference.

When making the decision to use a method that is new, emerging, innovative, or not demonstrated for the site-specific matrix, it is critical that method be tested first as to its applicability. This testing is best done by using site-specific performance evaluation (PE) materials that have been well characterized for the analytes of interest. During the ongoing period of sampling and analyses, performance information should be gathered, documented, and evaluated so that another potential user of the method may benefit from the precedent.

5.0 ON-SITE MEASUREMENTS

This special case of using on-site analytical methods needs special attention. Complete guidance for planning for the use of OM is provided in (DOE 1995, 52240). There are many benefits to be derived from using OM, such as

- abbreviated methods that are focused for the analytes of interest, and that may provide better data and be less costly for those parameters than the standard survey-type analyses;
- faster analyses—this is especially important when a decision must be made on-site and data must be collected in "real-time";
- the ability to make changes in the SAP based on new knowledge that may be gained from the OM data; and
- the opportunity for decreasing total error by maximizing the number of samples using the abbreviated methods.

When making a decision to use OM there are several critical elements that must be considered and criteria that should be met to justify the use. There are times that the same benefits can be derived from using fixed laboratories (either close-support such as the LANL laboratories or contractor laboratories) to perform the abbreviated, or even "screening" methods with a rapid turnaround time, if time is a factor. Unless there is a large number of analyses to be performed, it is not often cost-effective to set up in the field (other than for hand-held or "back of the pick-up" methodology). The critical elements are outlined in Chapter 2 of the cited draft OM guidance (DOE 1995 52240).

GLOSSARY

Abbreviated method A shortened form of a method. Usually refers to analytical methods that have been modified to require less rigorous sample preparation, analysis conditions or quality control.

Aliquot A portion of a sample or sample derivative taken for analysis.

Analysis A process used to measure one or more attributes of a sample in a clearly defined, controlled, systematic manner. Often requires treating a sample chemically or physically before the measurement step to render the sample or a derivative thereof (e.g., a digestate or extract) ready for measuring the selected attribute.

Analyte The particular chemical or radiochemical species to be identified and/or quantified in a sample of interest.

Assessment The evaluation process used to measure the performance or effectiveness of a system and its elements. In this document, assessment is an all-inclusive term used to denote any of the following: audit, performance evaluation, management system review, peer review, inspection, and surveillance.

Audit (quality) A systematic and independent examination to determine whether quality activities and related results comply with planned arrangements, whether these arrangements are implemented effectively, and whether they are suitable to achieve objectives.

Baseline data validation Data validation directed toward determining whether the data in question satisfy clearly defined quality control checks. This validation is used to assign a consistent set of qualifiers to data that draw attention to potential data deficiencies.

Bias (1) The degree to which the value obtained for a measured parameter deviates from the value accepted as the true, or reference, value. (2) A systematic deviation from the true value that remains constant over replicated measurements within the statistical precision of the measurement process. Synonymous with *deterministic error, fixed error,* and *systematic error.* Sometimes referred to as *accuracy*, though the mathematical equation for computing accuracy differs from that for bias. Typically expressed as a percentage deviation, bias is computed as follows:

$$Bias = \frac{1}{T}(\bar{x} - T) \times 100\%,$$

where

$\bar{x}$ is the average of several determinations and T is the true value.

The true value may be the value established for a spiked sample or a certified standard reference material such as a performance evaluation sample.

Blank sample A sample expected to have negligible or unmeasurable amounts of the analytes of interest. Results of blank sample analyses indicate whether or not field samples might have been contaminated during one or more steps of the sample collection, transport, storage, preparation and analysis process.

Blind sample See *Single Blind Sample* and *Double Blind Sample.*

Calibration A process used to identify the relationship between the true, or reference, analyte concentration or other variable and the response of a measurement instrument, chemical analysis method, or other measurement system. The response of the measurement system is typically established for a series of calibration standards and the relationship is represented graphically and/or mathematically.

Calibration blank A calibration standard prepared to contain negligible or unmeasurable amounts of the analytes of interest. Used to establish the zero concentration point for analytical measurement calibration.

Calibration Standard A sample prepared to contain known amounts of the analytes of interest and of other constituents required for the analysis. Ideally, the calibration standard matrices emulate the matrices of the environmental samples.

Chain of custody An unbroken, documented trail of accountability designed to ensure that the physical integrity of samples, data, and records remains uncompromised.

Collocated sample (collocated field sample) One of two or more samples collected as close together in time and space as the sampling equipment allows so that each sample is expected to be equally representative for a given analyte within the common space and time interval.

Comparability A qualitative measure of the degree to which one item or data set can be compared with another.

Corrective Actions Measures taken to rectify conditions adverse to quality and, where necessary, to preclude their recurrence.

Data quality assessment That process, based on data obtained by implementing a sampling and analysis plan, by which the design in the sampling and analysis plan is evaluated to assess the validity of the SAP approach and the assumptions upon which the SAP design was based. The process, which focuses on determining whether the data are sufficient for a specific use, should be applied whenever the outcome of a study is not obvious and before the results are delivered to the decision makers.

Data quality objectives (DQOs) The qualitative and quantitative statements that specify the quality of data required to support decisions.

Data Quality Objectives Process A Total Quality Management (TQM) tool, based on the Scientific Method and developed by the U.S. Environmental Protection Agency, to facilitate the planning of environmental data collection activities. The products of the DQO process are the DQOs.

Data validation A systematic process performed externally from the data generator which applies a defined set of performance-based criteria to a body of data that may result in qualification of the data. This process occurs prior to drawing a conclusion from the body of data. It may comprise a standardized review (baseline validation) and/or a problem-specific review (focused validation) of the data.

Data verification A process of evaluating the completeness, correctness, consistency, and compliance of a laboratory data package against a standard or contract. "Completeness" means all required information is present—both hard copy and electronic. "Correctness" means the reported results are based on properly documented and correctly applied algorithms. "Consistency" means that values are the same when they are reported in different reports or are transcribed from one report to another. "Compliance" means that the data pass numerical QC tests based on parameters or limits specified in a contract or in an auxiliary document. The primary purposes of verification are to determine appropriate payment to those providing services and to point out areas of noncompliance with QC specifications that may affect data use and that can be made a focus of further data validation or data quality assessment activities.

Double blind sample A sample whose analyte concentration and sample identity are unknown to the analyst. Double blind samples are usually submitted to an analytical laboratory without the laboratory's knowledge so that the ER Project can evaluate the laboratory's performance.

Duplicate analysis An analysis (includes sample preparation and analysis) performed on one of a pair of identically prepared subsamples of the same sample. Not to be confused with a duplicate measurement.

Duplicate measurement One of a pair of measurements performed on a prepared sample (e.g., digestate or extract) under identical conditions.

Environmental sample See *field sample.*

Error The inevitable uncertainty associated with scientific measurements or decisions. Measurement error comprises three types of errors: (1) systematic error (or bias), which is always of the same algebraic sign, (2) random error which varies in algebraic sign and is unpredictable, and (3) blunders which are unpredictable human errors such as transcription errors. Decision error comprises (1) false positive error which is quantified as the probability of rejecting a null hypothesis when the hypothesis is actually true and (2) false negative error which is quantified as the probability of not rejecting a null hypothesis when the hypothesis is false.

Estimated quantitation limit The lowest concentration that can be reliably achieved within specified limits of precision and accuracy during routine analytical laboratory operating conditions. The estimated quantitation limit is generally 5 to 10 times the method detection limit. However, a nominal value may be chosen for the estimated quantitation limit within these guidelines to simplify data reporting. For many analytes, the estimated quantitation limit is selected as the lowest non-zero standard in the calibration curve. Sample estimated quantitation limits are highly matrix-dependent, and the specified estimated quantitation limits might not always be achievable.

Equipment blank (equipment rinsate blank) A blank sample that is used to rinse the sample collection equipment and is then transferred to a sampling container. The equipment blank is collected after equipment decontamination is completed but prior to collection of another field sample.

Error The difference between an observed or computed value and the value accepted as the true value.

Field blank A blank sample either prepared in the field or carried to the sampling site, exposed to sampling conditions (e.g., bottle caps removed, preservatives added), and returned to a laboratory for analysis in the same manner in which environmental samples are analyzed. Used to identify the presence of contamination potentially added during the sampling and analysis process.

Field matrix spike A known amount of a field sample to which a known amount of target analyte has been added. Used to compute the proportion of added analyte that is recovered upon analysis.

Field reagent blank Same as *field blank.*

Field sample See *sample.*

Field split A field sample that has been divided in the field into equally representative portions (See *split sample*).

Focused data validation A technically based analyte-, sample-, and potentially data use-specific process that extends the qualification of data beyond method or contractual compliance and provides a level of confidence that an analyte is present or absent. If the analyte is present, the quality of the quantitation may be obtained through focused validation. This validation process may focus on the data needed for a given decision, which can include review of raw analytical data such as chromatograms or mass spectra.

Hazardous waste Any waste material that satisfies the definition of "hazardous waste" as given in 40 CFR Part 261, "Identification and Listing of Hazardous Waste."

Hypothesis A tentative assumption made to draw out and test its logical or empirical consequences. In hypothesis testing, the hypothesis is labeled as either "null" or "alternative," depending on the decision maker concern for making a decision error.

Interference A chemical or physical entity whose influence results in a decrease or increase in the response of an analytical method or other measurement system relative to the response obtained in the absence of the entity. Interferences in chemical analyses may often be mitigated by changing sample preparation methods or conditions, or by changing analysis methods or conditions.

Inspection examination or measurement of an item or activity to verify conformance to specific requirements

Laboratory split samples Portions of sample taken from the same sample container, prepared for analysis and analyzed independently but under identical conditions. Each split sample is expected to be equally representative of the original material.

Management systems review The qualitative assessment of a data collection operation and/or organization(s) to establish that the prevailing quality management structure, policies, practices, and procedures are adequate for ensuring that the type and quality of data needed are obtained.

Matrix See *sample matrix.*

Matrix spike An aliquot of sample spiked with a known concentration of target analyte(s). The spiking typically occurs before sample preparation and analysis.

Matrix spike duplicate An intralaboratory split sample spiked with a known amount of target analyte (s). Spiking occurs prior to sample preparation and analysis.

May Denotes permission but not a requirement.

Method A body of procedures and techniques for systematically performing an activity.

Method blank An analyte-free matrix to which all reagents are added in the same volumes or proportions as used in sample processing and which is prepared and analyzed in the same manner as samples.

Method detection limit (MDL) The minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero. The MDL is determined from analysis of samples of a given matrix type containing the analyte after subjecting the sample to the usual preparation and analyses.

Mixed waste Hazardous waste material as defined by 40 CFR part 261 (RCRA), mixed with radioactive contaminants.

Must Denotes a requirement that has to be met.

Nonroutine analysis Those analytical requests not defined as routine analyses. The LANL ER statement of work for analytical services provides more details concerning the nature of nonroutine analyses.

Out of control A condition for which the quality of outputs of a process are suspect based on a statistical interpretation of QC sample data.

Performance criteria Measurable criteria used to assess all or part of a process.

Performance evaluation A type of audit in which the quantitative data generated in a measurement system are obtained independently and compared with routinely obtained data to evaluate the proficiency of an analyst or laboratory.

Population (statistical) The total aggregate of observations that conceptually might occur as the result of performing a particular operation in a particular way. For example, the soil comprising a PRS or PRS aggregate.

Population unit The smallest subunit of the population that is of interest for a particular study.

Population variability The degree to which a particular characteristic of the population varies.

Precision A concept used to describe dispersion of measurements with respect to a measure of location or central tendency. Precision may be represented by the standard deviation of a set of measurements. The standard deviation is computed as follows (assuming each measured value, x_i, is statistically independent of the others and the measured values are normally distributed about an average value:

$$s_x = \sqrt{\frac{\sum_{i=1}^{n}(x_i - \bar{x})^2}{(n-1)}}$$

where

s_x is an estimate of the standard deviation of a sample of values taken from the population of x values,

x_i is the value of a single measurement,

$\bar{x}$ is the arithmetic mean of the measured values, and

n is the number of x values used in the computation.

Prepared sample A sample treated in such a manner as to render it amenable to analysis. May include: digestate, distillate, electroplate, extract, filter retentate, filtrate, homogenate, precipitate, pulverized/sieved portion of sample, residue, etc. See also *sample derivative.*

Quality assessment sample A sample submitted for analysis, the data from which are used to assess the quality of performance of a sampling or analysis process. May include performance evaluation samples, field duplicates, field blanks, etc.

Quality assessment The overall system of activities whose purpose is to provide assurance that the overall quality control job is being executed effectively. It involves a continuing evaluation of the products and of the performance of the production system.

Quality assurance (QA) An integrated system of management activities involving planning, implementation, reporting, and quality improvement to ensure that a process, item, or service is of the type and quality needed and expected by the customer.

Quality Assurance Project Plan A formal document describing in comprehensive detail the necessary QA, QC, and other technical activities that must be implemented to ensure that the results of the work performed will satisfy the stated performance criteria.

Quality control The overall system of activities whose purpose is to control the quality of a product or service while work is in progress so that the product or service meets the needs of users.

Quality control (QC) sample A sample which, upon analysis, provides information useful for adjusting, controlling, or verifying continuing acceptability of sampling or and analysis activities that are in progress.

Quality indicators Quantitative statistics and qualitative descriptors used to interpret the degree of acceptability or utility of data to the user. Indicators of quality include precision, bias, representativeness, reproducibility, comparability, and statistical confidence.

Quality management That aspect of the overall management system of the organization that determines and implements the quality policy. Quality management includes strategic planning, allocation of resources, and other systematic activities (e.g., planning implementation, and assessment) pertaining to the quality system.

Quality Management Plan (QMP) A formal document that describes the quality system in terms of the organizational structure, functional responsibilities of management and staff, lines of authority, and required interfaces for those planning, implementing, and assessing all activities.

Quality system A structured and documented management system describing the policies, objectives, principles, organizational authority, responsibilities accountability, and implementation plan of an organization for ensuring quality in its work processes, products (items), and services. The quality system provides the framework for planning, implementing, and assessing work performed by the organization and for carrying out required QA and QC.

Radioactive tracer A radioactive material added to, or induced in, a sample for the purpose of monitoring chemical or physical losses of the target analytes. The tracer is assumed to behave in the same manner as that of the target analytes.

Radioactive waste Waste material containing radionuclides, or contaminated by radionuclides.

Random Being or relating to a member of a set (1) whose members have equal probability of occurring or (2) from which each member has equal probability of being selected. Frequently applied to selection of sampling points. Should not be confused with haphazard.

Relative precision (See also *Precision*) The precision measured relative to a particular value. Relative precision expressed as the relative standard deviation (RSD) may be calculated as follows:

$$RSD = \frac{s_x}{\bar{x}} \times 100\%,$$

where

s_x is the standard deviation, and

$\bar{x}$ is the arithmetic mean of all the measurements used to compute the standard deviation.

Remediation The process of reducing the concentration of a contaminant)or contaminants) in air, water, or soil media to a level that poses an acceptable risk to human health.

Replicate measurement A re-analysis (remeasurement) of a prepared sample.

Replicate sample One of multiple samples taken from and expected to be representative of the same population and carried through all steps of the sampling and analysis procedures in an identical manner. One type of replicate sample is a duplicate sample.

Representativeness A measure of the degree to which data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition.

Rinsate Blank See *Equipment blank.*

Routine analysis The analysis categories of inorganics, metals, organics, radiochemistry and high explosives as defined in the current contract laboratory statement of work.

Sample A portion of a material (e.g., rock, soil, water, air), which, alone or in combination with other samples, is expected to be representative of the material or area from which it is taken. Samples are typically sent to a laboratory for analysis or inspection or are analyzed in the field, either with a portable apparatus or in a mobile laboratory. When referring to samples of environmental media, the term *field sample* may be used.

Sample derivative The material to be analyzed that results from subjecting a sample to a sample preparation process. May include: digestate, distillate, electroplate, extract, filter retentate, filtrate, homogenate, precipitate, pulverized/sieved portion of sample, residue, etc. See also *prepared sample.*

Sample matrix In chemical analysis, that portion of a sample which is exclusive of the analytes of interest. Together, the matrix and analytes of interest form the sample.

Screening Action Level (SAL) Medium-specific concentration level for a chemical derived using conservative criteria. The derivation of a SAL is most often based on low risk under a very restrictive exposure scenario, but if a regulatory standard exists and is less than the value derived by this risk-based computation, it will be used for the SAL.

Selectivity The ability of a chemical analysis method or physical measurement system to discriminate among the responses for individual variables of interest when a mixture of the variables is being measured. Selectivity for chemical analyses may be enhanced by changing sample preparation methods or by changing analysis methods or conditions.

Self-assessment Assessments of work that does not produce manufactured items. In environmental data operations or engineering projects, such as activities include design, inspection, laboratory and/or field analysis, repair, and installation.

Sensitivity An indication of the lowest analyte concentration that can be measured with a specified degree of confidence.

Service The category of economic activity that does not produce manufactured items. In environmental data operations or engineering projects, such activities include design, inspection, laboratory and/or field analysis, repair, and installation.

Shall Denotes a requirement that is mandatory and has to be met.

Should Denotes a guideline or recommendation.

Single blind sample A sample submitted for analysis whose composition is known to the submitter but not to the analyst, although the analyst might be aware that the sample is not a routine environmental sample.

Site-specific performance evaluation sample A sample of known composition with respect to selected analytes which, upon analysis, is expected to yield results that fall within a prescribed range. Performance evaluation samples are selected to mimic as closely as possible those matrices representative of environmental samples from a particular location. They may be naturally occurring materials or manufactured materials that have been characterized exhaustively, at least with respect to selected analytes and with respect to interferences associated with quantifying those analytes by selected analysis methods.

Split sample A sample that has been subdivided into two or more portions expected to be of the same composition. Used to characterize within-sample heterogeneity, sample handling, and measurement variability.

Standard operating procedure (SOP) A written document that details the method for an operation, analysis, or action with thoroughly prescribed techniques and steps, and that is officially approved as the method for performing certain routine or repetitive tasks.

Surrogate compound An organic compound used in the analyses of organic analytes that is similar to the target analytes in chemical composition and behavior in the analytical process but is not normally found in the field samples.

Third Party Implementable Enough information is provided at a level of detail that enables any qualified party to execute the plan as intended.

Total measurement error The sum of all errors that occur from sampling through reporting of results; the difference between the reported result and the true value of the population that was to have been sampled.

Total Quality Management (TQM) The process of applying quality management to all activities of the organization, including technical and administrative operations. See *Quality Management* and *Quality System.*

Trip blank A sample of analyte-free media taken to the sampling site and returned to the analytical laboratory unopened along with samples taken in the field. It is stored with the samples until the samples have been analyzed. Used to monitor cross contamination of samples during handling and storage both in the field and in the analytical laboratory.

Variance (statistical) The square of the standard deviation (See *Precision*). A concept used to describe the dispersion of measurements with respect to a measure of location or central tendency.

ACRONYMS AND ABBREVIATIONS

AAS	atomic absorption spectroscopy
ADS	activity data sheets
AEC	Army Environmental Center
ASTM	American Society for Testing and Materials
CLP	Contract Laboratory Program
CMS/CMI	corrective measures study/corrective measures implementation
COC	chemical of concern
COPC	chemical of potential concern
CRDL	contract-required detection limit
DOE	US Department of Energy
DQA	data quality assessment
DQO	data quality objective
DSC	Decision Support Council
EDL	estimated detection limit
EPA	US Environmental Protection Agency
EQL	estimated quantitation limit
ER	Environmental Restoration
FIMAD	Facility for Information Management, Analysis, and Display
FPL	Field Project Leader
GC	gas chromatography
GC/MS	gas chromatography/mass spectrometry
HAZWOPER	hazardous waste operator and emergency response
HE	high explosive
HSWA	Hazardous and Solid Waste Amendments
ICP(ICPAES)	inductively coupled plasma
IWP	Installation Work Plan
LANL	Los Alamos National Laboratory
NFA	no further action
NRAS	nonroutine analytical services
OM	on-site measurements
PE	performance evaluation
PP&C	Project Planning and Control
PRS	potential release site
QA	quality assurance
QAO	Quality Assurance Officer
QAPP	Quality Assurance Project Plan
QC	quality control
QMP	Quality Management Plan
RAS	routine analytical services
RCRA	Resource Conservation and Recovery Act
RFI	RCRA facility investigation
RPF	Records-Processing Facility
SAL	screening action level
SAP	sampling and analysis plan
SCA	site characterization analyses
SMO	Sample Management Office
SOP	standard operating procedure
SOW	statement of work
TCLP	Toxicity characteristic leaching procedure
TIC	tentatively identified compound
USATHAMA	US Army Toxic and Hazardous Materials Agency
UTL	upper tolerance level
VCA	voluntary corrective action
VOC	volatile organic contaminant/compound
VOST	volatile organic sampling train

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5.0 RECORDS MANAGEMENT PLAN

5.1 Introduction

This plan constitutes the Records Management Program for the Environmental Restoration (ER) Project at Los Alamos National Laboratory (the Laboratory). It supports environmental cleanup work conducted by the Department of Energy (DOE) and the University of California (UC) by establishing general guidelines for records management, including technical data. Specific actions for managing project records are implemented through quality procedures (QPs), administrative procedures (APs), standard operating procedures (SOPs), and management guidance documents. The guidelines have been developed in cooperation with the ER Project's quality assurance staff and the Laboratory's Computing, Information, and Communication Division staff.

5.1.1 Organization of Records Management Plan

This plan interfaces with other chapters of this Installation Work Plan mandated by the Hazardous and Solid Waste Amendments (HSWA) Module of DOE/UC's permit to operate the Laboratory under the Resource Conservation and Recovery Act (RCRA) (EPA 1990, 0306). This plan contains seven major sections: Section 5.1, the introduction, presents the organization, regulatory mandate, purpose, objectives, and terminology of the plan. Section 5.2 describes records management procedures and their implementation. The ER Project's Records-Processing Facility (RPF) and Facility for Information Management, Analysis, and Display (FIMAD) are described in Section 5.3. Sections 5.4 through 5.7 describe how records management is coordinated with the quality program, the health and safety program, project management, and public involvement activities.

5.1.2 Regulatory Mandate

The development and implementation of this plan are mandated by the HSWA Module. General requirements for data management are presented in Task II, Section B, of the HSWA Module, but many other references to technical data are made throughout the document. The manner in which documentation of work performed under the permit is managed is of primary importance. Proper records management ensures the integrity and intended function of the data and documentation submitted to the New Mexico Environment Department (NMED) and the Environmental Protection Agency (EPA). The ER Project's records also include the publicly accessible documentation that makes up the administrative record (AR) file as required by the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (DOE 1991, 0560; EPA 1990, 0559).

5.1.3 Objectives

The Records Management Program Plan establishes the framework necessary to

- provide general guidelines to process, manage, store, and protect records relevant to work conducted under the HSWA Module;
- provide an ongoing tool to support the technical efforts of DOE, UC, and its ER Project contractors;
- provide an opportunity for public involvement; and
- provide a support system for management decisions throughout the life of the project.

The plan addresses project needs for all forms of technical data, project records, photos, site reference literature, and other documentation. The records are collected, organized, indexed, microfilmed, stored, and protected with the goal of providing efficient use and retrievability to a diverse group of users. This goal applies to both manual and automated methods of handling records. The plan enhances interactions with the local community, adjacent communities, the NMED, EPA Region 6, DOE, and other parties who may have an interest in the ER Project at the Laboratory.

The objective of this framework is the effective management of records generated and/or used by the ER Project at the Laboratory, regardless of their physical form or characteristics. It is important that the plan be consistently implemented to provide an auditable and legally defensible system for records management. Coordination with other aspects of the ER Project is important for achieving useful projectwide guidelines for managing records and obtaining technical data, which, in some cases, are not reproducible.

5.1.4 Terminology

Terminology must be consistent to ensure that information is correctly conveyed to the reader of this plan. Definitions for records, technical data, information, and other terms are varied and rigorously debated. To ensure consistent use of terms, the statutory definition for "records" (44 USC 3301) is used. "Records" are ". . . 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 Project records. This usage is also consistent with the General Records Schedules for environmental records, as defined by the National Archives and Records Administration (1989, 0357).

5.2 Description of the Records Management Program

This plan delineates how ER Project records are handled to ensure the integrity and protection of information, efficient, centralized, and cost-effective access, and legal and technical defensibility.

5.2.1 Work Flow, Procedures, and Control

The plan incorporates a threefold approach based on records control and commitment to quality program guidelines. This approach includes the following precepts:

- structured work flow for records—records control is maintained through a structured work flow and processing procedure for records.
- use of approved procedures—auditable quality program requirements are met through the documented use of approved procedures by appropriately trained employees.
- referable information base—ER Project records are part of a compilation of an information base accessible to ER Project participants and the public while providing records protection through a documented process of change control.

5.2.2 Plan Implementation

5.2.2.1 Structured Work Flow for Records

The RPF functions as an interim repository for records while they are being processed for the ER Project.

5.2.2.1.1 Submittal of Records

ER Project participants must submit their records to the RPF. Records must be submitted in accordance with the "Procedure for LANL ER Records Management" (LANL-ER-AP-02.1). ER records normally are used to make a decision or they document the normal and routine course of conducting ER work. Documentation pertaining to decisions, including technical data, must be submitted to the RPF for inclusion in the AR. This documentation may take the form of RCRA facility investigation (RFI) reports or similar records documenting project decisions.

Participants are required to review their records to determine whether the information represents an ER record as defined in the procedure. This determination can be made in two ways:

- ER records are those specifically identified in QPs, APs, SOPs, ER Project plans, and management guidance documents;
- ER records are those identified at the discretion of ER Project participants as essential to the project and required for the functioning and/or interests of the ER Project.

Records are reviewed for legibility, completeness, sensitivity, and appropriateness to the publicly accessible AR file located on the Laboratory's RPF home page on the Worldwide Web. In the case of legally privileged or otherwise sensitive records, it may be necessary to summarize these records. These actions are taken with the advice and cooperation of the Laboratory's Legal Counsel/General Law and the Facilities, Security, and Safeguards offices.

5.2.2.1.2 Records Flow

Figure 5-1 is a detailed diagram of records flow in the ER Project. The model addresses the general types of records, showing how they proceed through processing from the time of generation to final disposition.

5.2.2.2 Use of Approved Procedures

Project records are processed under auditable procedures. Personnel involved in processing records are trained and documented in the use of applicable procedures.

5.2.2.3 Referable Information Base

Records sent to the RPF and the FIMAD provide a base of information to which all project participants can refer. They include records that document ER Project activities at the Laboratory, as well as certain records originating outside the ER Project that have been submitted in accordance with the records management procedure. When the originator needs to change a record in the referable information base, he/she completes an ER record correction form (LANL-ER-AP-02.1). This process ensures that ER Project participants have access to the latest version of the record.

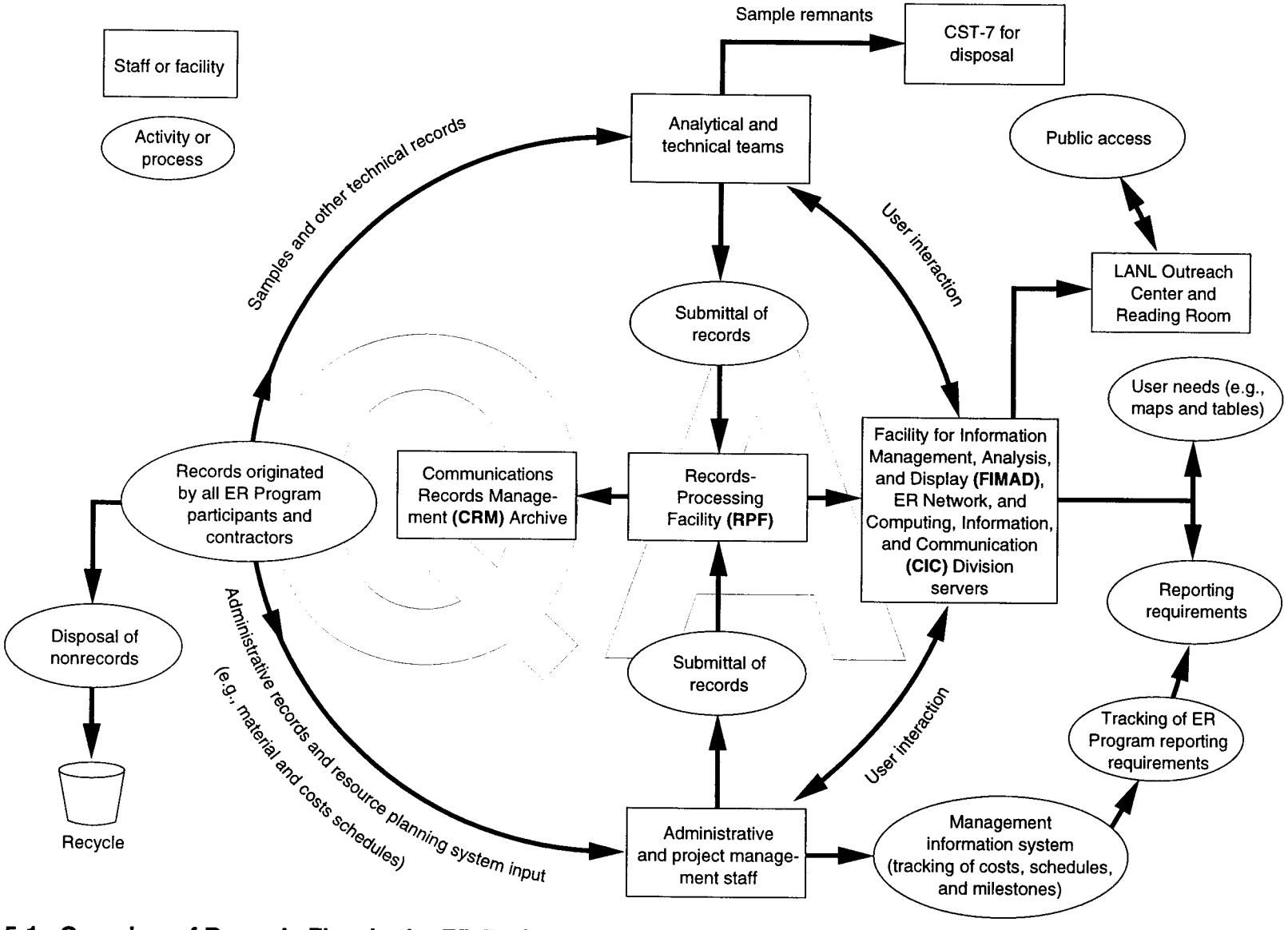

Figure 5-1. Overview of Records Flow in the ER Project.

5.2.3 Special Topics

5.2.3.1 Field Records

This Records Management Plan is the basis for managing records for all ER field projects at the Laboratory and meets the HSWA Module requirement for a data management plan. The QPs, APs, and SOPs define records requirements for technical work and typically address such matters as how to document samples, measurements, survey locations, and activity logs. In accordance with LANL-ER-AP-02.1, project participants protect the resulting field records on site until they are submitted to the RPF.

5.2.3.2 Technical Data

5.2.3.2.1 Data Validation

The process for validating data obtained from sampling addresses replicate measurements, identifies outlying values, and explains results determined to be below contaminant detection limits. These conditions are handled in accordance with ER Project SOPs and RFI guidance (EPA 1989, 0088), if applicable. The user may develop alternative means for handling inconsistencies in data as long as the method is documented, reproducible, and technically defensible. Any reduction of data must be documented in accordance with relevant SOPs.

5.2.3.2.2 Data Analysis

Once technical data have been submitted, they become part of the project's referable information base (Section 5.2.2.3). The FIMAD provides tools for preparing tabular and two- and three-dimensional graphical displays of data, generating maps, performing statistical analyses, and sorting data according to various parameters. This meets requirements specified in ER Project SOPs and the RCRA Corrective Action Plan (EPA 1988, 0295).

5.2.3.3 Records Working Group

An ad hoc team of project participants may need to meet periodically to resolve special issues related to records or specific technical data. The group comprises project participants with appropriate expertise and is selected and activated as needed by the manager of the ER Project (or designee).

5.2.3.4 Administrative Record

An AR, as required under 40 CFR 300 (EPA 1990, 0559), is the body of documentation that forms the basis for making a decision about a site. It also acts as a vehicle for public participation in the process of making a decision. There is a difference between ARs and AR files. To avoid the impression that a body of documentation is complete, it is called an "administrative record file" before completion of decisions and an "administrative record" upon their completion. The AR continues to serve as a historical record of the response selection. A queriable listing of documents referred to as the AR Electronic Index is accessible on the RPF's home page. Public access is available at the Laboratory's Outreach Center and Reading Room.

5.3 Description of the ER Project's Information Management Facilities

5.3.1 Records-Processing Facility

The RPF receives and processes ER Project records. The RPF maintains working copies of records used in compiling site histories for potential release sites (PRSs). Original submittals and a micrographic copy are sent to the Laboratory's Computing, Information, and Communications Division or a similar long-term storage facility to ensure compliance with NQA-1 (ANSI/ASME 1989, 0018) requirements for retention and protection. The RPF is the central location of the AR file and works closely with the Laboratory's Community Involvement and Outreach Office to fill records requests by the public sector. The RPF also functions as an information repository to assist project participants in conducting their work, particularly in locating site historical information, which may influence cleanup decisions. As part of this function, it provides the capability to retrieve records based on a variety of parameters such as subjects, originators, technical areas, dates, PRSs, and structures.

5.3.2 Facility for Information Management, Analysis, and Display

The ER Project Office established the FIMAD to provide the tools, systems, and expertise needed to support the large amount of spatial and tabular data collected as part of the ER Project. This information is readily available to project participants through a variety of media, including a network of workstations and X-terms. The FIMAD taps the expertise of diverse specialists who focus on different aspects of the ER Project's data needs yet work together to solve complex problems in data storage, visualization, and analysis.

5.3.2.1 System Capabilities

The FIMAD's capabilities are

- geographic analysis, which uses the ARC/INFO Geographic Information System (GIS) with ARC/View as the sophisticated graphical user interface;
- GIS capability, which is focused on data that are spatial in nature (location of buildings, roads, rivers, sample sites, boreholes, etc.);
- GIS specialists, who produce customized maps and perform complex spatial analysis (e.g., identify boreholes that penetrate the aquifer and are statistically within a certain distance of the action level);
- a database management team that uses the ORACLE relational database and focuses on specifying, constructing, and maintaining the complex database structures necessary to store a wide variety of data;
- expertise to understand the visualization and analysis needs of the ER Project and to meet these needs either by finding suitable commercial software or by developing in-house applications;
- provision of efficient and appropriate computer resources to access, maintain, and analyze data; and
- maintenance of an automated backup and copy to a disaster recovery facility.

5.3.2.2 Data Acquisition and Quality Control

ER Project participants have access to FIMAD database tables so that they can review and provide updated information. Only authorized personnel may modify data and then only under stringent documentation requirements. The FIMAD staff are also responsible for ensuring the quality of data originating at the FIMAD (e.g., orthophoto data and much of the GIS database). Project participants who provide data to the FIMAD for electronic conversion are responsible for the accuracy of the data they submit to the FIMAD.

5.3.2.3 Configuration Management

Configuration management is implemented as a means of accounting for, controlling, and reporting the planned and actual design of components for FIMAD. Configuration management ensures that the latest version of the whole system is always approved and accessible and meets the requirements set forth in DOE Order 5480.CM. The end product of configuration management is formal documentation of the process of systems development to permit identification of relevant configuration at any given period in the life of the ER Project. The documentation follows accepted practices for designing and developing information systems. Configuration management during development of FIMAD allows flexibility in selecting system components.

5.3.3 Integrated Capabilities of RPF and FIMAD

The ER Project uses a hybrid approach to records management that incorporates the power and functionality of imaging technology and the reliability and wide acceptance of micrographics.

5.3.3.1 Optical Disk Storage

Optical storage systems efficiently store enormous volumes of information. Optical disk storage is used at the FIMAD to efficiently store and disseminate information via the FIMAD network. Legal issues related to optical disk storage are accommodated through the use of micrographics, as described below.

5.3.3.2 Microfilm

Industry standards for microfilming technology are reliable and widely accepted; therefore, this technology is used for capturing most ER Project records. The ability of the human eye to read a record on microfilm compensates for the lack of hardware standards in some components of optical disk systems. Microfilm standards and legal defensibility are well established. Microfilm may also be used to transmit color graphics information or may be used as the source for digitizing project records in the future.

5.3.3.3 File Standards and Compatibility

The ER Project uses several different operating systems, including MS-DOS, Apple, UNIX, and the Virtual Memory System, that are not directly compatible. The problem of file compatibility is neither unique to the ER Project nor is it simple. This plan specifies using systems that adhere to existing standards and protocols to exchange information.

5.3.4 Progress in Technology

Changes in hardware and software technology are frequent and substantial and demand that attention be given to industry standards. How a product fulfills regulatory requirements for records retention, data access, and legal defensibility influences which products are selected. Personnel assigned to operate and maintain the RPF and the FIMAD keep abreast of industry trends and recommend conversions and/or modifications to the system, as necessary, to keep it a viable component of the ER Project.

Retention requirements for many records extend well beyond the typical life of systems currently used. Retention requirements are met by converting records, when practicable, to archive-quality micrographic media, subject to regulatory guidelines and approval. The ER Project currently uses an "indefinite" records retention period until the Laboratory's Information Resource Management Program is fully implemented.

5.4 Coordination with the Quality Program

LANL-ER-AP-02.1, approved by the quality project leader, is used for managing ER Project records. The procedure and subsequent updates are written in accordance with LANL-ER-AP-01.1, "Preparation, Review, and Approval of Administrative Procedures." The procedure is used uniformly throughout the ER Project to achieve the objectives of this plan and to fulfill the obligations defined in the HSWA Module.

5.4.1 Records Protection Before Submittal

Project participants must protect records resulting from ER Project activities. The originator should protect the records until they are submitted to the RPF in accordance with LANL-ER-AP-02.1. The protection is accomplished in a manner appropriate to the value and reproducibility of the information contained in the records.

5.4.2 Records Protection During Submittal

Because of the nature of mail services and the inherent risk of transporting documents, records may be at risk during transport. Originators must apply good judgment based on the value of information contained in the submittal. Specifically, if a document contains irreplaceable information, it should be hand-carried to the RPF to afford adequate protection until it is processed and turned over to the Computing, Information, and Communication Division for long-term protection.

5.4.3 Records Protection after Submittal

Records submitted to the RPF are processed in accordance with LANL-ER-AP-02.1 and other procedures specific to the RPF. During the processing stage, indexing information and the original record 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. (1986, 0358).

Upon receipt of the records, the RPF takes the following steps:

- reviews record for legibility and completeness;
- complete indexing for each record received;
- make a microfilm copy of the record;

- enter the indexing information and microfilm address in the ER record data base; and

- forward the original record and a microfilm copy to the Computing, Information, and Communication Division for long-term protection; working copies of the records are made available at the RPF and are queriable on bibliographic and indexing information in the RPF's home page on the Worldwide Web (http://iosun.lanl.gov:3001/).

5.5 Coordination with the Health and Safety Program

Certain health and safety records that result from ER Project activities are included in the referable information base. This information pertains to health and safety training and medical surveillance of each person working at a PRS. Because of the personal nature of certain types of medical information, many records are appropriately maintained in the Occupational Medicine Group (ESH-2) database or by participating contractors. Training records are maintained by the ER Project Office and in some cases by the contractors. ER training records contain information regarding the completion of training, the dates of required refresher training, and the site(s) each worker visits regularly. The information fields include

- a unique identifier for each worker,

- employer,

- dates required training was completed,

- dates of required refresher training,

- site(s) worker visits regularly, and

- field unit association.

5.6 Coordination with the Project Planning and Control Team

The ER Project Planning and Control Team (PP&C) coordinates, summarizes, and maintains the information in the performance measurement baseline in compliance with DOE-Albuquerque Environmental Restoration Division and DOE-Los Alamos Area Office guidance and is founded in the principles outlined in DOE Notice 4700.5/6 and the DOE Life Cycle Asset Management Order. The performance measurement baseline includes information on project assumptions, cost estimating, scheduling, time-phased budgets, and important project milestones and deliverables. Certain PP&C documents and the monthly reports to DOE are copied to the RPF to document project decisions. Any approved changes to the performance measurement baseline are incorporated by the PP&C team and field project leaders (FPLs) through a baseline change control process. These changes and the subsequent documentation are also copied to the RPF.

The software packages used by the PP&-C staff provide the capability for generating and analyzing the reporting documents required by the ER Project and DOE. The platform used for baseline development and management consists of Primavera Project Planner for scheduling and establishment of the performance measurement baseline, Excel for performance reporting, and G2 for estimating. Its basic structure is characterized by a risk-based graded approach to system design. In addition, the system as a tool is quite robust and reflects a conscious effort to accomodate different management styles and techniques. Its three basic elements consist of baseline development, performance reporting, and change control.

5.7 Coordination with the Public Involvement Program

The RPF staff works closely with the ER Project staff; Community Involvement and Outreach Office; Environmental Management Program's Policy and Public Involvement Office; Legal Counsel/ General Law; Public Affairs; and Facilities, Security, and Safeguards to facilitate timely public awareness and access to ER Project documentation.

5.7.1 Access to the Administrative Record

An AR, as required under 40 CFR 300, is the body of documentation that forms the basis for making a decision at a site. It also acts as a vehicle for public participation in the process of making a decision. The AR Electronic Index (Section 5.2.3.4) is available for public use during established hours of the Laboratory's Outreach Center and Reading Room (Chapter 7).

5.7.2 Public Information Repositories

The Laboratory and ER Project maintain several information repositories for public use in Los Alamos and surrounding communities. These repositories are listed in Section 7.1. In general, they contain final ER Project plans and reports expected to be of interest to the public, whereas, the RPF contains the backup documentation. Detailed information on the kinds of materials available in the public information repositories may be obtained from the points of contact given in Section 7.1.

5.7.3 Sensitive Documents

Documents not subject to public access are those that fall under sensitive categories (such as attorney work product, attorney-client privileged documents, and personal information) and documents that have no direct relevance to making a decision. However, even documents that are unavailable for public review are listed in the AR Electronic Index for the public's information at the Laboratory's Outreach Center and Reading Room.

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6.0 HEALTH AND SAFETY PLAN

6.1 Introduction

6.1.1 Purpose and Applicability

The Environmental Restoration (ER) Project at Los Alamos National Laboratory (the Laboratory) has developed a health and safety plan (HASP) to comply with applicable US Department of Energy (DOE) and federal and state occupational safety and health requirements. The HASP establishes generic health and safety (H&S) information and requirements applicable to ER field operations projectwide.

This Chapter 6 of the Installation Work Plan (IWP) is based on the HASP. The differences between this chapter and the HASP are that (1) some of the detail in the body of the HASP does not appear in this chapter, (2) the HASP contains several appendices that are cited in this chapter but have not been included in the IWP, and (3) to meet new requirements and changing project needs, the HASP is continuously updated; the changes that occur in the HASP in 1996 will be reflected in the next annual revision of the IWP.

In addition to the generic guidance published in this chapter, a site-specific health and safety plan (SSHASP) will be prepared for each field project as assigned by the field project leader (FPL). As used in this chapter, "field project" refers to investigation or cleanup of a potential release site (PRS) or group of PRSs. Each SSHASP supplements the HASP by providing additional H&S information and requirements indicated by the operations and conditions at individual project sites.

The Laboratory acknowledges that potential hazards are inherent in the performance of ER field operations. Accordingly, the Laboratory expects that work conducted under the ER Project will be performed in a safe and healthful manner that minimizes the threat and occurrence of hazards to health, property, and the environment to levels as low as reasonably achievable (ALARA). In the interest of protecting health and property (the Laboratory's personnel and property, the local public and their interests, and the personnel and equipment involved in conducting ER work), programs, plans, and procedures associated with the performance of ER field projects are subject to approval by designated Laboratory representatives before implementation. However, such approval in no way relieves ER participants from complying with specific regulatory requirements pertaining to H&S programs, plans, procedures, and work practices, nor does such approval relieve ER participants from their responsibility for maintaining a safe and healthful work environment. The term "ER participants" refers to anyone performing work, including DOE and Laboratory personnel, federal and state oversight personnel, subcontractor personnel, and their lower-tier contractors, consultants, and agents (see Section 6.3.1 on Visitor Policy).

Furthermore, ER Project participants are responsible for conducting work in accordance with applicable federal, state, and local regulations. In some cases in this chapter and as indicated in the SSHASP, the Laboratory has chosen to invoke Occupational Safety and Health Administration (OSHA) and Laboratory requirements that ordinarily might not apply to ER field operations [e.g., OSHA's general industry standards in Part 1910 of Title 29 of the Code of Federal Regulations (DOL 1994, 1256)]. These choices were made on a case-by-case basis to maintain consistency with the Laboratory's ALARA policy and to clarify the Laboratory's expectations with regard to interpretable requirements of the multiple agencies governing ER work.

When there is concern that implementation of work orders or H&S requirements would conflict with contract terms or could unreasonably compromise the safety or health of an individual or the environment, such concerns should be brought to the attention of the contract administrator and the

field unit H&S representative (Section 6.3.3.2) immediately. Failure to comply with the terms of H&S plans may constitute cause to stop activity or to issue a stop-work order as specified in Section 6.3.4 without cost or penalty to the Laboratory.

The ER Project has provided to project participants the ER Project HASP consisting of the material in this chapter and appendices containing forms and procedures. It has also provided a model SSHASP. Both the HASP and the completed SSHASP for each project shall be kept readily available for reference by individuals performing ER field operations and shall govern the conduct of work at the applicable site(s).

6.1.2 Review and Approval

Before any work is initiated, the project team shall submit a completed SSHASP, in draft form, to the H&S representative for the field unit, who will circulate it to appropriate Laboratory personnel for review and approval. Each SSHASP submitted must be signed by an authorized representative of each ER participant-employer whose employees are subject to the terms of the SSHASP. The employer's signature on the signature page shall serve as a certification that the employer has reviewed, concurs with, and will comply with the terms of the HASP and SSHASP. After signing the signature page, the FPL shall return the SSHASP to each employer.

Additionally, each individual who needs to enter a controlled area of a site where access has been limited in accordance with a SSHASP shall sign an acknowledgment form (Appendix A of the HASP) to acknowledge that he/she has read or has been briefed on and understands the contents of the HASP and applicable SSHASP and agrees to abide by the terms of these documents.

6.1.3 Updating and Numbering Health and Safety Documents

Evolutionary changes in H&S information and requirements that apply projectwide will be incorporated in the annual updates of this document. Any exceptions or deviations from the HASP must be described along with the rationale in the applicable SSHASP.

SSHASPs may be revised at any time to include new information and changes that make the SSHASP more useful (e.g., new site data based on contaminant sampling and monitoring, recent survey information, and changes in site conditions or work practices). Once the SSHASP has been approved, revisions will be tracked using a SSHASP modification form (Appendix B of the HSAP). Modifications in a SSHASP may necessitate change in the terms or scope of a contract. Completion of a SSHASP modification form is <u>not</u> the means for modifying the scope or terms of the project contract. To modify a contract under the changes clause, the subcontractor shall notify the contract administrator and field unit H&S representative (Section 6.3.3.2) and shall not proceed with the change until all parties agree through a change order or unless the contract administrator unilaterally directs the contractor to proceed with the change.

Generally, SSHASP modifications are completed by the site safety officer. Modifications in the SSHASP must be signed by a duly authorized representative of each party (including subcontractors and lower-tier subcontractors, consultants, or agents) affected by the modification(s) who has authority to approve of or concur with the terms of the modification(s). Changes to the SSHASP shall be communicated to affected individuals before implementation during tailgate H&S meetings (Section 6.10.1.4).

When a draft SSHASP is submitted for Laboratory review, ESH-5 will issue a unique document control number, which shall appear on the title page and in the footer of each page of the document. Each modification form shall be consecutively numbered using the SSHASP number (X), followed by a decimal point and a numeric suffix (e.g., X.01 or X.02) to indicate the modification number

sequentially.

6.2 Background Information

General background information descriptive of Los Alamos (i.e., location and prevailing weather conditions) is provided in the HASP (Section 2). Background information specific to the project is provided in the SSHASP (Section 2), including the project's scope of work and descriptions of the PRS(s).

6.3 Organization, Responsibilities, and Authority

The policies and personnel roles and responsibilities provided in this section have been established by the Laboratory to clarify expectations of ER participants and to comply with the requirements of 29 CFR 1926.65(b)(2) (DOL 1994, 1257).

6.3.1 Visitor Policy

A visitor (e.g., regulatory personnel, property owners, field auditors, and the public) is anyone who arrives at the work site who is not identified as a field team member or who does not appear in Table 3-1 of the SSHASP. When a visitor arrives, the site safety officer, field team leader, or delegate, should meet with him/her to ascertain the purpose of the visit.

Visitors are not permitted to enter controlled work zones where access has been limited unless absolutely necessary. In such cases, the visitor shall be briefed per Section 6.10.1.3, shall meet all applicable requirements of the HASP and SSHASP, and may need to be accompanied by an escort at the discretion of the field team leader. If a visitor does not comply with these requirements, the field team leader, or delegate, shall request the visitor to leave the controlled zone immediately or shall limit site operations to minimize threat of harm to the visitor (e.g., have the field team take a break, reset the zone boundaries if appropriate, or temporarily discontinue any threatening task). Alternatively, if a visitor needs to observe work being performed in a controlled zone that is not readily visible from outside the zone(s), videotaping or photographing the work should be considered.

6.3.2 Project Team Personnel

6.3.2.1 Line Managers

6.3.2.1.1 Field Project Leader

The FPL is a member of the Laboratory's staff and reports to the manager of the ER Project. The FPL is the project manager as defined by "Construction Project Safety and Health Management" (DOE 1994, 1153). The FPL is the line manager for his/her field unit and may direct one or more field team managers (Section 6.3.2.1.2) or field team leaders (Section 6.3.2.1.3).

The FPL is responsible for ensuring that provisions of the HASP, SSHASP, and other applicable H&S regulations are observed for field operations under his/her management. In addition, specific health and safety responsibilities of the FPL, or his/her delegate, include

- managing H&S activities of his/her field unit;

- serving as the final authority for resolving H&S issues concerning his/her field unit;
- ensuring that the necessary SSHASPs for his/her field unit are developed and that the comments of the field unit H&S representative and any other appropriate parties have been incorporated;
- ensuring that each individual performing ER work at his/her field unit is qualified in accordance with applicable H&S requirements;
- ensuring that onsite personnel abide by applicable H&S programs, procedures, plans, and applicable regulations;
- having the authority to ban personnel who do not abide by applicable H&S requirements from performing field operations;
- conducting inspections as required by Section 6.12.1; and
- ensuring the submittal of appropriate field project H&S records to the Laboratory's Records-Processing Facility (RPF).

6.3.2.1.2 Field Team Manager

The field team manager, who may be either a Laboratory staff member or contractor, reports to the FPL and is the line manager of one or more field teams. This person is the construction manager as defined by "Construction Project Safety and Health Management" (DOE 1994, 1153). Specific H&S responsibilities of the field team manager, or delegate, include

- coordinating with the FPL to ensure that provisions of the HASP, SSHASP, and other applicable H&S regulations are implemented for assigned field operations;
- ensuring that all known tasks and personnel have been identified sufficiently in the SSHASP;
- coordinating with the FPL to ensure that each concerned party has reviewed the SSHASP for accuracy and adequacy in accordance with Section 6.1.2, that review comments are resolved, and that the SSHASP is signed before any field activities are begun;
- coordinating with the FPL to ensure that only personnel qualified in accordance with applicable H&S requirements are used to perform ER Project work;
- coordinating with the FPL and the field unit H&S representative to select qualified H&S and health physics personnel;
- coordinating with the FPL to ensure that the necessary permits have been obtained before commencing field operations;
- conducting inspections as required by Section 6.12.1;
- coordinating with the FPL to ensure that necessary H&S records are produced and kept in accordance with the SSHASP; and

- coordinating with the FPL to provide necessary H&S records to the FPL at the close of the project.

6.3.2.1.3 Field Team Leader

The field team leader, who may be either a Laboratory staff member or a contractor, reports to the field team manager (or in some cases directly to the FPL, in which case, the responsibilities of the field team manager should be delegated to the field team leader by and at the discretion of the FPL). This person is the line manager for his/her field team. He/she oversees the work of one or more supervisors assigned to the field teams, the field team members, and the site safety officer. The field team leader or delegate

- coordinates with the field team manager and/or FPL to ensure that the provisions of the HASP, SSHASP, and other applicable H&S regulations are implemented for assigned field operations;
- coordinates with the field team manager and/or FPL to ensure that only field team members and support personnel qualified in accordance with applicable H&S requirements are allowed to perform field operations;
- coordinates with the field team manager and/or FPL to ensure that field team members attend H&S briefings and daily H&S tailgate meetings before beginning field operations;
- coordinates with the field team manager and/or FPL to ensure that the necessary preventative planning and employee training for emergency situations has occurred before beginning field operations (Section 6.9);
- coordinates with the field team manager and/or FPL to ensure that site control measures and hazard prevention and mitigation controls are implemented accordingly (Sections 6.4.2 and 6.5);
- ensures that a log of field activities is maintained, especially noting site personnel and visitors who enter and exit the site;
- notifies appropriate parties when action levels are reached and when personnel exposures exceed occupational exposure levels (Section 6.6);
- in the event of an incident or emergency, functions as site incident/emergency coordinator; as necessary, arranges for immediate notification of Laboratory emergency response personnel to take control of the scene; and/or arranges for immediate notification of appropriate authorities (Section 6.9); and
- coordinates with the field team manager and/or FPL to ensure that modifications to the SSHASP have been prepared and approved per Section 6.1.3 before initiating any operational changes.

6.3.2.1.4 Other Onsite Supervisory Personnel

For field teams involving multiple employers, each employer's onsite supervisory representative is responsible for ensuring that provisions of the HASP, SSHASP, and other applicable H&S requirements are observed by his/her employees during field operations. These supervisors are responsible for cooperating with the field team leader and site safety officer to resolve H&S matters

that affect site personnel and/or operations.

6.3.2.2 Field Team Members

Field team members are responsible for performing their work in a safe and healthful manner. They also are responsible for abiding by the requirements of the HASP, SSHASP, and other applicable H&S regulations and procedures and for fulfilling and maintaining their individual training and medical surveillance requirements. If there is concern that implementation of work orders or H&S requirements may unreasonably compromise the safety or health of an individual or the environment, such a concern should be brought to the attention of an immediate supervisor, the site safety officer, or the field team leader. When an H&S concern is not resolved adequately by field supervisors, the matter should be brought to the attention of the field team manger or field unit H&S representative, and, subsequently, the FPL if necessary. If adequate resolution still has not been achieved, team members are encouraged to call the Laboratory's ESH Division hotline at 665-5010 or to contact the Los Alamos DOE Area Office at 667-5105, where they may file a complaint form (DOE F 5480.4). DOE has a policy that employees who report a health and safety problem are protected from reprisal.

6.3.2.3 H&S Personnel

6.3.2.3.1 Site Safety Officer

The site safety officer assists the field team leader in seeing that the provisions of the HASP, SSHASP, and other applicable H&S requirements are observed in the field and serves as the primary contact in the field for H&S matters. The site safety officer shall be qualified, on a project-specific basis, to recognize and evaluate hazards and to minimize and mitigate occupational H&S hazards. The site safety officer may perform other duties on the field team, provided that these duties do not compromise the performance of his/her site safety officer duties. The specific responsibilities of the site safety officer are to

- assist with developing the SSHASP;
- verify that onsite personnel have current certification of the applicable training and medical surveillance requirements of Sections 10 and 11 of the HASP and SSHASP (Sections 10 and 11);
- assist the field team leader in effectively implementing the HASP and SSHASP in accordance with applicable federal, state, and local H&S regulatory requirements;
- notify the field team leader of any onsite personnel who are not abiding by applicable H&S requirements and of potential or actual hazardous situations needing to be rectified in accordance with applicable H&S requirements;
- notify the field team manager and, subsequently, the field unit H&S representative when elements of the HASP and SSHASP are not being met and when H&S hazards are not being minimized or mitigated sufficiently;
- watch for changes in site operations and conditions that warrant hazard mitigation and/or modifications in the SSHASP;
- ensure that copies of the HASP, SSHASP, and any modification forms are current and that these documents are readily accessible onsite and as needed

for ER work occurring elsewhere;

- assess the necessity of and arrange for monitoring employee exposures to H&S hazards and convey the results and known implications to the field team leader;
- notify the field team leader, the field unit H&S representative, and affected employee's(s') supervisors of the results of monitoring employee exposures (Section 6.13.3);
- monitor the levels and effectiveness of personal protective equipment and verify proper storage and maintenance of equipment;
- perform and document inspections of site operations per Section 6.12.1; and
- maintain H&S-related field project records, including a daily log of H&S-related matters concerning site operations, and provide these records to the field team manager as necessary before close of the project.

6.3.2.3.2 Industrial Hygiene Technician

The industrial hygiene technician is a designated team member who is capable of monitoring employee exposures to hazardous substances and, to the extent necessary for the site-specific work, is capable of evaluating exposure-monitoring results to determine actions necessary to protect individuals onsite. This person may be someone who is training to become a site safety officer and, with the approval of the FPL, someone to whom the site safety officer may delegate his/her responsibilities as this person is trained and qualified to perform such duties.

6.3.2.3.3 Trenching/Excavation-Competent Person

This individual is a designated team member or support person who, in accordance with 29 CFR 1910.146 (DOL 1994, 1256), is capable of identifying existing and predictable hazards in the surroundings or working conditions involving trenching or excavation that are unsanitary, hazardous, or dangerous to employees and who has authorization to take prompt corrective measures to eliminate them [29 CFR 1926.650(b) (DOL 1994, 1257)]. This person shall have had specific training in and be knowledgeable about soils analysis, the use of protective systems, and the requirements of 29 CFR 1926 Subpart P—Excavations (29 CFR 1926.650 et seq.).

6.3.2.3.4 Confined-Space-Entry Supervisor

The confined-space-entry supervisor is a designated team member or support person who is responsible for determining whether acceptable entry conditions exist at a confined-space where entry is planned, for authorizing and overseeing entry operations, and for terminating entry in accordance with regulatory and permit requirements [29 CFR 1910.146 (b), (DOL 1994, 1256)].

6.3.2.3.5 Other Competent or Qualified H&S Personnel

Throughout 29 CFR 1926 and applicable standards of 29 CFR 1910 evoked by the Laboratory, Occupational Safety and Health Act (OSHA) uses the terms "competent" and "qualified" to denote specially trained and knowledgeable individuals who are required to perform certain functions.

These specific standards are cited as applicable throughout the HASP and SSHASP. Whenever requirements exist in these standards for participation of a competent or qualified person, the person shall be trained and knowledgeable about the particular regulated subject matter in accordance with 29 CFR 1926.32(f) or (m), the applicable regulatory standard, and Section 6.10.3.

6.3.2.4 Health Physics Personnel

Health physics personnel include radiological screening personnel, health physics technicians, and radiological control technicians. These field team members are the primary source of information and guidance about radiation protection. They shall ensure compliance with the radiological requirements of the SSHASP and conduct monitoring per the radiological surveillance authorization agreement issued by ESH-1 and the terms of the SSHASP. If non-ESH-1 personnel perform these roles, ESH-1 must preapprove personnel and issue a radiological surveillance authorization agreement before any work is performed.

6.3.2.4.1 Radiological Screening Personnel

Radiological screening personnel are responsible for providing health physics monitoring support for the field team. Each radiological screening person is responsible for performing health physics monitoring support in accordance with his/her radiological surveillance authorization agreement. Specific responsibilities include

- performing and documenting radiological surveys,
- performing conditional equipment release surveys,
- performing daily instrument response checks,
- ensuring that all radiation-monitoring equipment is in good working order,
- ensuring that radiological postings are maintained,
- immediately notifying ESH-1 when an employee has been contaminated above action levels,
- providing ESH-1 personnel who oversee the ER Project with a daily verbal summary of site radiological conditions and copies of all radiological survey documentation, and
- notifying ESH-1 when action levels defined in the SSHASP have been reached.

6.3.2.4.2 Health Physics Technician and Radiological Control Technician

In addition to the responsibilities of the radiation screening personnel, the responsibilities of the health physics technician and the radiological control technician include

- preparing, ensuring compliance with, and closing out radiological work permits;
- stopping work and revising the site radiological work permit when the radiological controls required do not provide adequate worker protection or contamination control;

- providing guidance on radiological decontamination of equipment and personnel; and
- performing "unconditional release" surveys for equipment (radiological control technician only).

6.3.3 Project Support Personnel

6.3.3.1 Contractor/Subcontractor Representative

A contractor/subcontractor representative is a management or health and safety professional representing an employer affected by terms of the SSHASP. This individual must have the authority to approve the terms of the SSHASP and any modification forms and to see that employees of his/her employer abide by these terms. Additional responsibilities include

- interfacing with field project line managers, other employers' supervisory personnel, and support professionals, as necessary, to coordinate implementation of HASP, SSHASP, and other applicable H&S requirements; and
- assisting with resolving H&S issues involving employees performing ER work, particularly those issues involving discrepancies between policies of multiple employers represented onsite and site-specific H&S requirements.

6.3.3.2 Field Unit H&S Representative

The field unit H&S representative may be either a Laboratory employee or a contract employee who is assigned to one or two FPLs as a technical advisor. This person provides H&S support to personnel performing ER work involving the assigned field unit(s). This person serves as liaison between the field unit personnel and the ESH Division of the Laboratory and arranges for provision of technical assistance by ESH personnel concerning industrial hygiene, operational safety, and health physics matters. This person may also be responsible on behalf of the Laboratory for implementing the ER/H&S Oversight Program (Section 6.12.2) for field unit(s) as assigned by ESH-5 management. In addition to the responsibilities of the contractor/subcontractor representative, the field unit H&S representative has responsibilities that include

- ensuring that SSHASPs for his/her field unit(s) are reviewed by appropriate ESH groups;
- verifying that known hazards, preventive measures, and mitigation controls associated with the project scope of work and tasks have been adequately incorporated in the SSHASP;
- reviewing and approving SSHASPs and modification forms for ER work at his/her assigned field unit(s); and
- verifying that field operations associated with his/her field unit(s) are conducted in accordance with applicable H&S programs, plans, and regulatory requirements.

6.3.3.3 Registered Professional Engineer

A registered professional engineer is a person who is registered as a professional engineer in the state where the excavation or trenching work is to be performed (29 CFR 1926.650 [b]) (DOL 1994, 1257).

6.3.3.4 ESH-1 Personnel

ESH-1 will designate ESH-1 personnel to provide radiological control support to the ER Project and to conduct ER/H&S oversight duties (Section 6.12.2). In cases requiring immediate involvement by ESH-1 personnel, the field team leader or delegate may request direct ESH-1 participation. Such participation may include site visitation, the frequency of which will depend on the specific operations and radiological conditions occurring at the site. The responsibilities of the ESH-1 representative include

- performing reviews to ensure that the radiological safety program is in compliance with the Laboratory's Radiation Control Manual (LANL 1994, 1196) and applicable Laboratory requirements;
- ensuring that survey methods and equipment are appropriate for the type of radiological contamination expected and for current site conditions;
- providing direct support to field health physics personnel, when requested;
- ensuring that radiological controls are implemented in accordance with the radiological work permit (if any), the SSHASP, the Laboratory's Radiation Control Manual (LANL 1994, 1196), and any other applicable Laboratory requirements;
- ensuring that radiological surveys are performed and documented in accordance with required ESH-1 procedures;
- performing radiological surveys before the start and at the completion of field activities;
- providing guidance for radiological decontamination of equipment and personnel;
- taking the actions indicated in Table 4-3 and Section 6 of the SSHASP upon notification that the action levels given in the table have been reached;
- reviewing radiological work permits for the site;
- determining and, in some cases, providing appropriate radiological postings; and
- meeting notification and reporting requirements as specified in "Occurrence Reporting and Processing of Operations Information" (DOE 1993, 1197).

These responsibilities may be performed by designated contract personnel, provided ESH-1 has approved the subcontractor's radiological safety program to perform this work, which must be submitted to the Laboratory for approval during the prebid qualification or contract negotiation period, as required, or according to applicable requirements of Section 6.4.2.2.

6.3.4 Stop-Activity and Stop-Work Orders

Any individual observing an operation that presents a clear and imminent danger to the environment or to the health and safety of site personnel, visitors, or the public has the authority to immediately notify the individuals involved and the site safety officer or field team leader. In accordance with the Laboratory's Radiation Control Manual, radiological control technicians have the responsibility and authority to stop work or to mitigate the effect of an activity if they suspect that the initiation or continued performance of the activity will result in a violation of radiological control standards or result in imminent danger or unacceptable risk.

6.3.4.1 Stop Activity

The site safety officer or the field team leader shall notify supervisors and individuals on the site of the danger. Once it has been concluded that conditions or practices exist that pose a threat to personnel or environmental safety or health, the field team leader or other onsite supervisors or managers shall take action to diminish the immediate threat of harm. Operations shall be altered or discontinued to eliminate the immediate threat of harm, and individuals shall be directed to immediately leave an area of imminent danger. Authorization to begin the activity again shall be given by the field team leader only when it has been determined that the hazard(s) has/have been sufficiently abated and there is no further threat of harm. For example, a single activity, such as removing defective equipment or removing site personnel from a section of scaffolding that is defective, may be stopped without stopping the entire field operation. The field team leader is responsible for notifying the FPL and field unit H&S representative of activity stoppage and for determining whether the incident is reportable per Section 6.9.4.

6.3.4.2 Stop-Work Order

A formal "contractual" stop-work order can be issued only by a Laboratory contract administrator. Experts from ESH Division may provide recommendations regarding the need to issue a stop-work order by notifying the field unit H&S representative or the FPL, who will contact the contract administrator to arrange for review of the matter and will proceed in accordance with applicable internal Laboratory procedures.

6.4 Task Hazard Analysis

DOE (DOE 1994, 1153; 1147) and OSHA (29 CFR 1926.65[b][4][ii][A] (DOL 1994, 1257) require that a hazard analysis be prepared for each task to be performed during the ER field project. The task hazard analysis must identify the likely radiological, safety, chemical, physical, and biological hazards and the affected personnel so that determination can be made of the corresponding exposure-monitoring and response plans, administrative and engineering controls, site control measures, personal protective equipment, medical surveillance, training, and emergency/incident response requirements to be implemented to minimize or mitigate the anticipated site hazards.

Each SSHASP shall include a task hazard analysis (Section 4 of the SSHASP) for each of the tasks described in the project scope of work (Table 2-2 of the SSHASP). Field team participants and key H&S support personnel shall be identified in Table 4-1 of the SSHASP by the role (job title) and task(s) they are expected to perform. Then each anticipated task-specific hazard shall be assessed, as described in greater detail in this section, to determine the associated qualitative probability of occurrence of the hazard and the severity of injury/illness expected to result.

6.4.1 Hazard Assessment

According to DOE (1994, 1147), hazard assessment is the process of identifying and evaluating the hazards associated with operational activities. Evaluation and identification of hazards should occur

- during preoperational planning of ER field work,
- immediately after initiation of and during performance of tasks with potential hazards,
- before changes in tasks and/or operations,
- as required by changing site conditions, and
- continually as appropriate.

The Laboratory has provided a method for evaluating and rating hazards (Appendix C of the HASP). DOE has provided a list of several assessment methods in an appendix to its HASP guidelines publication (DOE 1994, 1147). It should be clearly stated in the SSHASP which hazard assessment method is being used.

Not all contaminants at a particular site or chemical products used during field operations pose an occupational health threat. The determination of which substances are expected to pose an occupational health threat is made by the process of hazard assessment. DOE suggests that the following criteria be used to identify the hazardous substances to be assessed:

- type, nature, form, quantity, and concentration of the hazardous substance(s);
- location of the substance(s);
- conditions under which exposure to the substance(s) may occur; and
- specific hazards associated with the substance(s).

Details of the site-specific hazard assessment of each known site contaminant and chemical product to be used shall be included in Appendix B of the SSHASP, unless there are none. Of the wide variety of potential chemicals of concern at each site, Table 4-2 of the SSHASP must include only the substances expected to pose an occupational health threat, together with the resulting hazard assessment rating. The signs and symptoms of chemical exposure, if any, shall be provided in Appendix C of the SSHASP. Corresponding detection methods, protective measures, and response actions shall be provided in Section 6 of the SSHASP.

Assessment of site-specific hazards that could result from unpredictable detonation of high explosives, exposure to radiological and safety hazards, and to chemical hazards by class of chemical are included in Table 4-3 of the SSHASP. This table shall also include the administrative and engineering controls to be implemented to prevent and/or mitigate occurrence of these hazards.

The likelihood of exposure to biological and physical hazards is fairly uniform for performance of ER tasks in and around Los Alamos. General biological hazards of concern include tick bites, rodent flea bites, poison ivy, poisonous snake bites, insect bites or stings, and transmission of bloodborne pathogens when first-aid or cardio-pulmonary resuscitation (CPR) is rendered. General physical hazards of concern include lightning strikes; slips, trips, and falls from less than 4-ft elevations; heat and cold stress; altitude sickness; and animal attacks. These hazards have been assessed by ESH-5 with input from ESH-2, assuming variable exposure conditions on a projectwide basis. Results of

this assessment, together with the symptoms of exposure, detection methods, protective measures, and response actions are provided in Table 1 of the HASP.

6.4.2 Administrative and Engineering Controls

As a first line of defense, DOE (1994, 1147) and OSHA (DOL 1994, 1256) require that employers implement administrative and/or engineering controls to prevent and/or mitigate hazards and protect site personnel. Secondarily, employers may require employees to use personal protective equipment (Section 6.7). This section addresses the basic administrative and engineering control requirements with which the Laboratory expects ER participants to comply. Site-specific administrative and engineering requirements shall be included in Table 4-3 of the SSHASP.

6.4.2.1 General Administrative Controls

The general work practices and administrative controls in Section 4.2.1 of the HASP are to be implemented as applicable during ER field operations. Requirements addressed in Section 4.2.1 of the HASP are

- drug and alcohol policy;
- housekeeping and sanitation;
- site controls; and
- packaging, labeling, handling, transport, and disposal of hazardous substances.

6.4.2.2 Required Written Programs and Permit Systems

In addition to these general administrative controls and the site-specific administrative controls indicated in the SSHASP, DOE (DOE 1990, 0730) and OSHA (29 CFR 1926, DOL 1994, 1256; 1257) have requirements that employers develop, implement, and maintain certain written programs and permit systems as a means for preventing or mitigating exposure to H&S hazards in the work place. The programs and permits required by these regulations are listed below and are described in Section 4.2.2 of the HASP. When the program or permit system has been addressed sufficiently in the employer's hazardous waste operations (HAZWOPER) program, it need not be repeated elsewhere. ER contractors are expected to maintain and implement these programs as they apply to the project work being performed:

- Assured Equipment-Grounding Conductor Program,
- Bloodborne Pathogens Exposure Control Program,
- Chemical Hazard Communication Program,
- Chemical-Specific Compliance Programs (OSHA-regulated substances in Subparts D and Z of 29 CFR 1926),
- Confined-Space-Entry Program (Permit Required),
- Hazardous Waste Operations Program,
- Hearing Conservation Program,

- Lockout/Tagout for Control of Hazardous Energy Sources for Personnel Safety (Red Lock Procedure) Program,
- Medical Surveillance Program,
- Personal Protective Equipment Program,
- Radiological Safety Program,
- Respiratory Protection Program,
- Spark- and Flame-Producing Operations (Hot Work/Burn Permit) Program, and
- Training Program.

Contractors are expected to submit their programs and permits to designated Laboratory representatives for review and approval before implementation. At least 30 days before the scheduled start date of an operation for which a written program is required, the program shall be submitted to the field unit H&S representative so that it can be reviewed and approved by appropriate ESH personnel. Similarly, unless indicated otherwise below, at least 30 days before the anticipated date of permit implementation, contractors shall initiate action to obtain the Laboratory's approval of their permits, which may include a requirement that the contractor submit project-specific standard operating procedures (SOPs).

As the host organization, the Laboratory will provide contractors with the hazard assessment information necessary for preparing permits. In addition, the Laboratory, as host organization, must be provided with a copy of the contractor's terminated permit. This copy should be given to the field unit H&S representative for distribution to the appropriate ESH group(s).

6.5 Site Control Measures

The primary site control measures include controlled zones (e.g., exclusion zone, contamination reduction zone, and support zone) and support facilities (e.g., equipment-staging area, support trailer(s), equipment decontamination pad, temporary drum storage area, mobile laboratory, and wash facility). The primary objectives of site control measures during field operations are

- to prevent and limit employee exposures during ER field operations;
- to ensure that only trained and fully informed persons are able to enter controlled areas of the work site, where operational hazards are of potential concern;
- to reduce the likelihood of spread of contamination by workers or equipment into uncontrolled areas of the site;
- to confine work activities to appropriate areas, thereby minimizing the likelihood of accidental exposures; and
- to facilitate the location and evacuation of personnel in case of an emergency.

For purposes of ER work, the DOE has identified the general equivalency of radiologically

contaminated areas and hazardous substance contamination zones as shown in Table 3 of the HASP.

The necessary site-specific control measures, some of which are required by applicable DOE and OSHA requirements, shall be provided in Table 5 of the SSHASP. Site maps required by OSHA shall be included in Appendix A of the SSHASP to show the intended locations of the specified controlled zones and support facilities. DOE states (DOE 1994, 1147) that, among other items, site maps should include

- site perimeter;
- direction of prevailing wind;
- site drainage points;
- natural and manmade features such as buildings, containers, impoundments, pits, ponds, and tanks; and
- locations of work zones.

Because some zone or facility locations may change as site work progresses, the site safety officer must explain current locations of zones and decontamination stations to field team members during daily H&S tailgate meetings and shall document these locations in his/her daily logbook.

Section 5 of the SSHASP also shall indicate whether each zone or facility is restricted as a radiological control area, a radioactive materials management area, or a regulated area and whether postings giving this information are required. Furthermore, whether the location of a facility is centralized onsite or localized at multiple work areas onsite, the means for demarcating each zone and other posting requirements [per 29 CFR 1926.200 and 1910.145 (DOL 1994, 1256; 1257) shall be specified.

6.6 Exposure Monitoring and Responses

Guidance for monitoring and assessing occupational exposure to chemical, biological, physical, and radiological hazards has been provided by the DOE (DOE 1994, 1147; 1148; 1149). According to the DOE, the exposure-monitoring strategy should be developed cooperatively by the following professionals:

- an industrial hygienist who is certified by the American Board of Industrial Hygiene or who is otherwise Board-eligible or who has a minimum of three years' experience developing such strategies; and
- a health physicist who is certified by the American Board of Health Physics or who is otherwise Board-eligible or who has a minimum of three years' experience developing such strategies.

Site-specific exposure-monitoring strategies, including action levels, that meet applicable DOE and OSHA requirements shall be specified in Section 6 of the SSHASP for each project task having different requirements. Exposure-monitoring strategies, including establishment of action levels, should be determined based on the hazards that can be monitored using analytical instrumentation and published exposure limits and physical, chemical, and toxicological properties of the chemical and/or radioactive substances of concern. This information shall be included in Appendix C of the SSHASP for the chemical substances of occupational concern included in Table 4-2 of the SSHASP and is included in the Laboratory's Radiation Control Manual (LANL 1994, 1196) for radiological

substances of concern. Guidance for setting action levels for exposure to chemical substances is provided by the DOE (1994, 1148; 1149) and in a publication developed by a member of the American Industrial Hygiene Association Hazardous Waste Committee (Marlowe 1994, 1155). Action levels in Section 6 of the SSHASP for monitoring exposure to radiological hazards have been set by ESH-1, unless otherwise indicated and approved by ESH-1.

Exposure monitoring shall include use of direct-reading instruments, personal dosimetry, and area sampling, as necessary, to evaluate the hazardous conditions posed by chemical and radiological substances onsite. DOE (DOE 1994, 1147) and OSHA (29 CFR 1926.65[b][4][ii][E]) (DOL 1994, 1257) require that the following information be specified in the SSHASP for each type of monitoring instrument to be used for exposure monitoring:

- procedure for calibration, maintenance, and use;
- locations and frequencies of monitoring; and
- corresponding action level(s), response actions, and rationales.

To promote greater consistency among the various ER contractors and field teams, ESH-5 has developed exposure-monitoring methods for the chemical exposure-monitoring instruments most commonly used during ER field operations. These methods are provided in the ER Project's Health and Safety Activities Manual (Environmental Restoration Decommissioning Project 1995, 1258) These methods include procedures and forms for calibration, maintenance, and use of instruments for monitoring exposure to chemicals. When OSHA has mandated methods in the chemical-specific regulatory standards included in Subparts D and Z of 29 CFR 1926 (Section 4.2.2.4 of the HASP), such methods shall be specified in Section 6 of the SSHASP. Project managers who choose to use alternative methods must provide a copy of the methods with the SSHASP for review and approval per Section 6.1.2.

Site health physics personnel shall monitor for alpha and/or beta/gamma radiation, as specified in the SSHASP and in accordance with their individual radiological surveillance authorization agreement and the Laboratory's Radiation Control Manual (LANL 1994, 1196). Health physics personnel shall use radiological instrumentation calibrated and maintained by ESH-4. Subcontractors shall abide by this requirement unless the subcontractor's radiological safety program, which must include identification of instruments and corresponding procedures, has been submitted to the Laboratory for approval during the prebid qualification or contract negotiation period, as required, or according to the applicable requirements of Section 6.4.2.2. All equipment leaving the site shall be monitored for release in accordance with the health physics representative's radiological surveillance authorization agreement.

Requirements for personal dosimetry of radiation exposure shall be determined by ESH-1 and ESH-12 personnel during the review of the draft SSHASP. Guidance for determining site-specific personal dosimetry requirements is provided in the ER Project's Health and Safety Activities Manual.

The results of exposure monitoring must be documented, and affected personnel must be informed of these results in accordance with the requirements of Section 6.13.2. Forms for recording the results of monitoring chemical exposure are included with the respective monitoring instrument method in the ER Project's Health and Safety Activities Manual. Forms for recording monitoring results for radiological exposure are provided in the Laboratory's Radiation Control Manual (LANL 1994, 1196).

Analytical laboratories analyzing samples for chemical contamination should be accredited by the Environmental Protection Agency (EPA) and/or the American Industrial Hygiene Association (AIHA). [Accreditation by the latter organization is necessary for samples collected using OSHA or National Institute for Occupational Safety and Health (NIOSH) methods.] Samples being analyzed for

radiological contamination should be analyzed by the Laboratory's health physics analytical laboratory or a mobile extension thereof or as indicated in the contractor's radiological safety program, which has been approved by the Laboratory.

6.7 Personal Protective Equipment

The purpose of personal protective equipment is to shield, isolate, or secure individuals from hazards that may be encountered when administrative or engineering controls are not feasible or cannot provide adequate protection. Accordingly, before requiring field team personnel to use personal protective equipment, appropriate administrative and engineering controls shall be implemented as the first means of defense for mitigating hazards and protecting site personnel.

In accordance with applicable OSHA regulations [Subpart E of 29 CFR 1926 (DOL 1995, 1257) personnel shall not be allowed to use personal protective equipment unless the hazards for which the personal protective equipment are intended to protect against have been assessed and the appropriate personal protective equipment has been specified by a qualified H&S professional. Personal protective equipment requirements must be based on a hazard assessment (Section 6.4.1) that includes a comparative evaluation of site conditions, task-specific operations, potential hazards relative to the performance characteristics of the personal protective equipment items, and anticipated durations of use. Only radiological protective clothing (ANTI-Cs) are to be used at sites contaminated by radiation. Other disposable protective clothing (e.g., Tyvek®) may be used at sites contaminated by mixed (radiological and chemical) wastes. Task-specific personal protective equipment requirements that meet applicable OSHA requirements of Subpart E of 29 CFR 1926 shall be provided in Section 7 of the SSHASP.

Furthermore, personnel who use personal protective equipment to perform a job shall be trained to recognize the limitations of the equipment and to properly select, fit, use, inspect, maintain, and store the equipment. Such training shall occur and be documented before the user enters an area requiring the use of the personal protective equipment. To promote greater consistency among the various ER contractors and field teams and to facilitate compliance with 29 CFR 1926.65(g)(5), ESH-5 has developed a procedure that addresses limitations, selection, fitting, use, inspection, and maintenance of personal protective equipment (ER Project's Health and Safety Activities Manual). When OSHA has mandated methods in the chemical-specific regulatory standards included in Subparts D and Z of 29 CFR 1926 (Section 4.2.2.4 of the HASP), such methods shall be specified, as applicable, in Section 7 of the SSHASP. Personnel who use ANTI-Cs shall have successfully completed Radiological Worker II training (Section 10.4.4 of the HASP).

The level of protective clothing and accessories selected may be upgraded or downgraded based on new findings or change(s) in site conditions or operations. Whenever a significant change occurs, the personal protective equipment requirements shall be reassessed by the site safety officer, and a SSHASP modification form shall be issued, as necessary.

It is the responsibility of the user of personal protective equipment to inspect the equipment before and as necessary during each use. Furthermore, the user should make it a practice not to use personal protective equipment that shows signs of compromised integrity. The site safety officer shall monitor individuals in areas where personal protective equipment is required to ensure that they are properly attired.

6.7.1 Respiratory Protective Equipment

Use of respiratory protection shall occur only in accordance with the requirements of 29 CFR 1910.134, ANSI Z88.2-1992 (ANSI 1992, 1198), the HASP, and SSHASP. When respiratory protective equipment requirements are mandated by OSHA in the chemical-specific standards included in Subparts D and Z of 29 CFR 1926 (Section 4.2.2.4 of the HASP), such requirements shall be specified, as applicable, in Section 7 of the SSHASP. Personnel required to use respirators shall have certification of current training, medical fitness, and respirator fit testing in accordance with these requirements, which are listed below and are summarized in Section 7.1 of the HASP. Contractors whose employees use respiratory protective equipment to perform ER Project work shall provide documentation to support compliance with each aspect of the mandated standards:

- designated qualified person,
- implementation of administrative and engineering controls,
- use of approved equipment,
- SOPs,
- respirator user's medical status,
- training,
- fit testing,
- work area surveillance,
- cleaning and disinfection,
- inspection and repair,
- storage, and
- quality assurance.

Employers of personnel who wear respirators to perform ER Project work shall maintain and implement a current written respiratory protection program, which addresses the requirements described in Section 7.1 of the HASP. A contractor's respiratory protection program shall be submitted to the field unit H&S representative for review and approval by appropriate ESH personnel at least 30 days before the scheduled start date of field operations involving use of the respiratory protective equipment. Whenever air-supplying (Level B) respiratory protection will be used, project-specific SOPs addressing the requirements and procedures for using the Level B equipment shall be submitted similarly for review and approval by appropriate ESH personnel.

6.8 Decontamination

Decontamination involves physically removing contaminants from personnel and equipment and/or chemically converting them into innocuous waste substances. This section has been developed to meet applicable DOE and OSHA requirements [i.e., those included in 29 CFR 1926.65(k), Subparts D and Z of 29 CFR 1926 (Section 4.2.2.4 of the HASP), and/or the Laboratory's Radiation Control Manual (LANL 1994, 1196)]. According to the DOE, the contamination reduction zone should include separate designated areas for a personnel contamination reduction corridor and an equipment

contamination reduction corridor. The contamination reduction corridor boundaries should be conspicuously marked and should have restricted entry and exit points. Personnel shall decontaminate themselves and any equipment that is contaminated or suspected of being contaminated according to the procedures specified in Section 8 of the SSHASP.

The site safety officer and health physics personnel shall monitor decontamination activities to determine their effectiveness. If procedures are found to be ineffective, these individuals shall take steps to correct any deficiencies and shall document any deviations from the SSHASP using a modification form per Section 6.1.3. The following general requirements apply to personnel and equipment decontamination processes for ER Project work:

- Personnel, equipment, and vehicles must be decontaminated before exiting the contamination reduction zone. Clothing and equipment that cannot be decontaminated sufficiently shall be properly contained and labeled before being transferred beyond the controlled work zones of the site. For sites having only radiological contamination, it is appropriate to first screen for radiological contamination to determine whether decontamination is necessary.

- If any significant contamination is encountered, personal protective equipment should be disposed rather than decontaminated for reuse (Section 8.2.2 of the HASP).

- Loose contaminants (dusts and vapors) that cling to clothing or equipment shall be removed according to the applicable decontamination procedures (e.g., using a water or water-based detergent rinse and scrub brush), except when radiation action levels are exceeded (Section 8.2.3 of the HASP).

- Care should be taken to avoid generating mixed waste during decontamination operations.

- Rinse water and waste generated onsite shall be contained and disposed according to Section 4.2.1.4 of the HASP.

6.8.1 Equipment Decontamination

Samples, sampling equipment, and mechanical equipment shall be decontaminated as specified in the site-specific waste management plan and in "Field Decontamination of Drilling and Sampling Equipment" (LANL-ER-SOP-1.08) or in a comparable procedure specified in Section 8 of the SSHASP.

When a centralized decontamination pad or facility is established for decontaminating heavy equipment (e.g., rigs, augers, loaders), Section 8 of the SSHASP shall specify site-specific procedures for addressing transport of equipment from the site of investigation to the centralized decontamination facility in a manner that minimizes the potential for or contains the spread of contamination.

6.8.2 Personnel Decontamination

This section was developed to meet the OSHA HAZWOPER requirements of 29 CFR 1926.65(k). It may be adapted in the SSHASP for use in meeting the chemical-specific decontamination requirements of the applicable OSHA standard(s) in Subparts D and Z of 29 CFR 1926 for the substance(s) included in Table 2 of the HASP (Section 4.2.2.4), which appear in Table 4-2 of the SSHASP.

Provided in Appendix D of the HASP are two possible strategies for personal decontamination: standard and extensive. Project managers who choose to use an alternative strategy must incorporate the strategy in the SSHASP for review and approval per Section 6.1.2. Both strategies provided in the HASP include procedures, diagrams of decontamination facilities, and suggested equipment for operations involving use of Levels D, C, and B personal protective equipment. Each of the diagrams is generic because the actual positions and orientations of decontamination stations may vary, depending on day-to-day variations in site operations and conditions. Some of the stations in the standard strategy serve multiple functions, which could be allocated to separate stations, as appropriate, to adjust for day-to-day variations in site operations and conditions. The quantities of equipment listed are those that should be on hand during each day's activities at the site. Because site conditions vary, some sites have more decontamination stations than others; thus, more equipment is necessary at these sites to decontaminate personnel and environmental monitoring equipment effectively.

The following guidelines are provided for determining decontamination strategy requirements for implementation under differing site conditions:

- The standard decontamination strategy (Options 1 through 3 in Appendix D of the HASP) assumes that waste minimization is practiced and should be implemented only when site contamination is relatively low.

- The extensive decontamination strategy (Options 4 through 6 in Appendix D of the HASP) should be implemented on a contingency basis at the discretion of the site safety officer, health physics personnel, and/or ESH-5 or ESH-1. No absolute levels have been set for triggering implementation of the extensive strategy for decontamination; rather, these personnel shall monitor the extent of contamination throughout site operations and shall determine whether the standard strategy is sufficient for existing conditions.

- If there is difficulty in successfully decontaminating personnel, personal protective equipment, or environmental monitoring equipment using the standard decontamination strategy, the extensive strategy should be implemented.

Additional requirements are included in Section 8.2 of the HASP concerning

- decontamination of environmental monitoring equipment,

- disposal versus laundering of personal protective equipment, and

- special procedures for decontamination of radioactively contaminated personal protective equipment and environmental monitoring equipment.

6.9 Emergency and Incident Action Plan

This section describes the generic aspects of the emergency and incident action plan, which apply to all field operations of the ER Project. Site-specific details of this plan and the necessary equipment and supplies to execute this plan shall be included in Section 9 of the SSHASP. Any deviations or exceptions to this section shall be described in Section 9 of the SSHASP.

This section has been developed to meet the requirements of 29 CFR 1926.24 and 1926.65(l), and, as applicable, 29 CFR 1926.65(q) or 1926.35(b). It addresses contingency planning, response actions, and associated personnel and equipment requirements in the event of occurrence of an incident or emergency as defined in this section. DOE and OSHA require that this plan be rehearsed regularly as part of the overall training program for site operations [(29 CFR 1926.65(l)(3)(iv)].

Explanations and definitions for determining the category of an unplanned or uncontrolled event are provided in the ER Project's Health and Safety Activities Manual. For purposes of this section, the term "emergency" is used to refer to unplanned or uncontrolled events, such as

- situations necessitating rescue and/or administration of first-aid and/or CPR by qualified onsite responders per this section;
- situations necessitating fire fighting by qualified onsite responders per this section;
- releases of hazardous substances that cannot be responded to and adequately dealt with by qualified onsite personnel and resources per this section; and
- incidents involving local or adjacent facility operations that may influence field operations.

For purposes of ER field work, the term "incidental release" is used to refer to unplanned or uncontrolled releases of hazardous substances that can be responded to and adequately dealt with by qualified onsite personnel and resources per this section. By this definition, incidental releases are defined as a release of insufficient quantity to pose a significant H&S hazard to field personnel in the immediate vicinity, to field personnel responding defensively, or to the surrounding environment (DOE, no date, 1151). The field team leader, assisted by the site safety officer, shall direct and coordinate responses to incidental releases. These responsibilities include appropriately responding to the situations listed above, safely evacuating onsite personnel, gathering onsite personnel at the designated muster area, notifying emergency contacts, documenting that onsite personnel are accounted for at the muster area, conducting a follow-up investigation, and reporting the incident.

Releases of hazardous substances in sufficient quantity to necessitate a response either by personnel from outside the immediate release area or by other designated responders, such as the fire department or the Laboratory's Hazardous Materials Response Team (HAZMAT) (ESH-10), are considered emergencies (DOE no date, 1151; Smith and Carnes, no date, 1150). In such circumstances, onsite personnel are only allowed to take defensive actions for which they have been trained and are equipped in accordance with this section. For onsite personnel having had first-responder awareness level training (Section 10.1.2.1 of the HASP), such defensive actions are limited to evacuating the site, identifying the nature of the release, isolating and denying entry to the site, and notifying authorities of the release. For onsite personnel having had first-responder operations level training (Section 10.1.2.2 of the HASP), such defensive actions are limited to those of first-responder awareness level training, plus

- preventing exposure,
- keeping the release from spreading, and
- containing the release from a safe distance.

The field team leader, assisted by the site safety officer, shall direct and coordinate responses to emergencies in accordance with this section until offsite emergency responders arrive and implement the Incident Command System. Onsite spills or releases of hazardous substances shall be handled in accordance with applicable requirements of this section and according to an approved site-specific spill prevention control and countermeasures plan prepared in accordance with the Laboratory's Spill Prevention Control and Countermeasures Plan.

6.9.1 Posting Requirements

At the start of field operations, emergency contacts and phone numbers, reporting information, emergency equipment, and maps of the route(s) to the Los Alamos Medical Center and to the Laboratory Occupational Medicine Clinic (ESH-2) shall be posted at a location onsite where personnel may readily access the information. This site-specific information shall be included in Appendix D of the SSHASP.

6.9.2 Emergency Alerting and Site Evacuation Procedures

The field team leader and site safety officer shall determine site-specific emergency alerting procedures, evacuation procedures and routes, and locations of muster areas. This information must be included in Section 9 of the SSHASP and shall be communicated by the site safety officer or field team leader to onsite personnel during the pre-job-start H&S briefing and/or the daily tailgate H&S meetings. The Department of Transportation provides information for determining the extent of and safe distances for evacuation (DOT 1993, 1199), which shall be referenced in Appendix C of the SSHASP for each chemical substance identified in Table 4-2 of the SSHASP. Evacuation routes and muster areas should be predominantly upwind, uphill, and upstream of work areas where fire or release of chemicals or radiological contaminants might occur.

An employee alarm system shall be specified in Section 9 of the SSHASP and shall be established at the work site in accordance with 29 CFR 1926.65(l)(3)(vi) and 1926.159. Section 9 of the SSHASP shall also include means and methods for alerting contact personnel at adjacent facilities of onsite events that could pose a threat to offsite facilities and for designated personnel at adjacent offsite facilities to alert onsite personnel of events that could pose a threat to onsite personnel or operations. The phone numbers or radio stations of contact personnel at adjacent facilities shall be given in the list of emergency contacts included in Appendix D of the SSHASP.

General procedures for site evacuation are included in Section 9.2 of the HASP, and procedures for onsite responders who are trained and equipped to respond to incidents in accordance with this section are also provided in Section 9.3 of the HASP, including procedures for

- emergency medical treatment and first aid/CPR,
- life-threatening cases,
- other cases,
- exposure to another's blood or body fluids, and
- emergency decontamination of personnel.

6.9.3 Reporting Emergencies and Incidents

The ER/ESH procedure for making notifications in follow-up to an emergency or incident is provided in the ER Project's Health and Safety Activities Manual. Accidents, emergencies, incidents, injuries, and illnesses must be reported to the FPL and/or the field unit H&S representative. In the event of an occurrence necessitating medical care, the field team leader shall arrange for notification of the key personnel listed in Appendix D of the SSHASP (i.e., other line managers, the field unit H&S representative, and the employee's manager) as soon as possible.

6.9.4 Response Critique and Follow-Up

Before normal site activities are resumed, the FPL, or his/her delegate, shall evaluate the incident or emergency to determine

- the cause;
- effectiveness of emergency/incident planning, preparedness, and response;
- how the emergency or incident could have been prevented; and
- considerations for improvements of the emergency/incident response plans.

Points to be considered include whether procedures are adequate and were implemented correctly and in a timely manner. Also, before resuming normal site activities, personnel must be fully trained and equipped to handle another emergency or incident, which requires restocking emergency equipment and supplies and inspecting, testing, and resetting emergency equipment and systems.

6.10 Training Requirements

Described in this section are the DOE, OSHA, and Laboratory worker H&S training requirements applicable to ER field operations. A summary of the training provided by ESH-13 is included in Table 4 of the HASP. In accordance with OSHA's training requirement in 29 CFR 1926.65(e)(1)(ii) (DOL 1994, 1257), field team personnel shall have the necessary training to perform their assigned task(s) and associated responsibilities. Before the field team leader tasks a field team member with performing an ER field duty, the site safety officer shall verify that the field team member has current certifications of required training.

Laboratory employees (including Laboratory contract employees) are eligible to take any courses offered by ESH-13 and BUS-6. ER Project contractors are responsible for implementing their own training programs. With the exception of the Laboratory-specific training described in Section 6.10.4, training offered by ESH-13 is available to ER contractors for a fee upon referral by an FPL. Training offered by BUS-6 is also available to ER contractors for a fee.

6.10.1 HAZWOPER Requirements

6.10.1.1 General Requirements

All employees working onsite exposed to safety hazards, health hazards, or hazardous substances and their supervisors and managers responsible for the site shall receive training that meets the requirements of Section 10 of the HASP before they are permitted to engage in HAZWOPER work. Employees are not permitted to participate in or supervise ER field activities until they have been trained at the level required by their job function and responsibility.

Employees and supervisors who have successfully completed the training and field experience requirements of Section 10.1.1 of the HASP shall be certified by their instructor, or the head instructor and trained supervisor, as having successfully completed the necessary training. OSHA requires that a written certificate be given to each person so certified.

Trainers shall be qualified to instruct employees about the subject matter that they are presenting. Trainers shall have the academic credentials and instructional experience necessary for teaching the subject(s) or shall have completed a training program for teaching the subject(s). Instructors shall demonstrate competent instructional skills and knowledge of the subject matter.

Employers who can show by documentation or certification that an employee's work experience and/ or training has resulted in training equivalent to the training requirements of Section 10.1.1 of the HASP shall not be required to provide the initial training requirements of Sections 10.1.1.1 or 10.1.1.2 of the HASP. They shall certify this equivalency and provide a copy of this certificate to the employee.

Anyone who has not been certified in accordance with Section 10.1.1 of the HASP is prohibited from engaging in ER field activities. The general HAZWOPER training requirements described in Section 10.1.1 of the HASP include

- worker training and supervised field work for periods determined by expected exposure:
  - initial 40 hours of training and 24 hours of supervised field work (for areas in which contaminant concentrations may exceed exposure limits) or
  - initial 24 hours of training and 8 hours of supervised fieldwork (for areas in which contaminant concentrations are not expected to exceed exposure limits),
- management and supervisor training,
- annual refresher training,
- site safety officer requirements,
- industrial hygiene technician requirements, and
- health physics personnel requirements.

6.10.1.2 Emergency Response Training

If a project manager chooses to have onsite personnel take any action other than immediate evacuation of the site in the event of a release or substantial threat of release of a hazardous substance, onsite personnel must receive the training described in Section 10.1.2 of the HASP as applicable for the tasks to be performed. The training categories include first-responder awareness level training and first-responder operations level training. OSHA requires that personnel who have been trained in accordance with this section receive annual refresher training of sufficient content and duration to maintain their competencies or demonstrate their competency at least yearly.

6.10.1.3 Pre-Job-Start H&S Briefing

In accordance with 29 CFR 1926.65(b)(4)(iii), the site safety officer shall conduct training on the contents of the SSHASP before field work begins so that each field team member is informed of the site-specific information and requirements applicable to the scope of work. This H&S briefing shall cover the contents of the SSHASP and applicable portions of the HASP.

6.10.1.4 Daily Tailgate H&S Meetings

Before beginning field work each day, the site safety officer and field team leader shall conduct a tailgate H&S meeting. Field team members should be encouraged to discuss any health- or safety-related concerns during this meeting without fear of reprisal. Topics covered and attendance shall be documented. During these tailgate meetings, field team members shall be informed of at least the following:

- any newly identified hazards and associated monitoring and exposure control measures and results not discussed previously and
- problems or concerns (especially H&S) that have arisen since the previous tailgate meeting.

6.10.2 First-Aid Requirements

In accordance with 29 CFR 1926.50, in the absence of a hospital or clinic that is reasonably accessible in terms of time and distance to the work site (i.e., capable of rendering treatment within 4 min of occurrence of the injury or illness), a person who has a valid certificate in first-aid training from the American Red Cross, or equivalent, shall be available at the work site to render first aid. Section 9.3.1 of the HASP contains more detailed information concerning first aid.

6.10.3 Other OSHA Requirements

OSHA has numerous other standards and associated training requirements applicable to ER work. Some of these requirements apply at a programmatic level and are addressed in Section 6.4.2.2. Other training requirements apply to specific individuals who are either a competent person or a qualified person in the subject matter pertaining to their job function (Section 6.3.2.3.5), as defined by OSHA [29 CFR 1926.32(f) and (m)], respectively, and/or as defined by applicable operation- or substance-specific standards (29 CFR 1926 and/or 1910), which are cited throughout the HASP and the SSHASP. Examples of these types of training are those for confined-space entry, lockout/tagout of energized equipment, electrical safety, trenching and excavation, respiratory protection, bloodborne pathogen exposure control, etc.

Site-specific training requirements that meet the requirements of this section are dictated by the operations and conditions occurring onsite and shall be specified in Section 10 of the SSHASP or in a modification form to the SSHASP as the requirement arises.

6.10.4 Laboratory-Specific Requirements

The Laboratory has certain training requirements that are applicable to personnel who perform work for the Laboratory, which are described in Section 10.4 of the HASP and include

- general employee training,
- health and safety read training,
- health physics checklist indoctrination,
- Radiological Worker II training, and
- waste generator and waste management training.

6.11 Medical Surveillance

Before the field team leader authorizes access to areas of the site where site controls have been established (e.g., exclusion and contamination reduction zones and other regulated areas), it is the responsibility of the site safety officer to verify that personnel entering such areas have a current certification of medical fitness for duty (Appendix E of the HASP) in accordance with this section. The

site-specific medical surveillance requirements that meet applicable OSHA regulations and DOE requirements shall be specified in Section 11 of the SSHASP.

A written medical surveillance program that complies with the requirements of this section shall be implemented by employers of personnel working for the ER Project. These requirements include

- identification of active participants in the employer's medical surveillance program,
- cost and frequency of examinations,
- content of examinations,
- information to be provided to the examining physician, and
- information to be obtained from the physician, including a form provided in Appendix E of the HASP.

6.12 Quality Control and Quality Assurance Plan

6.12.1 Site Inspections

According to DOE Order 5480.9A (DOE 1994, 1153), the construction contractor shall conduct daily inspections of the work site to identify hazards and instances of noncompliance with project H&S requirements. The construction contractor responsible for this duty is the prime ER contractor or, when a prime is not involved, the contractor performing the work. The field team manager, serving as the construction manager (as defined in DOE 5480.9A and Section 6.3.2.1.2), shall conduct work site H&S inspections on at least a weekly basis. The FPL, serving as the project manager (as defined in DOE 5480.9A and Section 6.3.2.1.1), shall conduct inspections of his/her ER projects exceeding $500,000 on at least a monthly basis during periods of active construction. For projects under $500,000, the FPL shall develop and implement an inspection schedule that ensures that a representative sample of ongoing projects is inspected on at least a monthly basis.

Records of inspections noting any hazards and the corrective actions taken shall be kept. Section 12 of the SSHASP specifies the site-specific inspections to be performed by the site safety officer or other designated person and the frequency of inspections.

6.12.2 ER/H&S Oversight Program

In accordance with the record-keeping requirements of Section 6.13, ER participants shall provide access to and/or furnish to the Laboratory all documentation necessary to verify compliance with requirements of the HASP, SSHASP, or any applicable law or regulation. This support shall include maintenance of appropriate H&S records at the site as required by the HASP, SSHASP, or any applicable regulatory requirement or as deemed necessary by the FPL or field unit H&S representative.

ER participants shall support an initial programmatic verification and periodic in-process verifications of compliance with applicable requirements. The initial programmatic verification will consist of a review of the applicable SSHASP document, including any necessary supplements [such as individual verification records for (training, medical)] and employer's program or procedure documents that verify the existence of and compliance with applicable requirements. The periodic in-process verifications, which will be conducted by the Laboratory, will include verification of ER

participants' records that demonstrate compliance with the requirements of the HASP, SSHASP, and applicable regulations. These inspections will be conducted primarily at the field sites but may involve the requirement to furnish current documentation not present at the field site.

Inspections may be conducted by the FPL, his/her delegate, and/or representatives of the ESH Division. It is also expected that occasional verification by the Laboratory's Audits & Assessments Branch or the DOE may be required. The results of these inspections will be in writing and will be submitted to the Laboratory performance fee evaluation team and to appropriate Laboratory management personnel. A copy of the results will also be furnished to the affected employer(s) for resolution of discrepancies, if any.

If during the course of verification a circumstance is discovered that presents a threat of serious injury or death, notice will be promptly provided to the affected onsite supervisor and to the field team leader for action as directed in Section 6.3.4.

6.13 Record Keeping

6.13.1 Site Records

The site safety officer shall keep a daily record of H&S-related events in a bound logbook and shall verify employee training and medical surveillance records in accordance with Section 6.3.2.3.1 of the HASP. Health physics personnel shall keep records of health-physics-related events in accordance with the requirements of their radiological surveillance authorization agreement (Section 6.3.2.4). Records of all training must be maintained and available for oversight review. Site records shall be provided to the field team manager at the close of the project, who will provide them to the FPL for storage at the RPF.

6.13.2 Employee Exposure and Medical Records

Employers must retain exposure-monitoring and medical records for their employees who work on the ER Project in accordance with OSHA's standard [29 CFR 1926.33 (DOL 1994, 1257] for access to employee exposure and medical records. Medical records shall not include examination or test results but shall include the employee's name and social security number, the physician's written opinion (Section 6.11) and recommended limitations, any medical complaints related to exposure of hazardous substances, and a copy of the information provided to the examining physician by the employer (not including a copy of the OSHA standard).

Records shall be retained in accordance with the following requirements, as well as any other applicable requirements:

- To the extent permitted by law, the employer shall maintain and keep in confidence records for each employee.

- The employer shall maintain medical records for each employee for the duration of employment plus 30 years (except health insurance claims records maintained separately from the employer's medical surveillance program records, first-aid records of one-time treatments, and medical records of employees who have worked for the employer for less than 1 year and who have seen the records before termination).

- The employer shall maintain exposure records for each employee monitored per Table 6-2 of the SSHASP for 30 years.

- The employer shall ensure that each employee, upon his/her request, has access to his/her records.

- At an employee's written request, the employer shall ensure that the employee's designee has access to the employee's record(s). A sample consent form is provided in Appendix A of 29 CFR 1926.33 (DOL 1994, 1257).

- Whenever an employee or his/her designated representative requests access to an employee record, the employer shall ensure that access is provided in a reasonable time and manner. If the employer cannot provide access to the record(s) within 15 working days, before the 15th working day following the request for access, the employer shall apprise the requester of the reason for the delay and the earliest date the record(s) can be made available.

- Whenever an employee, or his/her designated representative, requests a copy of a record, the employer shall ensure that either

  - a copy of the record is provided without cost to the requester,

  - the necessary copying equipment is made available with out cost to the requester for the purpose of copying the record, or

  - the record is lent to the requester for a reasonable time to enable a copy to be made.

- Once a record has been provided without cost to the requester, the employer may charge a reasonable, nondiscriminatory administrative cost for subsequent copies of the record. However, an employer shall not charge for an initial request for a copy of new information that has been added to a record which was previously provided.

For purposes of follow-up investigation of an accident or incident, the employee's consent for the investigator(s) to access his/her records shall be obtained in accordance with 29 CFR 1926.33 (DOL 1994, 1257).

6.13.3 Employee Notification Procedure

In accordance with 29 CFR 1926.33 (DOL 1994 1257), the site safety officer is required to report dosimetry data to each monitored employee, using the form provided in the ER Project's Health and Safety Activities Manual. The form must be reviewed and acknowledged by each affected employee. The site safety officer shall provide a copy of the notification form to the subject employee and to his/her supervisor. These records shall be maintained in confidence in accordance with the requirements of Section 6.13.2. The original form shall be retained with other original site records. When it is necessary to communicate the results of exposure monitoring to others, it shall be done in a manner that does not identify the monitored employee.

This confidentiality also precludes discussing affected onsite personnel during daily tailgate meetings following receipt and evaluation of the results.

6.13.4 Emergency/Incident Records

Records of emergency or incident reports and follow-up investigations shall be processed as specified in Section 6.9.4.

References for Chapter 6

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DOL (US Department of Labor), 1994. "Occupational Safety and Health Standards, Continued," 29 CFR Parts 1910.1000 to End, Occupational Safety and Health Administration, Washington, DC. **(DOL 1994, 1256)**

DOL (Department of Labor), 1994. "Safety and Health Regulations for Construction," Code of Federal Regulations, Title 29, Part 1926, Occupational Safety and Health Administration, Washington, DC. **(DOL 1994, 1257)**

DOT (US Department of Transportation), October 1993. "1993 Emergency Response Guidebook," Research and Special Programs Division, Office of Hazardous Materials Training and Initiatives (DHM-50), Washington, DC. **(DOT 1993, 1199)**

Environmental Restoration Decommissioning Project, July 1995. "Health and Safety Activities Manual," Los Alamos National Laboratory, Los Alamos, New Mexico. **(Environmental Restoration Decommissioning Project 1995, 1258)**

LANL (Los Alamos National Laboratory), 1994. "Radiation Control Manual," Los Alamos, New Mexico. **(LANL 1994, 1196)**

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7.0 PUBLIC INVOLVEMENT PLAN

7.1 Introduction

7.1.1 Role of Public Involvement in the Environmental Restoration Project

Under the Hazardous and Solid Waste Amendments (HSWA) portion (the HSWA Module) of Los Alamos National Laboratory's (Laboratory's) permit to operate under the Resource Conservation and Recovery Act (RCRA), the Environmental Restoration (ER) Project must adopt a community relations plan. The first edition of the project's Installation Work Plan (IWP) (LANL 1990, 0144) included the original plan. That plan has evolved into a public involvement plan, which emphasizes early public participation in developing recommendations for ER activities.

The goal of public involvement is to provide the public with the opportunity to advise the ER Project on issues that impact them. To create trust in the community, public involvement efforts must build long-term relationships based on accessibility and open communication. Key Department of Energy (DOE) and Executive Orders have made public involvement a cornerstone for Laboratory and DOE activities.

The ER Project recognizes that the advantages of early public involvement include the potential for (1) making decisions that satisfy both the public and the organizations responsible for implementing those decisions, (2) avoiding delays resulting from public challenges to decisions made without adequate public involvement, and (3) achieving cost savings that result from making better initial decisions and avoiding delays. The current plan (Section 7.2) describes the new approach in detail.

7.1.2 The Laboratory's Current Approach to Public Involvement

7.1.2.1 Community Involvement and Outreach Office

The Community Involvement and Outreach (CIO) Office is responsible for the overall public involvement efforts for the ER Project. The mission of the CIO Office is to foster lasting relationships between the Laboratory and its neighbors based on trust and mutual respect and foster public understanding of the Laboratory and its national security and science mission. The CIO Office supports Laboratory goals, initiatives, and scientific and technical programs by reaching out to stakeholders to involve them in decisions that affect them, by fostering greater public understanding of science and technology, and by promoting meaningful two-way communications with local, national, and global audiences about Laboratory programs and activities.

7.1.2.2 Citizens' Advisory Board

In September 1995, the Northern New Mexico Citizens' Advisory Board was created to advise DOE and the Laboratory on a wide range of issues. The board developed a mission statement, charter, and bylaws; the bylaws are awaiting approval. Meetings are held in nearby towns and pueblos to review information, hear presentations, and discuss the Laboratory operations that impact the neighboring communities. The board meets the second Tuesday of every month and has subcommittees devoted to Laboratory issues.

7.1.2.3 Public Information Repositories

The Los Alamos National Laboratory Outreach Center and Reading Room is located in downtown Los Alamos at 1350 Central Avenue (phone: 505-665-2127 or 1-800-508-4400). The Outreach Center is a repository for documents about the Laboratory's activities that are of interest to the public, including documents pertaining to the ER Project. In addition, the ER Project provides its work plans and reports and other key documents to Mesa Public Library in Los Alamos, the public libraries in Española and Santa Fe, and the office of the governor at San Ildefonso Pueblo.

7.1.3 ER Project's Current Approach to Public Involvement

In 1993 the DOE, the Laboratory, and the ER Project created a working group to look at ways of increasing public participation in the ER Project. In February 1994, the working group invited members of the public to brainstorm informally about ways to obtain more effective public participation. Their ideas and suggestions were implemented, and in 1995, the "Plan for Increasing Public Participation in Cleanup Decisions for the Los Alamos National Laboratory" was finalized.
The specific objectives of the public participation plan are to

- give the public the information it needs to understand ER cleanup issues and provide informed input;
- make information readily available to the public;
- increase contacts with the public in ways that encourage interaction, such as establishing dialogues with members of community organizations, chambers of commerce and church groups, as well as Laboratory employees outside the ER Project;
- involve the public in the cleanup process before decisions are made;
- treat the public as equals;
- ask for assistance from community members and use them as experts on their communities' concerns;
- coordinate public involvement activities for the ER Project with other related land use activities,
- develop alternatives for determining cleanup levels and site prioritization, and
- evaluate the effectiveness and efficiency of public participation activities.

The methods described in the plan for improving communication and trust during current activities will continue and expand with experience as the project moves through the corrective action process. The document will be revised as necessary.

7.2 The ER Project's Public Involvement Plan

The regulatory process requires the ER Project to investigate a site, analyze the data, and then, based on the analysis, develop recommendations. These recommendations include cleanup actions and

recommendations for no further action (Chapter 3). Factors in cleanup decisions include the amounts and kinds of waste to be cleaned up, the types of technologies to be used, public concerns, and the desired degree of cleanup. Cleanup actions may themselves disturb the environment and will produce wastes. Tax dollars spent in cleanup must also be considered. The ER Project needs the public's help in weighing these factors for cleanup decisions. The HSWA Module provides a staggered schedule for cleaning up contaminated sites at the Laboratory; thus, not all of the sites are in the same stage in the cleanup process.

The ER Project will provide the public with a variety of opportunities to personally observe and discuss issues as cleanup progresses. To improve its dialogue with the community, the project has replaced formal meetings, except when required by regulation, with less formal meetings with community members, such as round table discussions, site tours, and invitations to speak with interested groups and citizens. During these activities, the ER Project makes technical staff available to discuss the history and background of the potential release sites (PRSs) that are the subject of the activity, to describe the sampling and the data obtained on PRSs of interest, and to describe the risk assessment process and its relationship to various alternatives. As required by regulation, some of these meetings are held for the purpose of obtaining public comments and recommendations on certain proposed actions, which involve modifying the HSWA Module. Comments obtained at such meetings are forwarded to the New Mexico Environment Department (NMED) for consideration in deciding whether to accept the project's proposals.

As recommendations for PRS actions are developed, ER Project personnel will discuss with the public the ramifications of cleanup to residential, recreational, and industrial standards. With the public's involvement, the ER Project will prioritize PRSs and discuss appropriate cleanup standards.

The sections that follow provide descriptions of the specific activities proposed for use in implementing this public participation plan.

7.2.1 Preparing Information on the ER Project

The ER Project prepares a variety of materials for the northern New Mexico community, including the public schools. The materials consist of newsletters, progress reports, and information sheets that include history when appropriate, site maps, information about potential contamination, and cleanup alternatives such as no further action and accelerated cleanups. The Project attempts to make information sheets sensitive to cultural issues and will solicit comments from the public to make sure their concerns have been addressed. The Project also prepares informal handouts for tours. Information sheets are translated into Spanish. If the pueblos indicate a desire for an oral translation, the project will arrange for presentations in pueblo languages. The ER Project maintains a home page on the Worldwide Web through which the public can access information in the following categories:

- Environmental Restoration Mission Statement and Goals,
- Location Maps,
- Environmental Setting of Los Alamos National Laboratory,
- Overview of the Environmental Restoration Project at Los Alamos National Laboratory;
- Description of the Environmental Restoration Process,
- Environmental Restoration Success Stories,

- How to Obtain Additional Information About the Environmental Restoration Project, and
- Organizational Information.

7.2.2 Dissemination of Information

The major objective of all information dissemination is to familiarize the public with the ER Project so that citizens may participate more knowledgeably in the decision-making process. Presentations give in-depth information on a specific topic to a small or large group of people. This setting also offers an opportunity for personal interaction between the presenter and the audience (e.g., question/ answer). A number of types of presentations are given, including those at public meetings as well as at the regular meetings of community organizations.

Mailings are a primary way to provide general information to a large audience. For example, a mailing may be used to invite citizens to attend a meeting or poster session, clarify what was published in a newspaper, or provide general information of importance to the public. The media outreach is also used to communicate information in the broadest terms to the greatest number of people in a short period of time.

7.2.3 Community Meetings

Meetings offer the broadest choices for interacting with the public. Meetings provide direct contact, both formal and informal, with audiences of various sizes. The ER Project will continue to solicit invitations from community groups to attend their meetings for the purpose of sharing information and discussing the ER Project and public participation in the Project, targeting such groups as traditional clubs, acequia associations, land associations, cooperatives, Laboratory employees, media associations, local government, and church groups. The primary goals of these meetings are personal engagement and informal group dialogue. Ideally, a two-person team consisting of a technical representative of the ER Project and an individual from the public affiliated with the community group being visited will attend these meetings. Selected Laboratory specialists also attend, as appropriate. Participants are asked to suggest other stakeholders who might be interested in participating.

7.2.4 Tours of Environmental Restoration Sites

Tours help acquaint the public with the ER Project and specific PRSs as these PRSs are addressed throughout the corrective action process, especially prior to initiation of cleanup activities. Times convenient for the public are a primary consideration in scheduling these tours. Written information supplements the discussions during the tours. These tours are open to all members of the public interested in ER Project activities. Tour participants are asked if they would like to volunteer for further involvement in ER Project activities. To guide future planning and to aid in evaluation, the project records concerns and suggestions.

7.2.5 Education Programs

ER Project staff continues to be available to visit schools and to help teachers who request assistance in developing class projects that promote students' understanding of and involvement in the ER Project. Such assistance has been enthusiastically received in the past. The project will work with the Laboratory's Science Education and Outreach Group to develop programs for students and to provide support for existing efforts that focus on ER-related activities.

7.2.6 Public Input to Recommendations for Cleanup

Throughout the public involvement process, the ER Project asks people whether they would like to participate more actively in developing recommendations for cleanup decisions and invites such people to working meetings for this purpose. If there is a large response, the project works with all volunteers to develop a fair mechanism for selecting a workable number of participants. The documentation of this process will be sent to NMED.

7.2.7 Public Involvement in the Budget Process

Each of the DOE laboratories has developed a prioritized list of ER activities, which have been ranked based on risk to human health and the environment followed by other relevant criteria (e.g., technology availability, internal DOE strategies, etc.). The laboratories and DOE will present the prioritized lists for comment to the NMED and the Environmental Protection Agency (EPA) each year in the July to August timeframe. The prioritized lists will be agreed upon between DOE/laboratories and NMED and EPA followed by a presentation to the public for comment. The final prioritized lists will be used to allocate available funding for the next fiscal year and to plan funding for subsequent fiscal years.

Reference for Chapter 7

LANL (Los Alamos National Laboratory), November 1990. "Installation Work Plan for Environmental Restoration," Los Alamos National Laboratory Report LA-UR-90-3825, Los Alamos, New Mexico. **(LANL 1990, 0144)**

DESCRIPTIONS OF TECHNICAL AREAS AT LOS ALAMOS NATIONAL LABORATORY

The locations of the technical areas (TAs) operated by Los Alamos National Laboratory (the Laboratory) in Los Alamos County are shown in Chapter 2, Figure 2-2. The brief descriptions of activities conducted at the various TAs are from the Laboratory's 1990 Site Development Plan (Facilities Engineering Division Planning Group et. al. 1990, 0655).

Development Areas

Most Laboratory functions, about three-fifths of the land, and 93% of the population are concentrated in the following eight development areas. Each is composed of various TAs as indicated below.

Core Area and Two-Mile Mesa North
(TAs 3, 43, 58, 59, 62)
This development area includes the central technical, administrative, and physical support facilities of the Laboratory as well as experimental science and theoretical/computational science land uses.

Two-Mile Mesa South
(TAs 6, 22, 40)
This development area is presently used for the research and testing of special detonators and high-explosive systems and as a buffer zone for this function. Large portions of this development area therefore remain undeveloped.

Pajarito Corridor West
(TAs 35, 48, 50, 52, 55, 63, 64, 66)
Experimental science and special nuclear materials (SNM) land uses, which include radiochemistry, nuclear safeguards studies, analytical chemistry, reactor development, waste management, and plutonium processing occur in this development area.

Pajarito Corridor Central
(TAs 18, 46, 51, 65)
This development area includes experimental science land uses where research is performed in chemistry, photochemistry, solar energy, biological exposure effects, and nuclear chain reaction behavior.

East Jemez Corridor and Sigma Mesa
(TAs 2, 41, 60, 61)
This development area is used primarily for physical support and infrastructure land use activities and is the site of the existing sanitary landfill. The Omega West reactor is located in Los Alamos Canyon, as are special nuclear materials land uses involving the engineering design of nuclear components. It is also the location of lands leased to construction contractors and the privately owned Royal Crest Trailer Park.

Weapons Engineering
(TA-16)
This development area is dedicated to high-explosives research, development, and testing land uses. Functions at this site include engineering design, prototype manufacture, processing, and environmental testing of nuclear weapon warhead systems. Because TAs 11, 28, and 37 are not the focus of growth, they are not included in this development area, but are discussed elsewhere in this plan.

Dynamic Testing
(TAs 8, 9, 14, 15, 22, 36, 39, 40, 67, 68)
This extensive area is reserved specifically for high-explosives research, development, and testing land uses.

LAMPF
(TA-53)
The primary facility in this development area is the Los Alamos Meson Physics Facility, a linear particle accelerator used for basic physics research, material studies, and isotope production. Other facilities at TA-53 are also accelerator-related.

Other Technical Areas

Numerous other technical areas are spread throughout the site. These technical areas usually have small populations or are remote. They are not the focus of anticipated future growth and development. These include

- TA-0, Los Alamos townsite: The Laboratory leases approximately 116,000 square feet in eight buildings primarily for training and support functions.

- TA-5: This large area south of East Jemez Road is mostly undeveloped. It contains some physical support functions, several archaeological sites, and environmental monitoring and buffer areas.

- TA-11, K-Site: Located in the high-explosives area, facilities in this technical area test explosive systems and components under a variety of conditions.

- TA-21, DP-Site: This former radioactive materials processing facility has a problematic location, because its only access route is through Los Alamos townsite. The location is also inconveniently remote from other Laboratory facilities. Currently, decontamination and decommissioning (D&D) of several structures is under way. A study of future use options for TA-21 is also ongoing.

- TA-28, Magazine Area: This is an explosives storage area.

- TA-33, HP-Site: An old tritium handling facility located here is being phased out. This site is remote, constrained by limited utility service, and contains substandard structures. It has, however, proven ideal for experiments not requiring daily oversight, or those requiring isolation or that are sensitive to electromagnetic interference. Consequently, there has been increased activity at TA-33 recently. The technical area is also the location of the National Radio Astronomy Observatory's Very Large Baseline Array telescope, a prominent landmark.

- TA-37, Magazine Area C: This is an explosives storage area.

- TA-49: This site is currently restricted to carefully selected functions given its location near Bandelier National Monument and past use in high-explosives and radioactive materials experiments.

- TA-54: The main function of this site is radioactive solid and hazardous chemical waste management. This technical area is discussed within the environment, safety, and health element of this plan.

- TA-57, Fenton Hill Site: This technical area is located west of the Laboratory in the Jemez Mountains. It is the site of the geothermal energy recovery (Hot Dry Rock) project. The Laboratory may decide to convert this demonstration operation to a seismic research facility.

- TA-69: Located at the entry to TAs 6, 8, 9, 22, and 58, this technical area is suitable for future physical support and experimental science uses that have close functional ties to those technical areas. This area also provides an environmental buffer.

- TAs 70 and 71: These undeveloped buffer areas are located southwest of White Rock between the Rio Grande and New Mexico Route 4. They are reserved for future large-scale experimental science.

- TA-72: This undeveloped land along East Jemez Road and NM 502 may offer expansion opportunities for TA-53 related projects.

- TA-73: This is the Los Alamos Airport and an adjacent buffer area along the south side of East Road.

- TA-74, Otowi Tract: This large area, bordering San Ildefonso Pueblo on the east, is isolated form most of the Laboratory and contains significant concentrations of archaeological sites and an endangered species breeding area.

Reference for Appendix A

Facilities Engineering Division Planning Group (ENG-2), ICF Kaiser Engineers, Inc., and Royston Hanamoto Alley & Abey Landscape Architects/Planners, September 1990. "Los Alamos National Laboratory Site Development Plan—Technical Site Information." (Facilities Engineering Division Planning Group et al. 1990, 0655)

Potential Release Sites at Los Alamos National Laboratory

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
0-003	Yes	Container storage, Western Steam Plant	1	1071
0-004	No	Container storage, 6th St. Warehouses	1	1071
0-005	Yes	Landfill	1	1071
0-008	No	Surface disposal site	1	1071
0-010(a)	No	Surface disposal site	1	1071
0-010(b)	No	Surface disposal site, 6th St. Warehouses	1	1071
0-011(a)	Yes	Mortar impact area	1	1071
0-011(c)	Yes	Mortar impact area	1	1071
0-011(d)	Yes	Mortar impact area	1	1071
0-011(e)	Yes	Mortar impact area	1	1071
0-012	Yes	Underground tank, Western Steam Plant	1	1071
0-015	No	Firing range, Rendija Canyon	1	1071
0-016	Yes	Firing range	1	1071
0-017	Yes	Waste lines	1	1071
0-018(a)	Yes	Wastewater treatment plant Pueblo	1	1071
0-018(b)	No	Wastewater treatment plant Bayo	1	1071
0-019	Yes	Wastewater treatment plant, Central	1	1071
0-024	No	Cistern	1	1071
0-025	No	Landfill	1	1071

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
0-026	No	Landfill	1	1071
0-027	No	Storage area, DP Road	1	1071
0-028(a)	Yes	Effluent discharge, golf course	1	1071
0-028(b)	Yes	Effluent discharge, ball fields	1	1071
0-029(a)	No	Transformer	1	1071
0-029(b)	No	Transformer	1	1071
0-029(c)	No	Transformer	1	1071
0-030(a)	Yes	Septic system, DP Road	1	1071
0-030(b)	Yes	Septic system 6th St	1	1071
0-030(c)	No	Septic system	1	1071
0-030(d)	No	Septic system	1	1071
0-030(e)N	No	Septic system	1	1071
0-030(e)S	No	Septic system	1	1071
0-030(f)	No	Septic system	1	1071
0-030(g)	Yes	Septic system	1	1071
0-030(h)	No	Septic system	1	1071
0-030(i)	No	Septic system	1	1071
0-030(j)	No	Septic system	1	1071
0-030(k)	No	Septic system	1	1071

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
0-030(l)	Yes	Septic system, 6th St. Warehouses	1	1071
0-030(m)	Yes	Septic system, 6th St. Warehouses	1	1071
0-030(n)	No	Septic system	1	1071
0-030(o)	No	Septic system	1	1071
0-030(p)	No	Septic system	1	1071
0-030(q)	No	Septic system	1	1071
0-031(a)	No	Soil contamination beneath former service station	1	1071
0-031(b)	No	Soil contamination beneath former motorpool (Two USTs)	1	1071
0-032	No	Soil contamination beneath former motorpool (UST for used motor oil)	1	1071
0-033(a)	Yes	Warehouses, 6th Street (UST removal)	1	1071
0-033(b)	No	Oulet piping 6th Street Warehouse	1	1071
0-034(a)	No	Landfill, Eastern Area	1	1071
0-034(b)	No	Landfill, Western Area	1	1071
0-035(a)	No	Surface disposal	1	1071
0-039	Yes	Underground tanks	1	1071
0-040	No	Underground tank	1	1071
C-0-020	No	Mortar impact area	1	1071
C-0-036(a)	No	Borrow pit 1, Bandelier NM	1	1071
C-0-036(b)	No	Borrow pit 2, Bandelier NM	1	1071

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
C-0-036(c)	No	Borrow pit 3, Bandelier NM	1	1071
C-0-036(d)	No	Borrow pit 4, Bandelier NM	1	1071
C-0-037	No	Landfill, Bandelier NM	1	1071
C-0-038	No	Surface disposal, Bandelier NM	1	1071
C-0-041	No	Asphalt and tar remnant site	1	1071
C-0-042	No	tank (formerly part of 0-032)	1	1071
C-0-043	No	Manhole (abandoned)	1	
0-001	Yes	Sediment Traps Mortandad	4	1049
1-001(a)	Yes	Septic tank 134	1	1078
1-001(b)	Yes	Septic tank 135	1	1078
1-001(c)	Yes	Septic tank 137	1	1078
1-001(d)	Yes	Septic tank 138 (hillside)	1	1078
1-001(e)	Yes	Septic tank 139	1	1078
1-001(f)	Yes	Septic tank 140 (hillside)	1	1078
1-001(g)	Yes	Septic tank 141	1	1078
1-001(h)	Yes	Septic tank 142	1	1078
1-001(i)	Yes	Septic tank 143	1	1078
1-001(j)	Yes	Septic tank 149	1	1078
1-001(k)	Yes	Septic tank 268	1	1078

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
1-001(l)	Yes	Septic tank 269	1	1078
1-001(m)	Yes	Septic tank 275	1	1078
1-001(n)	Yes	Septic tank 276	1	1078
1-001(o)	Yes	Ind. or san. waste water treat.	1	1078
1-001(p)	No	Septic system	1	1078
1-001(q)	No	Septic system	1	1078
1-001(r)	No	Septic system	1	1078
1-001(s)	Yes	Septic system	1	1078
1-001(t)	Yes	Septic system	1	1078
1-001(u)	Yes	Septic system	1	1078
1-001(v)	No	Septic system	1	1078
1-001(w)	No	Septic system	1	1078
1-002	Yes	Outfall TA1 SWMU to be in TA45	1	1078
1-003(a)	Yes	Landfill	1	1078
1-003(b)	No	Surface disposal site	1	1078
1-003(c)	No	Surface disposal site	1	1078
1-003(d)	Yes	Surface disposal site (Can dump)	1	1078
1-003(e)	Yes	Surface disposal site	1	1078
1-004(a)	No	Incinerator	1	1078

Los Alamos Environmental Restoration Potential Release Sites
(sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
1-004(b)	No	Incinerator	1	1078
1-005	No	Incinerator	1	1078
1-006(a)	Yes	Drain lines and outfall	1	1078
1-006(b)	Yes	Drain lines and outfall	1	1078
1-006(c)	Yes	Drain lines and outfall	1	1078
1-006(d)	Yes	Drain lines and outfall	1	1078
1-006(e)	No	Drain lines and outfall	1	1078
1-006(f)	No	Drain lines and outfall	1	1078
1-006(g)	No	Drain lines and outfall	1	1078
1-006(h)	Yes	Drain lines and outfall	1	1078
1-006(i)	No	Drain lines and outfall	1	1078
1-006(j)	No	Drain lines and outfall	1	1078
1-006(k)	No	Drain lines and outfall	1	1078
1-006(l)	No	Drain lines and outfall	1	1078
1-006(m)	No	Drain lines and outfall	1	1078
1-006(n)	Yes	Drain lines and outfall	1	1078
1-006(o)	Yes	Drain lines and outfall	1	1078
1-006(p)	No	Drain lines and outfall	1	1078
1-006(q)	No	Drain lines and outfall	1	1078

Los Alamos Environmental Restoration Potential Release Sites
(sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
1-006(r)	No	Drain lines and outfall	1	1078
1-006(s)	No	Drain lines and outfall	1	1078
1-006(t)	No	Drain lines and outfall	1	1078
1-007(a)	Yes	Soil contamination area	1	1078
1-007(b)	Yes	Soil contamination area	1	1078
1-007(c)	Yes	Soil contamination area	1	1078
1-007(d)	Yes	Soil contamination area	1	1078
1-007(e)	Yes	Soil contamination area	1	1078
1-007(f)	No	Soil contamination area	1	1078
1-007(g)	No	Soil contamination area	1	1078
1-007(h)	No	Soil contamination area	1	1078
1-007(i)	No	Soil contamination area	1	1078
1-007(j)	Yes	Soil contamination area	1	1078
1-007(k)	No	Soil contamination area	1	1078
1-007(l)	Yes	Soil contamination area	1	1078
1-007(m)	No	Soil contamination area	1	1078
1-007(n)	No	Soil contamination area	1	1078
1-007(o)	No	Soil contamination area	1	1078
1-007(p)	No	Soil contamination area	1	1078

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
2-001	No	Open burning ground	4	1098
2-002	No	Storage area	4	1098
2-003(a)	No	Reactor facility	4	1098
2-003(b)	No	Reactor facility	4	1098
2-003(c)	No	Reactor facility	4	1098
2-003(d)	No	Reactor facility	4	1098
2-003(e)	No	Holding tank (near reactor water boiler)	4	1098
2-004(a)	No	Reactor facility	4	1098
2-004(b)	No	Reactor facility Effluent Storage tank TA 2-54	4	1098
2-004(c)	No	Reactor facility effluent storage tank TA 2-55	4	1098
2-004(d)	No	Reactor facility effluent storage tank TA 2-56	4	1098
2-004(e)	No	Reactor facility acid pit TA 2-53	4	1098
2-004(f)	No	Reactor facility equipment building	4	1098
2-004(g)	No	Aboveground tank	4	1098
2-005	Yes	Systematic leak Cooling tower blowdown, Cr	4	1098
2-006(a)	Yes	Ind. or san. waste water treat.	4	1098
2-006(b)	Yes	Ind. or san. waste water treat.	4	1098
2-006(c)	No	Waste line	4	1098
2-006(d)	No	Waste line	4	1098

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
2-006(e)	No	Waste line	4	1098
2-007	Yes	Septic system	4	1098
2-008(a)	Yes	Outfall	4	1098
2-008(b)	Yes	Ind. or san. waste water treat.	4	1098
2-008(c)	No	Outfall	4	1098
2-009(a)	Yes	Non-intentional release	4	1098
2-009(b)	Yes	Non-intentional release	4	1098
2-009(c)	Yes	Non-intentional release	4	1098
2-009(d)	No	Non-intentional release	4	1098
2-009(e)	No	Reactor facility	4	1098
2-010	No	Building	4	1098
2-011(a)	No	Storm drain and outfall	4	1098
2-011(b)	No	Storm drain and outfall	4	1098
2-011(c)	No	Storm drain and outfall	4	1098
2-011(d)	No	Storm drain and outfall	4	1098
2-011(e)	No	Storm drain and outfall	4	1098
2-012	No	Underground tanks former TA 2-29 and former 2-67 replaced w 2-1	4	1098
2-013	No	Storage area	4	1098
C-2-001	No	Metal Nugget Pile	4	1098

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
3-001(a)	Yes	<90 day storage	1	1114
3-001(b)	Yes	Satellite storage area	1	1114
3-001(c)	Yes	<90 day storage	1	1114
3-001(d)	No	Container storage area	1	1114
3-001(e)	No	<90 day storage	1	1114
3-001(f)	No	Satellite storage area	1	1114
3-001(g)	No	Satellite storage area	1	1114
3-001(h)	No	Satellite storage area	1	1114
3-001(i)	No	Satellite storage area	1	1114
3-001(j)	No	Satellite storage area	1	1114
3-001(k)	Yes	Storage pad	1	1114
3-001(l)	No	<90 day storage	1	1114
3-001(m)	No	Satellite storage area	1	1114
3-001(n)	No	Satellite storage area	1	1114
3-001(o)	No	Satellite storage area	1	1114
3-001(p)	No	Satellite storage area	1	1114
3-001(q)	No	Satellite storage area	1	1114
3-001(r)	No	Satellite storage area	1	1114
3-001(s)	No	Satellite storage area	1	1114

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
3-001(t)	No	Satellite storage area	1	1114
3-001(u)	No	Satellite storage area	1	1114
3-001(v)	No	Satellite storage area	1	1114
3-001(w)	No	Satellite storage area	1	1114
3-001(x)	No	Satellite storage area	1	1114
3-001(y)	No	Satellite storage area	1	1114
3-002(a)	Yes	Container storage area	1	1114
3-002(b)	Yes	Storage area	1	1114
3-002(c)	Yes	Storage area	1	1114
3-002(d)	Yes	Container storage area	1	1114
3-003(a)	Yes	Storage area	1	1114
3-003(b)	Yes	Storage area	1	1114
3-003(c)	Yes	Equipment storage area	1	1114
3-003(d)	No	Storage area (Transformers)	1	1114
3-003(e)	No	Storage area (Transformers)	1	1114
3-003(f)	No	Storage area (Transformers)	1	1114
3-003(g)	No	One-time spill (Transformer)	1	1114
3-003(h)	No	Storage area (Transformers)	1	1114
3-003(i)	No	Storage area (Transformer)	1	1114

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
3-003(j)	No	Storage area (Transformers)	1	1114
3-003(k)	No	Storage area (Transformer)	1	1114
3-003(l)	No	Storage area	1	1114
3-003(m)	No	Storage area (Capacitor banks)	1	1114
3-003(n)	No	Storage area	1	1114
3-003(o)	No	Storage area (Capacitor bank)	1	1114
3-003(p)	No	Storage area	1	1114
3-004(a)	No	Container storage	1	1114
3-004(b)	No	Container storage	1	1114
3-004(c)	No	Storage area	1	1114
3-004(d)	No	Storage area	1	1114
3-004(e)	No	Storage area	1	1114
3-004(f)	No	Storage area	1	1114
3-006(a)	No	Burn site	1	1114
3-007	No	Firing site	1	1114
3-008(a)	No	Firing site	1	1114
3-008(b)	No	Firing site	1	1114
3-009(a)	Yes	Surface disposal (soil fill)	1	1114
3-009(b)	Yes	Surface disposal	1	1114

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
3-009(c)	Yes	Surface disposal	1	1114
3-009(d)	Yes	Surface disposal site	1	1114
3-009(e)	Yes	Surface disposal	1	1114
3-009(f)	Yes	Surface disposal	1	1114
3-009(g)	Yes	Surface disposal	1	1114
3-009(h)	Yes	Surface disposal	1	1114
3-009(i)	Yes	Surface disposal site	1	1114
3-009(j)	Yes	Surface disposal site	1	1114
3-010(a)	Yes	Systematic release site	1	1114
3-010(b)	No	Operational release	1	1114
3-010(c)	No	Operational release	1	1114
3-010(d)	No	Operational release	1	1114
3-011	Yes	Systematic product release	1	1114
3-012(a)	Yes	One-time spill	1	1114
3-012(b)	Yes	Operational release and outfall	1	1114
3-013(a)	Yes	Operational release	1	1114
3-013(b)	No	Operational release	1	1114
3-013(c)	No	Operational release	1	1114
3-013(d)	No	Operational release	1	1114

Los Alamos Environmental Restoration Potential Release Sites
(sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
3-013(e)	No	Operational release	1	1114
3-013(f)	No	Operational release	1	1114
3-013(g)	No	Operational release	1	1114
3-013(h)	No	Operational release	1	1114
3-014(a)	Yes	Waste water treatment facility	1	1114
3-014(a2)	No	Waste water treatment facility	1	1114
3-014(b)	Yes	Waste water treatment facility	1	1114
3-014(b2)	No	Outfall	1	1114
3-014(c)	Yes	Waste water treatment facility	1	1114
3-014(c2)	No	Outfall	1	1114
3-014(d)	Yes	Waste water treatment facility	1	1114
3-014(e)	Yes	Waste water treatment facility	1	1114
3-014(f)	Yes	Waste water treatment facility	1	1114
3-014(g)	Yes	Waste water treatment facility	1	1114
3-014(h)	Yes	Waste water treatment facility	1	1114
3-014(i)	Yes	Waste water treatment facility	1	1114
3-014(j)	Yes	Waste water treatment facility	1	1114
3-014(k)	Yes	Waste water treatment facility	1	1114
3-014(l)	Yes	Waste water treatment facility	1	1114

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
3-014(m)	Yes	Waste water treatment facility	1	1114
3-014(n)	Yes	Waste water treatment facility	1	1114
3-014(o)	Yes	Waste water treatment facility	1	1114
3-014(p)	Yes	Waste water treatment facility	1	1114
3-014(q)	Yes	Waste water treatment facility	1	1114
3-014(r)	Yes	Waste water treatment facility	1	1114
3-014(s)	Yes	Waste water treatment facility	1	1114
3-014(t)	Yes	Waste water treatment facility	1	1114
3-014(u)	Yes	Waste water treatment facility	1	1114
3-014(v)	No	Waste water treatment facility	1	1114
3-014(w)	No	Waste water treatment facility	1	1114
3-014(x)	No	Waste water treatment facility	1	1114
3-014(y)	No	Waste water treatment facility	1	1114
3-014(z)	No	Waste water treatment facility	1	1114
3-015	Yes	Outfall	1	1114
3-016(a)	No	Septic system	1	1114
3-016(b)	No	Septic system	1	1114
3-016(c)	No	Septic system	1	1114
3-016(d)	No	Septic system	1	1114

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
3-016(e)	No	Septic system	1	1114
3-016(f)	No	Septic system	1	1114
3-018	Yes	Septic system	1	1114
3-019	Yes	Septic tank	1	1114
3-020(a)	Yes	Disposal pit	1	1114
3-020(b)	No	Surface disposal site	1	1114
3-021	Yes	Surface disposal site	1	1114
3-022	No	Sump	1	1114
3-023	No	Sump	1	1114
3-024	Yes	Tank and/or assoc. equipment	1	1114
3-025(a)	Yes	Tank and/or assoc. equipment	1	1114
3-025(b)	Yes	Tank and/or assoc. equipment	1	1114
3-025(c)	No	Tank and/or assoc. equipment	1	1114
3-026(a)	No	Sump	1	1114
3-026(b)	Yes	Sumps	1	1114
3-026(c)	Yes	Tank and/or assoc. equipment	1	1114
3-026(d)	Yes	Tank and/or assoc. equipment	1	1114
3-027	No	Separation site	1	1114
3-028	Yes	Surface impoundment	1	1114

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
3-029	Yes	Landfill	1	1114
3-030	No	Surface impoundment	1	1114
3-031	Yes	Tank and/or assoc. equipment	1	1114
3-032	Yes	Tank and/or assoc. equipment	1	1114
3-033	Yes	Sump	1	1114
3-034(a)	Yes	Tank and/or assoc. equipment Radioactive liquid waste tanks	1	1114
3-034(b)	Yes	Tank and/or assoc. equipment	1	1114
3-035(a)	Yes	Underground tank	1	1114
3-035(b)	Yes	Underground storage tank	1	1114
3-036(a)	Yes	Aboveground tanks	1	1114
3-036(b)	No	Aboveground tanks	1	1114
3-036(c)	Yes	Aboveground tanks	1	1114
3-036(d)	Yes	Aboveground tanks	1	1114
3-036(e)	No	Aboveground tank	1	1114
3-036(f)	No	Aboveground tank	1	1114
3-036(g)	No	Aboveground tank	1	1114
3-036(h)	No	Aboveground tank	1	1114
3-036(i)	No	Aboveground tank	1	1114
3-036(j)	No	Aboveground tanks	1	1114

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
3-037	Yes	Underground tank	1	1114
3-038(a)	Yes	Acid tank	1	1114
3-038(b)	Yes	Acid tank	1	1114
3-038(c)	No	Waste lines	1	1114
3-038(d)	No	Waste lines	1	1114
3-038(e)	No	Waste lines	1	1114
3-038(f)	No	Waste lines	1	1114
3-039(a)	Yes	Silver recovery unit	1	1114
3-039(b)	No	Silver recovery unit	1	1114
3-039(c)	No	Silver recovery unit	1	1114
3-039(d)	No	Silver recovery unit	1	1114
3-039(e)	No	Silver recovery unit	1	1114
3-040(a)	No	Storage area	1	1114
3-040(b)	No	Storage area	1	1114
3-041	No	Underground tank	1	1114
3-042	No	Sump	1	1114
3-043(a)	No	Aboveground tank	1	1114
3-043(b)	No	Aboveground tank	1	1114
3-043(c)	Yes	Tank and/or assoc. equipment	1	1114

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
3-043(d)	No	Aboveground tank	1	1114
3-043(e)	Yes	Underground tank	1	1114
3-043(f)	No	Aboveground tank	1	1114
3-043(g)	No	Aboveground tank	1	1114
3-043(h)	No	Aboveground tank	1	1114
3-043(i)	No	Aboveground tank	1	1114
3-044(a)	Yes	Container storage	1	1114
3-044(b)	No	Container storage	1	1114
3-045(a)	Yes	Outfall (Ind. or san. waste water treatment)	1	1114
3-045(b)	Yes	Ind. or san. waste water treatment	1	1114
3-045(c)	Yes	Outfall	1	1114
3-045(d)	Yes	Above Ground Storage tank (Ind. or san. waste water treatment)	1	1114
3-045(e)	Yes	Outfall (Ind. or san. waste water treatment)	1	1114
3-045(f)	Yes	Outfall from Drain (Ind. or san. waste water treatment)	1	1114
3-045(g)	Yes	Storm Drain	1	1114
3-045(h)	Yes	Outfall (Ind. or san. waste water treatment)	1	1114
3-045(i)	Yes	Outfall (Ind. or san. waste water treatment)	1	1114
3-046	Yes	Above Ground Storage Tank (Physical, chem. &/or bio. treat.)	1	1114
3-047(a)	No	Storage area	1	1114

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
3-047(b)	No	Storage area	1	1114
3-047(c)	No	Drum Storage	1	1114
3-047(d)	No	Storage area	1	1114
3-047(e)	No	Storage area	1	1114
3-047(f)	No	Storage area	1	1114
3-047(g)	No	Drum Storage	1	1114
3-047(h)	No	Storage area	1	1114
3-047(i)	No	Satellite storage area	1	1114
3-047(j)	No	Drum Storage	1	1114
3-047(k)	No	Drum Storage	1	1114
3-048	No	Satellite storage area	1	1114
3-049(a)	Yes	Outfall	1	1114
3-049(b)	Yes	Operational release	1	1114
3-049(c)	Yes	Outfall	1	1114
3-049(d)	Yes	Outfall	1	1114
3-049(e)	Yes	Outfall	1	1114
3-050(a)	Yes	Exhaust emissions Off-gas scrubber of HEPA filter sys.	1	1114
3-050(b)	No	Exhaust emissions Off-gas scrubber of HEPA filter sys.	1	1114
3-050(c)	No	Exhaust Emissions Off-gas scrubber of HEPA filter sys.	1	1114

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
3-050(d)	Yes	Exhaust Emissions Off-gas scrubber of HEPA filter sys.	1	1114
3-050(e)	Yes	Exhaust Emissions Off-gas scrubber of HEPA filter sys.	1	1114
3-050(f)	Yes	Exhaust Emissions Off-gas scrubber of HEPA filter sys.	1	1114
3-050(g)	Yes	Exhaust Emissions Off-gas scrubber of HEPA filter sys.	1	1114
3-051(a)	No	Soil contamination (Oil from leaking compressor)	1	1114
3-051(b)	No	Soil contamination (Oil from leaking compressor)	1	1114
3-051(c)	No	Soil contamination (Vacuum pump leaking)	1	1114
3-051(d)	No	Soil contamination (Oil form leaking compressor)	1	1114
3-052(a)	Yes	Storm drainage	1	1114
3-052(b)	No	Storm drainage	1	1114
3-052(c)	Yes	Storm drainage	1	1114
3-052(d)	No	Storm drainage (nonPCB transformers/ capacitors)	1	1114
3-052(e)	Yes	Storm drainage	1	1114
3-052(f)	Yes	Storm drainage	1	1114
3-053	No	Operational facility	1	1114
3-054(a)	Yes	Outfall	1	1114
3-054(b)	Yes	Outfall	1	1114
3-054(c)	Yes	Outfall	1	1114
3-054(d)	Yes	Outfall	1	1114

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
3-054(e)	Yes	Outfall	1	1114
3-055(a)	Yes	Outfall	1	1114
3-055(b)	No	Outfall	1	1114
3-055(c)	Yes	Outfall	1	1114
3-055(d)	Yes	Outfall	1	1114
3-056(a)	Yes	Storage area	1	1114
3-056(b)	No	Container storage area	1	1114
3-056(c)	Yes	Transformer storage area	1	1114
3-056(d)	Yes	Drum Storage	1	1114
3-056(e)	No	Satellite storage area	1	1114
3-056(f)	No	Drum Storage	1	1114
3-056(g)	No	Satellite storage area	1	1114
3-056(h)	No	Transformer storage area	1	1114
3-056(i)	No	Drum Storage	1	1114
3-056(j)	No	Storage area	1	1114
3-056(k)	No	Container storage area	1	1114
3-056(l)	Yes	Drum Storage	1	1114
3-056(m)	Yes	Drum Storage	1	1114
3-056(n)	Yes	Drum Storage	1	1114

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
3-057	No	Sump/Grease trap	1	1114
3-058	No	Container storage	1	1114
3-059	Yes	Storage area	1	1114
C-3-001	No	Gas trap	1	1114
C-3-002	No	One-time spill- Leak from asphalt machine	1	1114
C-3-003	No	One-time spill- Stained asphalt	1	1114
C-3-004	No	Miscellaneous debris	1	1114
C-3-005	No	Oil Spill	1	1114
C-3-006	No	One-time spill	1	1114
C-3-007	No	Storage area	1	1114
C-3-008	No	Storage area/ rad contaminated	1	1114
C-3-009	No	Storage area	1	1114
C-3-010	No	Outfall	1	1114
C-3-011	No	Waste oil tank	1	1114
C-3-012	No	Satellite storage area	1	1114
C-3-014	No	Storage area	1	1114
C-3-015	No	Underground dist. tank	1	1114
C-3-016	No	Oil metal bin	1	1114
C-3-017	No	Underground storage tank	1	1114

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
C-3-018	No	Underground storage tank	1	1114
C-3-019	No	Underground storage tank	1	1114
C-3-020	No	Storage tank	1	1114
C-3-021	No	Underground storage tank	1	1114
C-3-022	No	Kerosene tanker trailer	1	1114
4-001	Yes	Firing Site	4	1129
4-002	Yes	Surface disposal	4	1129
4-003(a)	Yes	Outfall	4	1129
4-003(b)	Yes	Outfall	4	1129
4-004	No	Soil contamination beneath bldgs.	4	1129
C-4-001	No	Former Building Location	4	1129
5-001(a)	Yes	Firing Site	4	1129
5-001(b)	Yes	Firing Site	4	1129
5-001(c)	No	Firing Site	4	1129
5-002	Yes	Canyonside disposal	4	1129
5-003	Yes	Calibration chamber	4	1129
5-004	Yes	Septic system	4	1129
5-005(a)	Yes	French drain	4	1129
5-005(b)	Yes	Outfall	4	1129

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
5-006(a)	No	Former Building Location	4	1129
5-006(b)	Yes	Soil contamination beneath bldgs.	4	1129
5-006(c)	Yes	Soil contamination beneath bldgs.	4	1129
5-006(d)	No	Former Building Location	4	1129
5-006(e)	Yes	Soil contamination beneath bldgs.	4	1129
5-006(f)	No	Former Building Location	4	1129
5-006(g)	No	Former Building Location	4	1129
5-006(h)	Yes	Soil contamination beneath bldgs.	4	1129
C-5-001	No	Former Building Location	4	1129
6-001(a)	Yes	Septic system	5	1111
6-001(b)	Yes	Septic system	5	1111
6-002	Yes	Septic system	5	1111
6-003(a)	Yes	Firing site	5	1111
6-003(b)	No	Firing site	5	1111
6-003(c)	Yes	Firing site	5	1111
6-003(d)	Yes	Firing site	5	1111
6-003(e)	Yes	Firing site	5	1111
6-003(f)	Yes	Firing site	5	1111
6-003(g)	Yes	Firing site & building	5	1111

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
6-003(h)	Yes	Firing site	5	1111
6-004	No	Sump	5	1111
6-005	Yes	Firing site (pit)	5	1111
6-006	Yes	Storage area	5	1111
6-007(a)	Yes	Material disposal area (MDA F)	5	1111
6-007(b)	Yes	Landfill	5	1111
6-007(c)	Yes	Landfill	5	1111
6-007(d)	Yes	Landfill	5	1111
6-007(e)	Yes	Landfill	5	1111
6-007(f)	Yes	Surface disposal	5	1111
6-007(g)	Yes	Building & surface disposal	5	1111
6-008	No	Underground tank	5	1111
C-6-001	No	Building	5	1111
C-6-003	No	Building	5	1111
C-6-005	No	Building	5	1111
C-6-006	No	Building	5	1111
C-6-007	No	Building	5	1111
C-6-008	No	Building	5	1111
C-6-009	No	Building	5	1111

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
C-6-010	No	Building	5	1111
C-6-011	No	Building	5	1111
C-6-012	No	Building	5	1111
C-6-013	No	Building	5	1111
C-6-014	No	Building	5	1111
C-6-015	No	Building	5	1111
C-6-016	No	Building	5	1111
C-6-017	No	Building	5	1111
C-6-018	No	Building	5	1111
C-6-019	No	Building	5	1111
C-6-020	No	Building	5	1111
C-6-021	No	Building	5	1111
7-001(a)	Yes	Firing site	5	1111
7-001(b)	Yes	Firing site	5	1111
7-001(c)	Yes	Firing site	5	1111
7-001(d)	Yes	Firing site	5	1111
7-003(c)	Yes	Never existed	5	1111
7-003(d)	Yes	Never existed	5	1111
8-001(a)	No	Buildings	5	1157

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
8-001(b)	No	Buildings	5	1157
8-002	Yes	Firing site	5	1157
8-003(a)	Yes	Septic system	5	1157
8-003(b)	Yes	Septic system	5	1157
8-003(c)	Yes	Septic system	5	1157
8-004(a)	Yes	Floor drain	5	1157
8-004(b)	Yes	Drain line	5	1157
8-004(c)	Yes	Floor drain	5	1157
8-004(d)	Yes	Drain	5	1157
8-005	Yes	Container storage area	5	1157
8-006(a)	Yes	Landfill (MDA Q)	5	1157
8-006(b)	Yes	Landfill (duplicate of 8-006(a)	5	1157
8-007	Yes	Silver recovery unit	5	1157
8-008(a)	No	Storage area	5	1157
8-008(b)	No	Storage area	5	1157
8-008(c)	No	Storage area	5	1157
8-008(d)	No	Storage area	5	1157
8-009(a)	Yes	Ind. or san. wastewater treat.	5	1157
8-009(b)	No	Ind. or san. wastewater treat.	5	1157

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
8-009(c)	No	Storm drain and outfall	5	1157
8-009(d)	Yes	Ind. or san. wastewater treat.	5	1157
8-009(e)	Yes	Ind. or san. wastewater treat.	5	1157
8-009(f)	No	Outfall	5	1157
8-010(a)	No	Storage area	5	1157
8-010(b)	No	Storage area	5	1157
8-010(c)	No	Storage area	5	1157
8-011(a)	No	Underground tank	5	1157
8-011(b)	No	Underground tank	5	1157
C-8-001	No	Building	5	1157
C-8-002	No	Building	5	1157
C-8-003	No	Building	5	1157
C-8-004	No	Building	5	1157
C-8-005	No	Building	5	1157
C-8-006	No	Building	5	1157
C-8-007	No	Building	5	1157
C-8-008	No	Building	5	1157
C-8-009	No	Building	5	1157
C-8-010	Yes	Building	5	1157

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
C-8-011	No	Building	5	1157
C-8-012	No	Building	5	1157
C-8-013	No	Building	5	1157
C-8-014	No	Laboratory	5	1157
C-8-015	No	Building	5	1157
C-8-016	No	Building	5	1157
C-8-017	No	Storage area	5	1157
C-8-018	No	Storage area	5	1157
C-8-019	No	Storage area	5	1157
C-8-020	No	Disposal area	5	1157
9-001(a)	Yes	Firing sites	5	1157
9-001(b)	Yes	Firing sites	5	1157
9-001(c)	Yes	Firing sites	5	1157
9-001(d)	Yes	Firing sites	5	1157
9-002	Yes	Burn pit	5	1157
9-003(a)	Yes	Settling tank	5	1157
9-003(b)	Yes	Settling tank	5	1157
9-003(c)	Yes	Electric manhole	5	1157
9-003(d)	Yes	Settling tank	5	1157

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
9-003(e)	Yes	Settling tank	5	1157
9-003(f)	Yes	Settling tank	5	1157
9-003(g)	Yes	Settling tank	5	1157
9-003(h)	Yes	Settling tank	5	1157
9-003(i)	Yes	Settling tank	5	1157
9-004(a)	Yes	Settling tank	5	1157
9-004(b)	Yes	Settling tank	5	1157
9-004(c)	Yes	Settling tank	5	1157
9-004(d)	Yes	Settling tank	5	1157
9-004(e)	Yes	Settling tank	5	1157
9-004(f)	Yes	Settling tank	5	1157
9-004(g)	Yes	Settling tank	5	1157
9-004(h)	Yes	Settling tank	5	1157
9-004(i)	Yes	Settling tank	5	1157
9-004(j)	Yes	Settling tank	5	1157
9-004(k)	Yes	Settling tank	5	1157
9-004(l)	Yes	Settling tank	5	1157
9-004(m)	Yes	Settling tank	5	1157
9-004(n)	Yes	Settling tank	5	1157

Los Alamos Environmental Restoration Potential Release Sites
(sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
9-004(o)	Yes	Settling tank	5	1157
9-005(a)	Yes	Septic system	5	1157
9-005(b)	Yes	Septic system	5	1157
9-005(c)	Yes	Septic system	5	1157
9-005(d)	Yes	Septic system	5	1157
9-005(e)	Yes	Septic system	5	1157
9-005(f)	Yes	Septic system	5	1157
9-005(g)	Yes	Septic system	5	1157
9-005(h)	Yes	Septic system	5	1157
9-006	Yes	Septic system	5	1157
9-007	Yes	Basket pit	5	1157
9-008(a)	No	Surface impoundment	5	1157
9-008(b)	Yes	Surface impoundment	5	1157
9-009	Yes	Surface impoundment	5	1157
9-010(a)	No	Storage area	5	1157
9-010(b)	No	Storage area	5	1157
9-010(c)	No	Storage area	5	1157
9-011(a)	No	Storage area	5	1157
9-011(b)	No	Storage area	5	1157

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
9-011(c)	No	Storage area	5	1157
9-012	No	Disposal pit	5	1157
9-013	Yes	Material disposal area (MDA M)	5	1157
9-014	No	Firing site	5	1157
9-015	No	Manhole	5	1157
9-016	No	Underground tank	5	1157
C-9-001	Yes	Soil contamination	5	1157
C-9-002	No	Buildings	5	1157
C-9-003	No	Buildings	5	1157
C-9-004	No	Building	5	1157
C-9-005	No	Building	5	1157
C-9-006	No	Buildings	5	1157
C-9-007	No	Building	5	1157
C-9-008	No	Underground tank	5	1157
C-9-009	No	Non-intentional release	5	1157
C-9-010	No	Burn site	5	1157
C-9-011	No	Burn site	5	1157
10-001(a)	Yes	Firing Site	1	1079
10-001(b)	Yes	Firing Site	1	1079

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
10-001(c)	Yes	Firing Site	1	1079
10-001(d)	Yes	Firing Site	1	1079
10-001(e)	No	Detonation Test Area	1	1079
10-002(a)	Yes	Disposal pit	1	1079
10-002(b)	Yes	Disposal pit	1	1079
10-003(a)	Yes	Disposal pit	1	1079
10-003(b)	Yes	Disposal pit	1	1079
10-003(c)	Yes	Disposal pit	1	1079
10-003(d)	Yes	Disposal pit	1	1079
10-003(e)	Yes	Disposal pit	1	1079
10-003(f)	Yes	Disposal pit	1	1079
10-003(g)	Yes	Manholes	1	1079
10-003(h)	Yes	Manholes	1	1079
10-003(i)	Yes	Septic tank	1	1079
10-003(j)	Yes	Tank	1	1079
10-003(k)	Yes	Tank	1	1079
10-003(l)	Yes	Tank	1	1079
10-003(m)	Yes	Waste line	1	1079
10-003(n)	Yes	Leach field	1	1079

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
10-003(o)	Yes	Leach field	1	1079
10-004(a)	Yes	Septic system	1	1079
10-004(b)	Yes	Septic system	1	1079
10-005	Yes	Surface disposal	1	1079
10-006	Yes	Burn site	1	1079
10-007	Yes	Landfill	1	1079
10-008	No	Tree Rimmed Firing Point, Bayo Canyon	1	1079
10-009	No	Former Bayo Landfill	1	1079
C-10-001	No	Surface soil, 2 10x10 foot plots, Bayo Canyon	1	1079
11-001(a)	Yes	Firing site	3	1082
11-001(b)	Yes	Firing site	3	1082
11-001(c)	Yes	Firing site	3	1082
11-002	Yes	Burn site	3	1082
11-003(a)	No	Mortar impact area	3	1082
11-003(b)	No	Firing range	3	1082
11-004(a)	Yes	Drop tower	3	1082
11-004(b)	Yes	Drop tower	3	1082
11-004(c)	Yes	Drop tower	3	1082
11-004(d)	Yes	Drop tower	3	1082

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
11-004(e)	Yes	Drop tower	3	1082
11-004(f)	No	Drop tower	3	1082
11-005(a)	Yes	Septic system	3	1082
11-005(b)	Yes	Septic system	3	1082
11-005(c)	Yes	Ind. or san. wastewater treat.	3	1082
11-006(a)	Yes	Sump	3	1082
11-006(b)	Yes	Tank and/or assoc. equip.	3	1082
11-006(c)	Yes	Tank and/or assoc. equip.	3	1082
11-006(d)	Yes	Tank and/or assoc. equip.	3	1082
11-007	Yes	Surface disposal	3	1082
11-008	No	Surface disposal	3	1082
11-009	Yes	Material disposal area (MDA S)	3	1082
11-010(a)	No	Container storage area	3	1082
11-010(b)	No	Container storage	3	1082
11-011(a)	Yes	Ind. or san. wastewater treat.	3	1082
11-011(b)	Yes	Ind. or san. wastewater treat.	3	1082
11-011(c)	Yes	Ind. or san. wastewater treat.	3	1082
11-011(d)	Yes	Ind. or san. wastewater treat.	3	1082
11-012(a)	No	Building	3	1082

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
11-012(b)	No	Building	3	1082
11-012(c)	No	Building	3	1082
11-012(d)	No	Building	3	1082
C-11-001	No	Laboratory	3	1082
C-11-002	No	Laboratory	3	1082
C-11-003	No	One-time release site	3	1082
12-001(a)	Yes	Firing site Steel lined chamber	2	1085
12-001(b)	Yes	Firing site (former)	2	1085
12-002	Yes	Open burning ground	2	1085
12-003	No	Storage area	2	1085
12-004(a)	No	Radiation Test facility	2	1085
12-004(b)	No	Pipe	2	1085
C-12-001	No	Building	2	1085
C-12-002	No	Building	2	1085
C-12-003	No	Building	2	1085
C-12-004	No	Building	2	1085
C-12-005	No	Building	2	1085
C-12-006	No	Pole Duplicate of 12-004(a)	2	1085
13-001	Yes	Firing site	3	1082

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
13-002	Yes	Landfill	3	1082
13-003(a)	Yes	Septic tank same as 16-005(i).	3	1082
13-003(b)	No	Septic system	3	1082
13-004	Yes	Disposal pit	3	1082
14-001(a)	No	Firing site	2	1085
14-001(b)	No	Firing site	2	1085
14-001(c)	No	Firing site	2	1085
14-001(d)	No	Firing site	2	1085
14-001(e)	No	Firing site	2	1085
14-001(f)	No	Firing site-Bullet Test Facility	2	1085
14-001(g)	No	Firing site (active)	2	1085
14-002(a)	Yes	Firing site	2	1085
14-002(b)	Yes	Firing site	2	1085
14-002(c)	Yes	Building	2	1085
14-002(d)	Yes	Firing site	2	1085
14-002(e)	Yes	Firing site	2	1085
14-002(f)	Yes	Firing site	2	1085
14-003	Yes	Open burning ground	2	1085
14-004(a)	No	Storage area (still active)	2	1085

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
14-004(b)	Yes	Storage area	2	1085
14-004(c)	No	Storage area	2	1085
14-005	Yes	Incinerator (active)	2	1085
14-006	Yes	Tank and/or assoc. equip.	2	1085
14-007	Yes	Septic system	2	1085
14-008	No	Landfill and surface disposal	2	1085
14-009	Yes	Surface disposal site	2	1085
14-010	Yes	Sump	2	1085
C-14-001	No	Building	2	1085
C-14-002	No	Building	2	1085
C-14-003	No	Building	2	1085
C-14-004	No	Building	2	1085
C-14-005	No	Building	2	1085
C-14-006	No	Building	2	1085
C-14-007	No	Building	2	1085
C-14-008	No	Building	2	1085
C-14-009	No	Building	2	1085
15-001	No	Surface disposal	2	1086
15-002	Yes	Disposal pit and burn site	2	1086

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
15-003	Yes	Firing site (still active)	2	1086
15-004(a)	Yes	Firing site C	2	1086
15-004(b)	Yes	Firing site A	2	1086
15-004(c)	Yes	Firing site B	2	1086
15-004(d)	No	Firing site C	2	1086
15-004(e)	No	Mistakenly called firing site (actually manhole bunker)	2	1086
15-004(f)	Yes	Machine firing site E-F non RCRA hazard but VCA uranium	2	1086
15-004(g)	Yes	Machine firing site	2	1086
15-004(h)	No	Firing site	2	1086
15-004(i)	Yes	Detonation ground	2	1086
15-005(a)	No	Storage area	2	1086
15-005(b)	No	Storage area	2	1086
15-005(c)	No	Storage area (R-41)	2	1086
15-005(d)	No	Storage area	2	1086
15-006(a)	Yes	Firing site PHERMEX (still active)	2	1086
15-006(b)	Yes	Firing site Ector (still active)	2	1086
15-006(c)	Yes	Firing site R-44	2	1086
15-006(d)	Yes	Firing site R-45	2	1086
15-006(e)	No	Not in TA-15 @TA-36	2	1130

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
15-007(a)	Yes	Landfill (MDA N)	2	1086
15-007(b)	Yes	Landfill (MDA Z)	2	1086
15-007(c)	Yes	Shaft	2	1086
15-007(d)	Yes	Shaft	2	1086
15-008(a)	Yes	Surface disposal E/F site	2	1086
15-008(b)	Yes	Surface disposal	2	1086
15-008(c)	Yes	Surface disposal	2	1086
15-008(d)	Yes	Surface disposal (still active)	2	1086
15-008(e)	No	Surface disposal	2	1086
15-008(f)	No	Not in TA-36	2	1130
15-008(g)	No	Surface disposal	2	1086
15-009(a)	Yes	Septic system	2	1086
15-009(b)	Yes	Septic system	2	1086
15-009(c)	Yes	Septic tank	2	1086
15-009(d)	No	Septic tank	2	1086
15-009(e)	Yes	Septic system E/F site	2	1086
15-009(f)	Yes	Septic tank	2	1086
15-009(g)	Yes	Septic tank (still active)	2	1086
15-009(h)	Yes	Septic tank	2	1086

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
15-009(i)	Yes	Septic tank	2	1086
15-009(j)	Yes	Septic tank	2	1086
15-009(k)	Yes	Septic tank	2	1086
15-010(a)	Yes	Septic system	2	1086
15-010(b)	Yes	Septic system	2	1086
15-010(c)	Yes	Operational release (still active)	2	1086
15-011(a)	Yes	Sump	2	1086
15-011(b)	Yes	Dry well	2	1086
15-011(c)	Yes	Sump	2	1086
15-012(a)	Yes	Surface disposal (not located)	2	1086
15-012(b)	Yes	Surface disposal site	2	1086
15-013(a)	No	Underground tank	2	1086
15-013(b)	No	Underground tank	2	1086
15-014(a)	Yes	Ind. or san. wastewater treat.	2	1086
15-014(b)	Yes	Ind. or san. wastewater treat.	2	1086
15-014(c)	No	Ind. or san. wastewater treat.	2	1086
15-014(d)	No	Ind. or san. wastewater treat.	2	1086
15-014(e)	No	Ind. or san. wastewater treat. (active)	2	1086
15-014(f)	No	Ind. or san. wastewater treat.	2	1086

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
15-014(g)	No	Ind. or san. wastewater treat.	2	1086
15-014(h)	No	Outfall	2	1086
15-014(i)	Yes	Outfall	2	1086
15-014(j)	Yes	Outfall	2	1086
15-014(k)	Yes	Outfall	2	1086
15-014(l)	Yes	Outfall (still active)	2	1086
15-014(m)	Yes	Outfall (still active)	2	1086
C-15-001	No	Surface disposal	2	1086
C-15-002	No	Surface disposal	2	1086
C-15-003	No	Surface disposal	2	1086
C-15-004	No	Transformers	2	1086
C-15-005	No	Laboratory and building	2	1086
C-15-006	No	Building	2	1086
C-15-007	No	Non-intentional release	2	1086
C-15-008	No	Non-intentional release	2	1086
C-15-009	No	Underground tank	2	1086
C-15-010	No	Underground tank	2	1086
C-15-011	No	Underground tank	2	1086
C-15-012	No	Underground tank (still active)	2	1086

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
C-15-013	No	Underground tank	2	1086
16-001(a)	Yes	Tank	3	1082
16-001(b)	Yes	Dry wells	3	1082
16-001(c)	Yes	Tank	3	1082
16-001(d)	Yes	Dry well	3	1082
16-001(e)	Yes	Dry well	3	1082
16-003(a)	Yes	Sump	3	1082
16-003(b)	Yes	Sump	3	1082
16-003(c)	Yes	Sump	3	1082
16-003(d)	Yes	Sump	3	1082
16-003(e)	Yes	Sump	3	1082
16-003(f)	Yes	Sump	3	1082
16-003(g)	Yes	Sump	3	1082
16-003(h)	Yes	Sump	3	1082
16-003(i)	Yes	Sump	3	1082
16-003(j)	Yes	Sump	3	1082
16-003(k)	Yes	Sumps/Dralinlines with TA-16-260	3	1082
16-003(l)	Yes	Sump	3	1082
16-003(m)	Yes	Sump	3	1082

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
16-003(n)	Yes	Sump	3	1082
16-003(o)	Yes	Sump	3	1082
16-003(p)	No	Sump	3	1082
16-003(q)	No	Sump	3	1082
16-004(a)	Yes	Waste water treatment facility	3	1082
16-004(b)	Yes	Waste water treatment facility	3	1082
16-004(c)	Yes	Waste water treatment facility	3	1082
16-004(d)	Yes	Waste water treatment facility	3	1082
16-004(e)	Yes	Waste water treatment facility	3	1082
16-004(f)	Yes	Waste water treatment facility	3	1082
16-005(a)	Yes	Septic tank	3	1082
16-005(b)	Yes	Decommissioned septic system	3	1082
16-005(c)	Yes	Septic tank	3	1082
16-005(d)	Yes	Septic tank	3	1082
16-005(e)	Yes	Septic tank	3	1082
16-005(f)	Yes	Decommissioned septic system	3	1082
16-005(g)	Yes	Burn Site	3	1082
16-005(h)	Yes	Septic tank	3	1082
16-005(i)	Yes	Septic tank same as 13-003(a)	3	1082

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
16-005(j)	Yes	Septic tank	3	1082
16-005(k)	Yes	Septic tank	3	1082
16-005(l)	Yes	Grease trap	3	1082
16-005(m)	Yes	Chemical pit	3	1082
16-005(n)	Yes	Septic system	3	1082
16-005(o)	Yes	Septic system	3	1082
16-006(a)	Yes	Septic system	3	1082
16-006(b)	Yes	Septic system	3	1082
16-006(c)	Yes	Septic system	3	1082
16-006(d)	Yes	Septic system	3	1082
16-006(e)	Yes	Septic system	3	1082
16-006(f)	Yes	Septic system	3	1082
16-006(g)	Yes	Septic tank	3	1082
16-006(h)	Yes	Pump pit	3	1082
16-006(i)	Yes	Septic system	3	1082
16-007(a)	Yes	Surface impoundment	3	1082
16-007(b)	No	Surface disposal site	3	1082
16-008(a)	Yes	Surface impoundment	3	1082
16-008(b)	No	Surface impoundment	3	1082

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
16-009(a)	Yes	Burn site	3	1082
16-010(a)	Yes	Burn site	3	1082
16-010(b)	Yes	Burn site	3	1082
16-010(c)	Yes	Burn site	3	1082
16-010(d)	Yes	Burn site	3	1082
16-010(e)	Yes	Burn site	3	1082
16-010(f)	Yes	Burn site	3	1082
16-010(g)	Yes	Waste water treatment facility	3	1082
16-010(h)	Yes	Burn site	3	1082
16-010(i)	Yes	Burn site	3	1082
16-010(j)	Yes	Burn site	3	1082
16-010(k)	Yes	Trough	3	1082
16-010(l)	Yes	Trough	3	1082
16-010(m)	Yes	Trough	3	1082
16-010(n)	Yes	Trough	3	1082
16-011	No	Incinerator	3	1082
16-012(a)	Yes	Container storage- Rest House	3	1082
16-012(a2)	No	Container storage	3	1082
16-012(b)	Yes	Container storage- Rest House	3	1082

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
16-012(c)	Yes	Container storage- Rest House	3	1082
16-012(d)	Yes	Satellite storage area	3	1082
16-012(e)	Yes	Container storage- Rest House	3	1082
16-012(f)	Yes	Container storage- Rest House	3	1082
16-012(g)	Yes	Container storage- Rest House	3	1082
16-012(h)	Yes	Container storage- Rest House	3	1082
16-012(i)	Yes	Satellite storage area	3	1082
16-012(j)	Yes	Satellite storage area	3	1082
16-012(k)	Yes	Container storage- Rest House	3	1082
16-012(l)	Yes	Satellite storage area	3	1082
16-012(m)	Yes	Satellite storage area	3	1082
16-012(n)	Yes	Satellite storage area	3	1082
16-012(o)	Yes	Container storage- Rest House	3	1082
16-012(p)	Yes	Container storage	3	1082
16-012(q)	Yes	Container storage- Rest House	3	1082
16-012(r)	Yes	Container storage- Rest House	3	1082
16-012(s)	Yes	Container storage- Rest House	3	1082
16-012(t)	Yes	Satellite storage area	3	1082
16-012(u)	Yes	Satellite storage area	3	1082

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
16-012(v)	Yes	Container storage- Rest House	3	1082
16-012(w)	Yes	Container storage- Rest House	3	1082
16-012(x)	Yes	Satellite storage area	3	1082
16-012(y)	Yes	Container storage- Rest House	3	1082
16-012(z)	Yes	Container storage- Rest House	3	1082
16-013	Yes	Container storage	3	1082
16-015(a)	Yes	Operational facility	3	1082
16-015(b)	Yes	Operational facility	3	1082
16-015(c)	No	Operational facility	3	1082
16-015(d)	No	Operational facility	3	1082
16-016(a)	Yes	Landfill	3	1082
16-016(b)	Yes	Landfill	3	1082
16-016(c)	Yes	Landfill	3	1082
16-016(d)	Yes	Surface disposal site	3	1082
16-016(e)	Yes	Surface disposal site	3	1082
16-016(f)	No	Landfill	3	1082
16-016(g)	Yes	Surface disposal site	3	1082
16-017	Yes	Abandoned building & appurtenances	3	1082
16-018	Yes	Material disposal area MDA P RCRA (closure)	3	1082

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
16-019	Yes	Material disposal area (MDA R)	3	1082
16-020	Yes	Silver recovery unit	3	1082
16-021(a)	Yes	Systematic release site	3	1082
16-021(b)	No	Systematic leak	3	1082
16-021(c)	Yes	Ind. or san. waste water treatment	3	1082
16-022(a)	No	Underground tank	3	1082
16-022(b)	No	Underground tank	3	1082
16-023(a)	No	Incinerator	3	1082
16-023(b)	No	Incinerator	3	1082
16-024(a)	No	Magazine	3	1082
16-024(b)	No	Magazine	3	1082
16-024(c)	No	Magazine	3	1082
16-024(d)	No	Magazine	3	1082
16-024(e)	Yes	Operational facility	3	1082
16-024(f)	No	Magazine	3	1082
16-024(g)	No	Magazine	3	1082
16-024(h)	No	Magazine	3	1082
16-024(i)	No	Magazine	3	1082
16-024(j)	No	Magazine	3	1082

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
16-024(k)	No	Magazine	3	1082
16-024(l)	No	Magazine	3	1082
16-024(m)	No	Magazine	3	1082
16-024(n)	No	Magazine	3	1082
16-024(o)	No	Magazine	3	1082
16-024(p)	No	Magazine	3	1082
16-024(q)	No	Magazine	3	1082
16-024(r)	No	Magazine	3	1082
16-024(s)	No	Magazine	3	1082
16-024(t)	No	Operational facility	3	1082
16-024(u)	No	Magazine	3	1082
16-024(v)	No	Magazine	3	1082
16-025(a)	Yes	Abandoned building & appurtenances	3	1082
16-025(a2)	Yes	Abandoned building & appurtenances	3	1082
16-025(b)	Yes	Abandoned building & appurtenances	3	1082
16-025(b2)	Yes	Abandoned building & appurtenances	3	1082
16-025(c)	Yes	Abandoned HE building & appurtenances	3	1082
16-025(c2)	Yes	Abandoned building & appurtenances	3	1082
16-025(d)	Yes	Abandoned building & appurtenances	3	1082

Los Alamos Environmental Restoration Potential Release Sites
(sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
16-025(d2)	Yes	Abandoned building & appurtenances	3	1082
16-025(e)	Yes	Abandoned building & appurtenances	3	1082
16-025(e2)	Yes	Abandoned building & appurtenances	3	1082
16-025(f)	Yes	Abandoned building & appurtenances	3	1082
16-025(f2)	Yes	Abandoned building & appurtenances	3	1082
16-025(g)	Yes	Abandoned building & appurtenances	3	1082
16-025(g2)	Yes	Magazine	3	1082
16-025(h)	Yes	Abandoned building & appurtenances	3	1082
16-025(h2)	Yes	Abandoned building & appurtenances	3	1082
16-025(i)	Yes	Abandoned building & appurtenances	3	1082
16-025(j)	Yes	Abandoned building & appurtenances	3	1082
16-025(k)	Yes	Abandoned building & appurtenances	3	1082
16-025(l)	Yes	Abandoned building & appurtenances	3	1082
16-025(m)	Yes	Abandoned building & appurtenances	3	1082
16-025(n)	Yes	Abandoned building & appurtenances	3	1082
16-025(o)	Yes	Abandoned building & appurtenances	3	1082
16-025(p)	Yes	Abandoned building & appurtenances	3	1082
16-025(q)	Yes	Abandoned building & appurtenances	3	1082
16-025(r)	Yes	Abandoned building & appurtenances	3	1082

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
16-025(s)	Yes	Abandoned building & appurtenances	3	1082
16-025(t)	Yes	Abandoned building & appurtenances	3	1082
16-025(u)	Yes	Abandoned building & appurtenances	3	1082
16-025(v)	Yes	Abandoned building & appurtenances	3	1082
16-025(w)	Yes	Abandoned building & appurtenances	3	1082
16-025(x)	Yes	Abandoned building & appurtenances	3	1082
16-025(y)	Yes	Abandoned building & appurtenances	3	1082
16-025(z)	Yes	Abandoned building & appurtenances	3	1082
16-026(a)	Yes	Outfall	3	1082
16-026(a2)	Yes	Outfall	3	1082
16-026(b)	Yes	Outfall	3	1082
16-026(b2)	Yes	Outfall	3	1082
16-026(c)	Yes	Outfall	3	1082
16-026(c2)	Yes	Outfall	3	1082
16-026(d)	Yes	Outfall	3	1082
16-026(d2)	Yes	Outfall	3	1082
16-026(e)	Yes	Outfall	3	1082
16-026(e2)	Yes	Outfall	3	1082
16-026(f)	Yes	Outfall	3	1082

Los Alamos Environmental Restoration Potential Release Sites
(sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
16-026(f2)	Yes	Outfall	3	1082
16-026(g)	Yes	Outfall	3	1082
16-026(g2)	Yes	Outfall	3	1082
16-026(h)	Yes	Outfall	3	1082
16-026(h2)	Yes	Outfall	3	1082
16-026(i)	Yes	Outfall	3	1082
16-026(i2)	Yes	Outfall (inactive)	3	1082
16-026(j)	Yes	Outfall	3	1082
16-026(j2)	Yes	Outfall	3	1082
16-026(k)	Yes	Outfall	3	1082
16-026(k2)	Yes	Outfall	3	1082
16-026(l)	Yes	Outfall	3	1082
16-026(m)	Yes	Outfall	3	1082
16-026(n)	Yes	Outfall	3	1082
16-026(o)	Yes	Outfall	3	1082
16-026(p)	Yes	Outfall	3	1082
16-026(q)	Yes	Outfall	3	1082
16-026(r)	Yes	Outfall	3	1082
16-026(s)	Yes	Outfall	3	1082

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description.	Field Unit	Former OU
16-026(t)	Yes	Outfall	3	1082
16-026(u)	Yes	Outfall	3	1082
16-026(v)	Yes	Outfall	3	1082
16-026(w)	Yes	Outfall	3	1082
16-026(x)	Yes	Outfall	3	1082
16-026(y)	Yes	Outfall	3	1082
16-026(z)	Yes	Outfall	3	1082
16-027(a)	No	Transformer	3	1082
16-027(b)	No	Transformer	3	1082
16-027(c)	No	Transformer	3	1082
16-027(d)	No	Transformer	3	1082
16-028(a)	Yes	South Drainage	3	1082
16-028(b)	Yes	Ind. or san. waste water treatment	3	1082
16-028(c)	Yes	Ind. or san. waste water treatment	3	1082
16-028(d)	Yes	Ind. or san. waste water treatment	3	1082
16-028(e)	Yes	Ind. or san. waste water treatment	3	1082
16-029(a)	Yes	Sump	3	1082
16-029(a2)	Yes	Sump	3	1082
16-029(b)	Yes	Sump	3	1082

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
16-029(b2)	Yes	Sump	3	1082
16-029(c)	Yes	Sump	3	1082
16-029(c2)	Yes	Sump	3	1082
16-029(d)	Yes	Sump	3	1082
16-029(d2)	Yes	Sump	3	1082
16-029(e)	Yes	Sump	3	1082
16-029(e2)	Yes	Sump	3	1082
16-029(f)	Yes	Sump	3	1082
16-029(f2)	Yes	Outfall	3	1082
16-029(g)	Yes	Sump	3	1082
16-029(g2)	Yes	Pump pit	3	1082
16-029(h)	Yes	Sump	3	1082
16-029(h2)	Yes	Drain line and outfall	3	1082
16-029(i)	Yes	Outfall	3	1082
16-029(j)	Yes	Outfall	3	1082
16-029(k)	Yes	Sump	3	1082
16-029(l)	Yes	Sump	3	1082
16-029(m)	Yes	Sump	3	1082
16-029(n)	Yes	Sump	3	1082

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
16-029(o)	Yes	Sump	3	1082
16-029(p)	Yes	Sump	3	1082
16-029(q)	Yes	Sump	3	1082
16-029(r)	Yes	Outfall	3	1082
16-029(s)	Yes	Sump	3	1082
16-029(t)	Yes	Sump	3	1082
16-029(u)	Yes	Sump	3	1082
16-029(v)	Yes	Sump	3	1082
16-029(w)	Yes	Sump	3	1082
16-029(x)	Yes	Sump	3	1082
16-029(y)	Yes	Sump	3	1082
16-029(z)	Yes	Sump	3	1082
16-030(a)	Yes	Ind. or san. waste water treatment	3	1082
16-030(b)	Yes	Ind. or san. waste water treatment	3	1082
16-030(c)	Yes	Ind. or san. waste water treatment	3	1082
16-030(d)	No	Outfall	3	1082
16-030(e)	Yes	Ind. or san. waste water treatment	3	1082
16-030(f)	Yes	Ind. or san. waste water treatment	3	1082
16-030(g)	No	Outfall	3	1082

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
16-030(h)	Yes	Outfall	3	1082
16-031(a)	Yes	Ind. or san. waste water treatment	3	1082
16-031(b)	Yes	Ind. or san. waste water treatment	3	1082
16-031(c)	Yes	Ind. or san. waste water treatment	3	1082
16-031(d)	Yes	Ind. or san. waste water treatment	3	1082
16-031(e)	Yes	Ind. or san. waste water treatment	3	1082
16-031(f)	Yes	Ind. or san. waste water treatment	3	1082
16-031(g)	Yes	Cooling tower outfall (inactive)	3	1082
16-031(h)	Yes	Ind. or san. waste water treatment	3	1082
16-032(a)	Yes	Sump	3	1082
16-032(b)	No	Decommissioned HE sump	3	1082
16-032(c)	Yes	Sump	3	1082
16-032(d)	Yes	Decommissioned HE sump	3	1082
16-032(e)	Yes	Decommissioned HE sump	3	1082
16-033(a)	No	Underground tank	3	1082
16-033(b)	No	Underground tank	3	1082
16-033(c)	No	Underground tank	3	1082
16-033(d)	No	Tank and/or assoc. equip	3	1082
16-033(e)	No	Underground tank	3	1082

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
16-033(f)	No	Underground tank	3	1082
16-033(g)	No	Underground tank	3	1082
16-033(h)	No	Underground tank	3	1082
16-033(i)	No	Underground tank	3	1082
16-033(j)	No	Underground tank	3	1082
16-033(k)	No	Underground storage tank <100 gallons	3	1082
16-034(a)	Yes	Soil contamination area	3	1082
16-034(b)	Yes	Soil contamination area	3	1082
16-034(c)	Yes	Soil contamination area	3	1082
16-034(d)	Yes	Soil contamination area	3	1082
16-034(e)	Yes	Soil contamination area	3	1082
16-034(f)	Yes	Soil contamination area	3	1082
16-034(g)	Yes	Soil contamination	3	1082
16-034(h)	Yes	Soil contamination area	3	1082
16-034(i)	Yes	Soil contamination area	3	1082
16-034(j)	Yes	Soil contamination area	3	1082
16-034(k)	Yes	Soil contamination area	3	1082
16-034(l)	Yes	Soil contamination area	3	1082
16-034(m)	Yes	Soil contamination area	3	1082

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
16-034(n)	Yes	Soil contamination area	3	1082
16-034(o)	Yes	Soil contamination area	3	1082
16-034(p)	Yes	Soil contamination area	3	1082
16-035	Yes	Soil contamination area	3	1082
16-036	Yes	Soil contamination area	3	1082
16-037	No	Aboveground tank	3	1082
C-16-001	No	Building	3	1082
C-16-002	No	Building	3	1082
C-16-003	No	Septic system (see 16-005n)	3	1082
C-16-004	No	Building	3	1082
C-16-005	No	Building	3	1082
C-16-006	No	Building	3	1082
C-16-007	No	Tank stand	3	1082
C-16-008	No	Building	3	1082
C-16-009	No	Building	3	1082
C-16-010	No	Building	3	1082
C-16-011	No	Building	3	1082
C-16-012	No	Building	3	1082
C-16-013	No	Storage area	3	1082

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
C-16-014	No	Building	3	1082
C-16-015	No	Building	3	1082
C-16-016	No	Building	3	1082
C-16-017	No	Building	3	1082
C-16-018	No	Aboveground tank	3	1082
C-16-019	No	Building	3	1082
C-16-020	No	Building	3	1082
C-16-021	No	Building	3	1082
C-16-022	No	Building	3	1082
C-16-023	No	Warehouse	3	1082
C-16-024	No	Building	3	1082
C-16-025	Yes	Building	3	1082
C-16-026	Yes	Building	3	1082
C-16-027	No	Building	3	1082
C-16-028	No	Building	3	1082
C-16-029	No	Building	3	1082
C-16-030	No	Building	3	1082
C-16-031	No	Building	3	1082
C-16-032	No	Building	3	1082

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
C-16-033	No	Warehouse	3	1082
C-16-034	No	Aboveground tank	3	1082
C-16-035	No	Aboveground tank	3	1082
C-16-036	No	Septic system	3	1082
C-16-037	No	Storage area	3	1082
C-16-038	No	Storage area	3	1082
C-16-039	No	Building	3	1082
C-16-040	No	Building	3	1082
C-16-041	No	Building	3	1082
C-16-042	No	Steam manhole	3	1082
C-16-043	No	Steam manhole	3	1082
C-16-044	No	Manhole	3	1082
C-16-045	No	Manhole	3	1082
C-16-046	No	Manhole	3	1082
C-16-047	No	Transport area	3	1082
C-16-048	No	Steam manhole	3	1082
C-16-049	No	Building	3	1082
C-16-050	No	Building	3	1082
C-16-051	No	Transport area	3	1082

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
C-16-052	No	Steam manhole	3	1082
C-16-053	No	Water manhole	3	1082
C-16-054	No	Steam manhole	3	1082
C-16-055	No	Switch Box	3	1082
C-16-056	No	Steam manhole	3	1082
C-16-057	No	Steam manhole	3	1082
C-16-058	No	Transport area	3	1082
C-16-059	No	Electrical pit	3	1082
C-16-060	No	Building	3	1082
C-16-061	No	Building	3	1082
C-16-062	No	Generation area	3	1082
C-16-063	No	Generation area	3	1082
C-16-064	No	Drum Storage Area (HE scrap pick-up)	3	1082
C-16-065	No	Storage area	3	1082
C-16-066	No	Storage area	3	1082
C-16-067	No	Storage area	3	1082
C-16-068	No	Building	3	1082
C-16-069	No	Building	3	1082
C-16-070	No	Underground tank	3	1082

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
C-16-071	No	One-time spill	3	1082
C-16-072	No	Tank	3	1082
C-16-073	No	Underground tank	3	1082
C-16-074	No	Storage	3	1082
18-001(a)	Yes	Lagoon	2	1093
18-001(b)	Yes	Sewer lines	2	1093
18-001(c)	Yes	Sump	2	1093
18-002(a)	Yes	Firing site	2	1093
18-002(b)	Yes	Firing site	2	1093
18-002(c)	No	Drop tower	2	1093
18-003(a)	Yes	Settling pit	2	1093
18-003(b)	Yes	Septic system	2	1093
18-003(c)	Yes	Septic system	2	1093
18-003(d)	Yes	Septic system	2	1093
18-003(e)	Yes	Septic system	2	1093
18-003(f)	Yes	Septic system	2	1093
18-003(g)	Yes	Septic system	2	1093
18-003(h)	Yes	Septic system	2	1093
18-004(a)	Yes	Waste lines containment	2	1093

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
18-004(b)	Yes	Pit	2	1093
18-005(a)	Yes	Storage area	2	1093
18-005(b)	No	Storage area	2	1093
18-005(c)	No	Storage area	2	1093
18-006	No	Storage pipe	2	1093
18-007	Yes	Buried armored vehicle (does not exist)	2	1093
18-008	No	Underground tank	2	1093
18-009(a)	No	Transformer	2	1093
18-009(b)	No	Transformer	2	1093
18-009(c)	No	Transformer	2	1093
18-009(d)	No	Transformer	2	1093
18-009(e)	No	Transformer	2	1093
18-010(a)	No	Outfall	2	1093
18-010(b)	No	Outfall	2	1093
18-010(c)	No	Outfall	2	1093
18-010(d)	No	Outfall	2	1093
18-010(e)	No	Outfall	2	1093
18-010(f)	No	Outfall	2	1093
18-011	No	Soil containment	2	1093

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
18-012(a)	Yes	Outfall	2	1093
18-012(b)	Yes	Outfall	2	1093
18-012(c)	No	Sump and drain lines	2	1093
18-012(d)	No	Drain line	2	1093
18-013	No	Waste Tank	2	1093
C-18-001	No	Laboratory	2	1093
C-18-002	No	Building	2	1093
C-18-003	No	Storage area	2	1093
19-001	Yes	Septic system	1	1071
19-002	Yes	Surface disposal site	1	1071
19-003	Yes	Septic tank	1	1071
C-19-001	No	Soil contamination	1	1071
20-001(a)	Yes	Landfill	2	1100
20-001(b)	Yes	Landfill	2	1100
20-001(c)	Yes	Landfill	2	1100
20-002(a)	Yes	Firing site	2	1100
20-002(b)	Yes	Firing site	2	1100
20-002(c)	Yes	Firing site	2	1100
20-002(d)	Yes	Firing site	2	1100

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
20-003(a)	Yes	Firing site	2	1100
20-003(b)	No	Firing site	2	1100
20-003(c)	No	Firing site	2	1100
20-003(d)	No	Firing site	2	1100
20-004	No	Septic system	2	1100
20-005	Yes	Septic tank	2	1100
C-20-001	No	Storage building	2	1100
C-20-002	No	Storage building	2	1100
C-20-003	No	Building	2	1100
21-001	No	Container storage	1	1106
21-002(a)	Yes	Container storage	1	1106
21-002(b)	No	Container storage	1	1106
21-003	Yes	Container storage	1	1106
21-004(a)	No	Aboveground tank	1	1106
21-004(b)	Yes	Tank and/or assoc. equipment	1	1106
21-004(c)	Yes	Tank and/or assoc. equipment	1	1106
21-004(d)	No	Drain line	1	1106
21-005	Yes	Disposal pit	1	1106
21-006(a)	Yes	Disposal pit Bldg 21-2	1	1106

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
21-006(b)	Yes	Disposal pit	1	1106
21-006(c)	Yes	Disposal pit Bldg 21-3	1	1106
21-006(d)	Yes	Disposal pit Bldg 21-3	1	1106
21-006(e)	Yes	Surface disposal site Bldg 21-4	1	1106
21-006(f)	No	Disposal pit Bldg 21-4	1	1106
21-007	Yes	Incinerators	1	1106
21-008	No	Incinerator	1	1106
21-009	No	Waste treatment lab	1	1106
21-010(a)	Yes	Waste treatment facility	1	1106
21-010(b)	Yes	Waste treatment facility	1	1106
21-010(c)	Yes	Waste treatment facility	1	1106
21-010(d)	Yes	Waste treatment facility	1	1106
21-010(e)	Yes	Waste treatment facility	1	1106
21-010(f)	Yes	Waste treatment facility	1	1106
21-010(g)	Yes	Waste treatment facility	1	1106
21-010(h)	Yes	Waste treatment facility	1	1106
21-011(a)	Yes	Waste treatment facility	1	1106
21-011(b)	Yes	Sump	1	1106
21-011(c)	Yes	Tank and Sump	1	1106

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
21-011(d)	Yes	Aboveground tank	1	1106
21-011(e)	Yes	Aboveground tank	1	1106
21-011(f)	Yes	Aboveground tank	1	1106
21-011(g)	Yes	Aboveground tank	1	1106
21-011(h)	No	Aboveground tank	1	1106
21-011(i)	Yes	Aboveground tank	1	1106
21-011(j)	Yes	Aboveground tank	1	1106
21-011(k)	Yes	Outfall	1	1106
21-012(a)	Yes	Dry well	1	1106
21-012(b)	Yes	Dry well	1	1106
21-013(a)	Yes	Surface disposal site	1	1106
21-013(b)	Yes	Surface disposal site	1	1106
21-013(c)	Yes	Surface disposal site	1	1106
21-013(d)	Yes	Surface disposal site (Cold Dump)	1	1106
21-013(e)	Yes	Surface disposal site	1	1106
21-013(f)	No	Surface disposal site	1	1106
21-013(g)	No	Surface disposal site	1	1106
21-014	Yes	Material disposal area (MDA A)	1	1106
21-015	Yes	Material disposal area (MDA B)	1	1106

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
21-016(a)	Yes	Material disposal area (MDA T)	1	1106
21-016(b)	Yes	Material disposal area (MDA T)	1	1106
21-016(c)	Yes	Material disposal area (MDA T)	1	1106
21-017(a)	Yes	Material disposal area (MDA U)	1	1106
21-017(b)	Yes	Material disposal area (MDA U)	1	1106
21-017(c)	Yes	Material disposal area (MDA U)	1	1106
21-018(a)	Yes	Material disposal area (MDA V)	1	1106
21-018(b)	Yes	Material disposal area (MDA V) Laundry Facility	1	1106
21-019(a)	No	Filter houses/ exhaust stacks	1	1106
21-019(b)	No	Filter houses/ exhaust stacks	1	1106
21-019(c)	No	Filter houses/ exhaust stacks	1	1106
21-019(d)	No	Filter houses/ exhaust stacks	1	1106
21-019(e)	No	Filter houses/ exhaust stacks	1	1106
21-019(f)	No	Filter houses/ exhaust stacks	1	1106
21-019(g)	No	Filter houses/ exhaust stacks	1	1106
21-019(h)	No	Filter houses/ exhaust stacks	1	1106
21-019(i)	No	Filter houses/ exhaust stacks	1	1106
21-019(j)	No	Filter houses/ exhaust stacks	1	1106
21-019(k)	No	Filter houses/ exhaust stacks	1	1106

Los Alamos Environmental Restoration Potential Release Sites
(sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
21-019(l)	No	Filter houses/ exhaust stacks	1	1106
21-019(m)	No	Filter houses/ exhaust stacks	1	1106
21-020(a)	No	Filter house	1	1106
21-020(b)	No	Filter house	1	1106
21-021	Yes	Systematic release (site -wide)	1	1106
21-022(a)	Yes	Waste lines	1	1106
21-022(b)	Yes	Waste lines Bldg 21-2	1	1106
21-022(c)	Yes	Waste lines Bldg 21-3	1	1106
21-022(d)	Yes	Waste lines Bldg 21-4	1	1106
21-022(e)	Yes	Waste lines Bldg 21-5	1	1106
21-022(f)	Yes	Waste lines	1	1106
21-022(g)	Yes	Waste lines Bldg 21-150	1	1106
21-022(h)	Yes	Waste lines	1	1106
21-022(i)	Yes	Tank and/or assoc. equipment	1	1106
21-022(j)	Yes	Tank and/or assoc. equipment	1	1106
21-023(a)	Yes	Septic system Bldg 21-3	1	1106
21-023(b)	Yes	Septic system Bldg 21-3	1	1106
21-023(c)	Yes	Septic system	1	1106
21-023(d)	Yes	Septic system Bldg 21-3	1	1106

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
21-024(a)	Yes	Septic system	1	1106
21-024(b)	Yes	Septic system	1	1106
21-024(c)	Yes	Septic system	1	1106
21-024(d)	Yes	Septic system VCA for rad	1	1106
21-024(e)	Yes	Septic system	1	1106
21-024(f)	Yes	Septic system	1	1106
21-024(g)	Yes	Septic system	1	1106
21-024(h)	Yes	Septic system	1	1106
21-024(i)	Yes	Septic system	1	1106
21-024(j)	Yes	Septic system	1	1106
21-024(k)	Yes	Septic system	1	1106
21-024(l)	Yes	Ind. or san. waste water treat.	1	1106
21-024(m)	Yes	Drain line	1	1106
21-024(n)	Yes	Drain line	1	1106
21-024(o)	Yes	Drain line	1	1106
21-025(a)	No	Operational facility	1	1106
21-025(b)	No	Operational facility	1	1106
21-026(a)	Yes	Ind. or san. waste water treat.	1	1106
21-026(b)	Yes	Surface disposal site	1	1106

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
21-026(c)	No	Waste water treatment facility	1	1106
21-026(d)	No	Outfall	1	1106
21-027(a)	Yes	Ind. or san. waste water treat.	1	1106
21-027(b)	Yes	Outfalls	1	1106
21-027(c)	Yes	Ind. or san. waste water treat.	1	1106
21-027(d)	Yes	Drain line	1	1106
21-028(a)	No	Container storage	1	1106
21-028(b)	No	Container storage	1	1106
21-028(c)	No	Container storage Bldg 21-3	1	1106
21-028(d)	No	Container storage	1	1106
21-028(e)	No	Container storage	1	1106
21-029	Yes	Soil contamination area	1	1106
C-21-001	No	One-time spill Bldg 21-5	1	1106
C-21-002	No	Non-intentional release area	1	1106
C-21-003	No	Non-intentional release area	1	1106
C-21-004	No	Non-intentional release area	1	1106
C-21-005	No	One-time spill	1	1106
C-21-006	No	Non-intentional release area Bldg 21-2	1	1106
C-21-007	No	Non-intentional release area	1	1106

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
C-21-008	No	One-time spill	1	1106
C-21-009	No	One-time spill	1	1106
C-21-010	No	Systematic leak	1	1106
C-21-011	No	One-time spill	1	1106
C-21-012	No	One-time spill	1	1106
C-21-013	No	Disposal pit	1	1106
C-21-014	No	Warehouse	1	1106
C-21-015	No	Building	1	1106
C-21-016	No	Storage area	1	1106
C-21-017	No	Storage area	1	1106
C-21-018	No	Storage area	1	1106
C-21-019	No	Storage area	1	1106
C-21-020	No	Storage area	1	1106
C-21-021	No	Storage area	1	1106
C-21-022	No	Laboratory	1	1106
C-21-023	No	Laboratory	1	1106
C-21-024	No	Warehouse	1	1106
C-21-025	No	Building	1	1106
C-21-026	No	Building	1	1106

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
C-21-027	No	Machinery	1	1106
C-21-028	No	Tank	1	1106
C-21-029	No	Aboveground tank	1	1106
C-21-030	No	Aboveground tank	1	1106
C-21-031	No	Tank	1	1106
C-21-032	No	Machinery and tanks	1	1106
C-21-033	No	One-time spill	1	1106
C-21-034	No	Tank	1	1106
C-21-035	No	Aboveground tank	1	1106
C-21-036	No	Aboveground tank	1	1106
C-21-037	No	Aboveground tank	1	1106
22-001	No	Building	5	1111
22-003(a)	No	Satellite storage area	5	1111
22-003(b)	No	Satellite storage area	5	1111
22-003(c)	No	Satellite storage area	5	1111
22-003(d)	No	Satellite storage area	5	1111
22-003(e)	No	Satellite storage area	5	1111
22-003(f)	No	Satellite storage area	5	1111
22-003(g)	No	Satellite storage area	5	1111

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
22-010(a)	Yes	Septic system	5	1111
22-010(b)	yes	Septic system	5	1111
22-011	Yes	Disposal pit	5	1111
22-012	Yes	Decontamination facility	5	1111
22-013	No	Liquid waste treatment/storage	5	1111
22-014(a)	Yes	Ind. or san. wastewater treat.	5	1111
22-014(b)	Yes	Sump	5	1111
22-014(c)	No	Unit (does not exist)	5	1111
22-015(a)	Yes	Drain lines and dry wells	5	1111
22-015(b)	Yes	Sump and outfall	5	1111
22-015(c)	Yes	Outfall	5	1111
22-015(d)	Yes	Drain line and outfall	5	1111
22-015(e)	Yes	Ind. or san. wastewater treat.	5	1111
22-016	Yes	Septic system	5	1111
25-001	No	Pit	3	1082
C-25-001	No	Building	3	1082
26-001	Yes	Surface disposal site	1	1071
26-002(a)	Yes	Tank and/or assoc. equip.	1	1071
26-002(b)	Yes	Ind. or san. waste water treat.	1	1071

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
26-003	Yes	Septic tank	1	1071
27-001	Yes	Buried naval guns	2	1093
27-002	Yes	Firing sites	2	1093
27-003	Yes	Bazooka impact area	2	1093
27-004	No	Building	2	1093
30-001	No	Surface disposal and landfill	1	1114
31-001	Yes	Outfall from sanitary Septic system	1	1079
C-31-001	No	Buildings	1	1079
32-001	Yes	Incinerator	1	1079
32-002(a)	Yes	Septic tank	1	1079
32-002(b)	Yes	Septic tank	1	1079
32-003	No	Former transformer site	1	1079
32-004	No	Drain line and outfall	1	1079
C-32-001	No	Buildings	1	1079
33-001(a)	Yes	Material disposal area (MDA E)	3	1122
33-001(b)	Yes	Material disposal area (MDA E)	3	1122
33-001(c)	Yes	Material disposal area (MDA E)	3	1122
33-001(d)	Yes	Material disposal area (MDA E)	3	1122
33-001(e)	Yes	Material disposal area (MDA E)	3	1122

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
33-002(a)	Yes	Septic tank located at (MDA K)	3	1122
33-002(b)	Yes	Sump located at (MDA K)	3	1122
33-002(c)	Yes	Sump located at (MDA K)	3	1122
33-002(d)	Yes	Drain line and outfall located at (MDA K)	3	1122
33-002(e)	Yes	Drain line and outfall located at (MDA K)	3	1122
33-003(a)	Yes	Material disposal area (MDA D)	3	1122
33-003(b)	Yes	Material disposal area (MDA D)	3	1122
33-004(a)	Yes	Septic system	3	1122
33-004(b)	Yes	Septic system	3	1122
33-004(c)	Yes	Septic system	3	1122
33-004(d)	Yes	Septic system	3	1122
33-004(e)	Yes	Seepage pit	3	1122
33-004(f)	Yes	Septic system	3	1122
33-004(g)	Yes	Outfall	3	1122
33-004(h)	Yes	Outfall	3	1122
33-004(i)	Yes	Outfall	3	1122
33-004(j)	Yes	Outfall	3	1122
33-004(k)	Yes	Outfall	3	1122
33-004(l)	No	Outfall	3	1122

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
33-004(m)	Yes	Septic system	3	1122
33-004(n)	No	Septic system	3	1122
33-005(a)	Yes	Septic system	3	1122
33-005(b)	Yes	Septic system	3	1122
33-005(c)	Yes	Septic system	3	1122
33-006(a)	Yes	Firing site	3	1122
33-006(b)	Yes	Firing range	3	1122
33-007(a)	Yes	Firing range	3	1122
33-007(b)	Yes	Firing range	3	1122
33-007(c)	Yes	Firing range	3	1122
33-008(a)	Yes	Landfill	3	1122
33-008(b)	Yes	Landfill	3	1122
33-008(c)	No	landfill	3	1122
33-009	Yes	Surface disposal	3	1122
33-010(a)	Yes	Surface disposal	3	1122
33-010(b)	Yes	Surface disposal	3	1122
33-010(c)	Yes	Surface disposal	3	1122
33-010(d)	Yes	Surface disposal	3	1122
33-010(e)	No	Surface disposal (Area 6)	3	1122

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
33-010(f)	Yes	Surface disposal	3	1122
33-010(g)	Yes	Surface disposal	3	1122
33-010(h)	Yes	Surface disposal	3	1122
33-011(a)	Yes	Storage area	3	1122
33-011(b)	No	Storage area	3	1122
33-011(c)	Yes	Storage area	3	1122
33-011(d)	Yes	Storage area	3	1122
33-011(e)	Yes	Drum storage	3	1122
33-012(a)	Yes	Drum storage	3	1122
33-012(b)	No	Satellite storage area	3	1122
33-012(c)	No	Satellite storage area	3	1122
33-012(d)	No	Satellite storage area	3	1122
33-013	Yes	Storage area	3	1122
33-014	Yes	Burn site	3	1122
33-015	Yes	Incinerator	3	1122
33-016	Yes	Sump	3	1122
33-017	Yes	Operational release	3	1122
C-33-001	No	Transformer	3	1122
C-33-002	No	Transformer	3	1122

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
35-001	No	Material disposal area (MDA W)	4	1129
35-002	Yes	Material disposal area (MDA X)	4	1129
35-003(a)	Yes	Waste water treatment facility	4	1129
35-003(b)	Yes	Waste water treatment facility	4	1129
35-003(c)	Yes	Waste water treatment facility	4	1129
35-003(d)	Yes	Waste water treatment facility	4	1129
35-003(e)	Yes	Waste water treatment facility	4	1129
35-003(f)	Yes	Waste water treatment facility	4	1129
35-003(g)	Yes	Waste water treatment facility	4	1129
35-003(h)	Yes	Waste water treatment facility	4	1129
35-003(i)	Yes	Waste water treatment facility storage tanks	4	1129
35-003(j)	Yes	Waste water treatment facility	4	1129
35-003(k)	Yes	Waste water treatment facility	4	1129
35-003(l)	Yes	Waste water treatment facility	4	1129
35-003(m)	Yes	Waste water treatment facility	4	1129
35-003(misc)	No	Industrial waste lines	4	1129
35-003(n)	Yes	Waste water treatment facility	4	1129
35-003(o)	Yes	Waste water treatment facility	4	1129
35-003(p)	Yes	Waste water treatment facility	4	1129

Los Alamos Environmental Restoration Potential Release Sites
(sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
35-003(q)	Yes	Waste water treatment facility	4	1129
35-003(r)	No	Outfall	4	1129
35-004(a)	Yes	Storage areas	4	1129
35-004(b)	Yes	Storage areas	4	1129
35-004(c)	No	Storage areas	4	1129
35-004(d)	No	Container storage area	4	1129
35-004(e)	Yes	Container storage area	4	1129
35-004(f)	No	Container storage area	4	1129
35-004(g)	Yes	Container storage area	4	1129
35-004(h)	Yes	Container storage area	4	1129
35-004(i)	No	Container storage area	4	1129
35-004(j)	No	Container storage area	4	1129
35-004(k)	No	Container storage area	4	1129
35-004(l)	No	Container storage area	4	1129
35-004(m)	No	Container storage area	4	1129
35-004(n)	No	Container storage area	4	1129
35-004(o)	No	Container storage area	4	1129
35-005(a)	No	Surface impoundment (closure) Bldg 85 duplicate of 35-006	4	1129
35-005(b)	No	Surface impoundment (closure) Bldg 125	4	1129

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
35-006	Yes	Surface impoundment (closure) Bldg 85 duplicate of 35-005(a)	4	1129
35-007	No	Waste oil treatment	4	1129
35-008	Yes	Surface disposal and landfil	4	1129
35-009(a)	Yes	Septic system	4	1129
35-009(b)	Yes	Septic system	4	1129
35-009(c)	Yes	Septic system	4	1129
35-009(d)	Yes	Septic system	4	1129
35-009(e)	Yes	Septic system	4	1129
35-010(a)	Yes	Sanitary lagoon & sand filters	4	1129
35-010(b)	Yes	Sanitary lagoon & sand filters	4	1129
35-010(c)	Yes	Sanitary lagoon & sand filters	4	1129
35-010(d)	Yes	Sanitary lagoon & sand filters	4	1129
35-010(e)	No	Discharge Headwall	4	1129
35-011(a)	Yes	Underground storage tank	4	1129
35-011(b)	No	Underground storage tank	4	1129
35-011(c)	No	Underground storage tank	4	1129
35-011(d)	No	Underground storage tank	4	1129
35-012(a)	No	Underground storage tank	4	1129
35-012(b)	No	Underground storage tank (inactive)	4	1129

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
35-013(a)	Yes	Sump	4	1129
35-013(b)	Yes	Sump	4	1129
35-013(c)	Yes	Sump	4	1129
35-013(d)	Yes	Sump	4	1129
35-014(a)	Yes	Operational release	4	1129
35-014(b)	Yes	Leaking Drum	4	1129
35-014(c)	No	Operational release	4	1129
35-014(d)	No	Operational release	4	1129
35-014(e)	Yes	Oil Spill	4	1129
35-014(e2)	No	Oil Spill	4	1129
35-014(e3)	No	Operational release	4	1129
35-014(f)	No	Soil contamination	4	1129
35-014(g)	Yes	Soil contamination	4	1129
35-014(g2)	No	Soil contamination	4	1129
35-014(g3)	No	Soil contamination	4	1129
35-015(a)	Yes	Soil contamination	4	1129
35-015(b)	Yes	Waste oil treatment	4	1129
35-016(a)	Yes	Drains and outfalls	4	1129
35-016(b)	No	Outfall	4	1129

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
35-016(c)	Yes	Outfall	4	1129
35-016(d)	Yes	Outfall	4	1129
35-016(e)	No	Outfall	4	1129
35-016(f)	No	Storm drain	4	1129
35-016(g)	No	Outfall	4	1129
35-016(h)	No	Storm drain	4	1129
35-016(i)	Yes	Drains and outfalls	4	1129
35-016(j)	No	Storm drain	4	1129
35-016(k)	Yes	Drains and outfalls	4	1129
35-016(l)	No	Storm drain	4	1129
35-016(m)	Yes	Drains and outfalls	4	1129
35-016(n)	No	Storm drain	4	1129
35-016(o)	Yes	Drains and outfalls	4	1129
35-016(p)	Yes	Outfall	4	1129
35-016(q)	Yes	Drains and outfalls	4	1129
35-017	No	Soil contamination from Reactor	4	1129
35-018(a)	No	Transformer	4	1129
35-018(b)	No	Former transformer site	4	1129
C-35-001	No	Former UST site	4	1129

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
C-35-002	No	Former UST site	4	1129
C-35-003	No	Former UST site	4	1129
C-35-004	No	Operational release	4	1129
C-35-005	No	Operational release	4	1129
C-35-006	No	Operational release	4	1129
C-35-007	No	Soil contamination	4	1129
C-35-008	No	Leaking transformer	4	1129
36-001	Yes	Material disposal area (MDA AA)	2	1130
36-002	Yes	Sump	2	1130
36-003(a)	Yes	Septic system	2	1130
36-003(b)	Yes	Septic system	2	1130
36-003(c)	Yes	Septic system	2	1130
36-003(d)	No	Septic system	2	1130
36-004(a)	No	Firing site	2	1130
36-004(b)	No	Firing site	2	1130
36-004(c)	No	Firing site	2	1130
36-004(d)	Yes	Firing site (Lower Slabovia, Skunk works, Burn pit)	2	1130
36-004(e)	No	Firing site	2	1130
36-004(f)	No	Firing site	2	1130

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
36-005	Yes	Surface disposal site	2	1130
36-006	Yes	Surface disposal site	2	1130
36-007(a)	No	Storage area	2	1130
36-007(b)	No	Storage area	2	1130
36-007(c)	No	Storage area	2	1130
36-007(d)	No	Storage area	2	1130
36-007(e)	No	Storage area	2	1130
36-007(f)	No	Storage area	2	1130
C-36-001	No	Containment vessel	2	1130
C-36-002	No	Surface disposal	2	1130
C-36-003	Yes	Storm drainages	2	1130
C-36-006(e)	No	Firing site	2	1130
37-001	No	Septic system	3	1082
39-001(a)	Yes	Landfill	2	1132
39-001(b)	Yes	Material disposal area (MDA Y)	2	1132
39-002(a)	Yes	Storage area	2	1132
39-002(b)	No	Storage area	2	1132
39-002(c)	No	Storage area	2	1132
39-002(d)	No	Storage area	2	1132

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
39-002(e)	No	Storage area	2	1132
39-002(f)	No	Storage area	2	1132
39-002(g)	No	Storage area (still active)	2	1132
39-003	Yes	Incinerator	2	1132
39-004(a)	Yes	Firing site	2	1132
39-004(b)	Yes	Firing site	2	1132
39-004(c)	Yes	Firing site	2	1132
39-004(d)	Yes	Firing site	2	1132
39-004(e)	Yes	Firing site	2	1132
39-005	Yes	Seepage pit	2	1132
39-006(a)	Yes	Septic system	2	1132
39-006(b)	Yes	Septic system	2	1132
39-007(a)	Yes	Storage area	2	1132
39-007(b)	No	Storage area	2	1132
39-007(c)	No	Storage area	2	1132
39-007(d)	No	Storage area	2	1132
39-007(e)	No	Storage area	2	1132
39-008	Yes	Firing range	2	1132
39-009	No	Outfall	2	1132

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
40-001(a)	Yes	Septic system	5	1111
40-001(b)	Yes	Septic system	5	1111
40-001(c)	Yes	Septic system	5	1111
40-002(a)	No	Container storage area	5	1111
40-002(b)	No	Container storage area	5	1111
40-002(c)	No	Container storage area	5	1111
40-003(a)	Yes	Firing site- (closure)	5	1111
40-003(b)	No	Burning area/open detonation (closure)	5	1111
40-004	Yes	Oper. release	5	1111
40-005	Yes	Sump	5	1111
40-006(a)	Yes	Firing site	5	1111
40-006(b)	Yes	Firing site	5	1111
40-006(c)	Yes	Firing site	5	1111
40-007(a)	No	Storage area	5	1111
40-007(b)	No	Storage area	5	1111
40-007(c)	No	Storage area	5	1111
40-007(d)	No	Storage area	5	1111
40-007(e)	No	Storage area	5	1111
40-008	No	HE storage area decommissioned	5	1111

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description*	Field Unit	Former OU
40-009	Yes	Landfill	5	1111
40-010	Yes	Surface disposal site	5	1111
C-40-001	No	Usage site	5	1111
41-001	Yes	Septic system	4	1098
41-002(a)	Yes	Waste water treatment facility	4	1098
41-002(b)	Yes	Waste water treatment facility	4	1098
41-002(c)	Yes	Waste water treatment facility	4	1098
41-003	No	Sump	4	1098
41-004	No	Container storage	4	1098
C-41-001	No	Sump	4	1098
C-41-002	No	Underground tank	4	1098
C-41-003	No	Underground tank	4	1098
C-41-004	No	Storm drains	4	1098
C-41-005	No	Underground tank Mystery tank	4	1098
42-001(a)	Yes	Incinerator complex.	4	1129
42-001(b)	Yes	Incinerator complex.	4	1129
42-001(c)	Yes	Incinerator complex.	4	1129
42-002(a)	No	Decontam. facility	4	1129
42-002(b)	Yes	Decontam. facility driveway	4	1129

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
42-003	Yes	Septic system	4	1129
42-004	No	Canyon disposal	4	1129
43-001(a1)	Yes	Waste lines (Pre 1981)	1	1136
43-001(a2)	No	Waste lines (Post 1981)	1	1136
43-001(b1)	No	Outfall	1	1136
43-001(b2)	No	Outfall	1	1136
43-002	Yes	Incinerator	1	1136
43-003	No	Carcass Storage	1	1136
43-004	No	Waste Storage	1	1136
43-005	No	Radioactive liquid Storage	1	1136
C-43-001	No	Outfall	1	1136
45-001	Yes	Waste water treatment facility	1	1079
45-002	Yes	Vehicle Decontamination facility	1	1079
45-003	Yes	Waste lines	1	1079
45-004	Yes	Sanitary Sewer Outfall	1	1079
C-45-001	No	Parking lot of Former Treatment Plant	1	1079
46-001	No	Aboveground tank	3	1140
46-002	Yes	Surface impoundment	3	1140
46-003(a)	Yes	Septic system	3	1140

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
46-003(b)	Yes	Septic system	3	1140
46-003(c)	Yes	Septic system	3	1140
46-003(d)	Yes	Septic system	3	1140
46-003(e)	Yes	Septic system	3	1140
46-003(f)	Yes	Septic system	3	1140
46-003(g)	Yes	Septic system	3	1140
46-003(h)	Yes	Operational release	3	1140
46-004(a)	Yes	Waste line	3	1140
46-004(a2)	Yes	Outfall	3	1140
46-004(b)	Yes	Operational release	3	1140
46-004(b2)	Yes	Operational release	3	1140
46-004(c)	Yes	Sump	3	1140
46-004(c2)	Yes	Outfall	3	1140
46-004(d)	Yes	Sump	3	1140
46-004(d2)	Yes	Stack emissions	3	1140
46-004(e)	Yes	Sump	3	1140
46-004(e2)	No	Outfall	3	1140
46-004(f)	Yes	Outfall	3	1140
46-004(f2)	No	Outfall	3	1140

Los Alamos Environmental Restoration Potential Release Sites
(sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
46-004(g)	Yes	Outfall/Stack Emissions	3	1140
46-004(h)	Yes	Outfall/Stack Emissions	3	1140
46-004(i)	No	Outfall	3	1140
46-004(j)	No	Outfall	3	1140
46-004(k)	No	Outfall	3	1140
46-004(l)	No	Outfall	3	1140
46-004(m)	Yes	Outfall	3	1140
46-004(n)	No	Outfall	3	1140
46-004(o)	No	Outfall	3	1140
46-004(p)	Yes	Sump	3	1140
46-004(q)	Yes	Outfall	3	1140
46-004(r)	Yes	Outfall	3	1140
46-004(s)	Yes	Outfall/	3	1140
46-004(t)	Yes	Outfall	3	1140
46-004(u)	Yes	Outfall	3	1140
46-004(v)	Yes	Outfall	3	1140
46-004(w)	Yes	Outfall	3	1140
46-004(x)	Yes	Outfall	3	1140
46-004(y)	Yes	Outfall	3	1140

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
46-004(z)	Yes	Outfall	3	1140
46-005	Yes	Surface impoundment	3	1140
46-006(a)	Yes	Operational release	3	1140
46-006(b)	Yes	Operational release	3	1140
46-006(c)	Yes	Operational release	3	1140
46-006(d)	Yes	Operational release	3	1140
46-006(e)	No	Surface Disposal	3	1140
46-006(f)	Yes	Storage area	3	1140
46-006(g)	Yes	Operational Release	3	1140
46-007	Yes	Operational Release	3	1140
46-008(a)	Yes	Storage area	3	1140
46-008(b)	Yes	Storage area	3	1140
46-008(c)	Yes	Storage area	3	1140
46-008(d)	Yes	Storage area	3	1140
46-008(e)	Yes	Storage area	3	1140
46-008(f)	Yes	Storage area	3	1140
46-008(g)	Yes	Storage area	3	1140
46-008misc	No	Storage area	3	1140
46-009(a)	Yes	Surface disposal	3	1140

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
46-009(b)	Yes	Surface disposal	3	1140
46-010(a)	No	Storage area	3	1140
46-010(b)	No	Storage area	3	1140
46-010(c)	No	Storage area	3	1140
46-010(d)	Yes	Operation release	3	1140
46-010(e)	No	Storage area	3	1140
46-010(f)	No	Storage area	3	1140
46-010misc	No	Storage area	3	1140
C-46-001	No	One-time spill	3	1140
C-46-002	No	Stack Emissions	3	1140
C-46-003	No	Stack Emissions	3	1140
48-001	No	Air exhaust system	4	1129
48-002(a)	Yes	Container storage area	4	1129
48-002(b)	Yes	Container storage area	4	1129
48-002(c)	No	Container storage area	4	1129
48-002(d)	No	Container storage	4	1129
48-002(e)	No	Container storage	4	1129
48-003	Yes	Septic system	4	1129
48-004(a)	Yes	Sumps and tanks	4	1129

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
48-004(b)	Yes	Sumps and tanks	4	1129
48-004(c)	Yes	Sumps and tanks	4	1129
48-004(d)	No	Sumps and tanks	4	1129
48-005	Yes	Waste lines	4	1129
48-006	No	Septic system	4	1129
48-007(a)	Yes	Drains and outfalls	4	1129
48-007(b)	Yes	Drains and outfalls	4	1129
48-007(c)	Yes	Drains and outfalls	4	1129
48-007(d)	Yes	Drains and outfalls	4	1129
48-007(e)	No	Outfall	4	1129
48-007(f)	Yes	Drains and outfalls	4	1129
48-008	No	Transformer leak	4	1129
48-009	No	Soil contamination	4	1129
48-010	Yes	Surface Impoundment	4	1129
48-011	No	Disposal shaft	4	1129
49-001(a)	Yes	Material disposal area (MDA AB) (experimental shafts)	5	1144
49-001(b)	Yes	Material disposal area (MDA AB) (experimental shafts)	5	1144
49-001(c)	Yes	Material disposal area (MDA AB) (experimental shafts)	5	1144
49-001(d)	Yes	Material disposal area (MDA AB) (experimental shafts)	5	1144

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description.	Field Unit	Former OU
49-001(e)	Yes	Material disposal area (MDA AB) (experimental shafts)	5	1144
49-001(f)	Yes	Material disposal area (MDA AB) (experimental shafts)	5	1144
49-001(g)	Yes	Material disposal area (MDA AB) (miscellaneous)	5	1144
49-002	No	Operational facility (Area 10 underground chamber)	5	1144
49-003	Yes	Leach field (Area 11 Radchem and small shot area)	5	1144
49-004	Yes	Burn site and landfill (Area 6)	5	1144
49-005(a)	Yes	Landfill (east of Area 10)	5	1144
49-005(b)	No	Landfill (Area 5)	5	1144
49-006	Yes	Sump (Area 5)	5	1144
49-007(a)	No	Septic system (Area 6)	5	1144
49-007(b)	No	Septic system (HDT area)	5	1144
49-008(a)	No	Soil contamination (Area 5)	5	1144
49-008(b)	No	Soil contamination (Area 6)	5	1144
49-008(c)	No	Soil contamination (Area 11)	5	1144
49-008(d)	No	Firing sites (Bottle House area) soil contamination and underground chamber	5	1144
49-009	No	Underground tank (non-existent)	5	1144
50-001(a)	Yes	Waste treatment facility	5	1147
50-001(b)	No	Waste lines and manholes	5	1147
50-002(a)	Yes	Underground tanks	5	1147

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
50-002(b)	Yes	Underground tank	5	1147
50-002(c)	Yes	Underground tank	5	1147
50-002(d)	No	Underground tank	5	1147
50-003(a)	No	Storage area	5	1147
50-003(b)	No	Storage area	5	1147
50-003(c)	No	Storage area	5	1147
50-003(d)	No	Storage area	5	1147
50-003(e)	No	Storage area	5	1147
50-004(a)	Yes	Waste lines	5	1147
50-004(b)	Yes	Underground tanks	5	1147
50-004(c)	Yes	Waste lines	5	1147
50-005	No	Waste treatment facility	5	1147
50-006(a)	Yes	Operational release	5	1147
50-006(b)	No	Operational release	5	1147
50-006(c)	Yes	Operational release	5	1147
50-006(d)	Yes	Effluent discharge	5	1147
50-006(e)	No	Aboveground tank	5	1147
50-007	No	Incinerator	5	1147
50-008	No	Reduction site	5	1147

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
50-009	Yes	Material disposal area (MDA C)	5	1147
50-010	No	Decontamination facility	5	1147
50-011(a)	Yes	Septic system	5	1147
50-011(b)	No	Septic system	5	1147
C-50-001	No	Transformer	5	1147
51-001	No	Septic system	5	1148
51-002(a)	No	Usage site (Environmental Research Caisson)	5	1148
51-002(b)	No	Usage site (Environmental Research Caisson)	5	1148
C-51-001	No	Storage area	5	1148
C-51-002	No	Buildings	5	1148
52-001(a)	Yes	UHTREX equip.	4	1129
52-001(b)	Yes	UHTREX equip.	4	1129
52-001(c)	Yes	UHTREX equip.	4	1129
52-001(d)	Yes	UHTREX equip.	4	1129
52-002(a)	Yes	Septic system	4	1129
52-002(b)	Yes	Septic system	4	1129
52-002(c)	Yes	Septic system	4	1129
52-002(d)	Yes	Septic system	4	1129
52-002(e)	Yes	Septic system with 63-001(a)	4	1129

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
52-002(f)	Yes	Septic system	4	1129
52-002(g)	No	Septic system	4	1129
52-003(a)	No	Waste treatment facility	4	1129
52-003(b)	No	Industrial Wasteline	4	1129
52-004	No	Evaporator	4	1129
C-52-001	No	Former transformer site	4	1129
C-52-002	No	Former transformer site	4	1129
53-001(a)	Yes	Storage area	2	1100
53-001(b)	Yes	Storage area	2	1100
53-001(c)	No	Storage area	2	1100
53-001(d)	No	Storage area	2	1100
53-001(e)	No	Storage area	2	1100
53-001(f)	No	Storage area	2	1100
53-001(g)	No	Storage area	2	1100
53-001(h)	No	Storage area	2	1100
53-001(i)	No	Storage area	2	1100
53-001(j)	No	Storage area	2	1100
53-001(k)	No	Storage area	2	1100
53-001(l)	No	Storage area	2	1100

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
53-001(m)	No	Storage area	2	1100
53-001(n)	No	Storage area	2	1100
53-001(o)	No	Storage area	2	1100
53-002(a)	Yes	Disposal lagoon inactive (closure)	2	1100
53-002(b)	Yes	Disposal lagoon (active) RCRA closure	2	1100
53-003	No	Septic tank	2	1100
53-004	No	Operational facility	2	1100
53-005	Yes	Disposal pit	2	1100
53-006(a)	No	Underground tank	2	1100
53-006(b)	Yes	Underground tank	2	1100
53-006(c)	Yes	Underground tank	2	1100
53-006(d)	Yes	Underground tank	2	1100
53-006(e)	Yes	Underground tank	2	1100
53-006(f)	Yes	Underground tank	2	1100
53-007(a)	Yes	Aboveground neutralizer tank	2	1100
53-007(b)	Yes	Aboveground tanks (2)	2	1100
53-008	No	Storage area, Boneyard	2	1100
53-009	No	Aboveground tanks (3)	2	1100
53-010	No	Container storage	2	1100

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
53-011(a)	No	Transformer	2	1100
53-011(b)	No	Transformer	2	1100
53-011(c)	No	Transformer	2	1100
53-011(d)	No	Transformer	2	1100
53-011(e)	No	Transformer	2	1100
53-012(a)	No	Outfall	2	1100
53-012(b)	No	Outfall	2	1100
53-012(c)	No	Outfall	2	1100
53-012(d)	No	Outfall	2	1100
53-012(e)	No	Outfall	2	1100
53-012(f)	No	Outfall	2	1100
53-012(g)	No	Outfall	2	1100
53-012(h)	No	Outfall	2	1100
53-013	No	Soil Contamination -Lead storage site I	2	1100
53-014	No	Soil Contamination -Lead storage site II	2	1100
C-53-001	No	Transformer	2	1100
C-53-002	No	Transformer	2	1100
C-53-003	No	Transformer	2	1100
C-53-004	No	Transformer	2	1100

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
C-53-005	No	Transformer	2	1100
C-53-006	No	Transformer	2	1100
C-53-007	No	Transformer	2	1100
C-53-008	No	Transformer	2	1100
C-53-009	No	Transformer	2	1100
C-53-010	No	Transformer	2	1100
C-53-011	No	Transformer	2	1100
C-53-012	No	Transformer	2	1100
C-53-013	No	Transformer	2	1100
C-53-014	No	Transformer	2	1100
C-53-015	No	Transformer	2	1100
C-53-016	No	Transformer	2	1100
C-53-017	No	One-time spill	2	1100
C-53-018	No	One-time spill	2	1100
C-53-019	No	One-time spill	2	1100
54-001(a)	Yes	Storage area surface	5	1148
54-001(b)	No	Storage area	5	1148
54-001(c)	Yes	Storage area	5	1148
54-001(d)	No	Storage area	5	1148

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
54-001(e)	No	Storage area	5	1148
54-001(f)	No	Storage area	5	1148
54-002	No	Storage area (gas cylinder storage area)	5	1148
54-004	Yes	Material disposal area (MDA H) (except sh. 9)	5	1148
54-005	Yes	Material disposal area (MDA J) (Pits 1-5, Shafts 1-4)	5	1148
54-006	Yes	Material disposal area (MDA L) (All subsurface units such as Pit A, SI B,C,D Shafts 1-28, 29-34)	5	1148
54-007(a)	Yes	Septic system (tank and seepage trench)	5	1148
54-007(b)	Yes	Septic system	5	1148
54-007(c)	Yes	Septic system	5	1148
54-007(d)	No	Septic system	5	1148
54-007(e)	No	Septic system	5	1148
54-008	No	Underground tank	5	1148
54-009	No	Aboveground tanks (treatment tanks)	5	1148
54-010	No	Underground tank (supply wash-water tank)	5	1148
54-012(a)	No	Reduction site (drum compactor)	5	1148
54-012(b)	Yes	Reduction site	5	1148
54-013(a)	Yes	Decontamination facility (not buildt)	5	1148
54-013(b)	Yes	Disposal Pit (MDA G) (truck washing pit converted to Pit 19)	5	1148
54-014(a)	No	Storage shafts (MDA L) (Pb stringer shafts)	5	1148

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
54-014(b)	Yes	Storage pit (MDA G) (Pit 9, TRU waste)	5	1148
54-014(c)	Yes	Storage shafts (MDA G) (shafts 200-233)	5	1148
54-014(d)	Yes	Storage trenches A, B, C, D (MDA G)	5	1148
54-015(a)	No	Storage area(active surface corrosive inhibitor)	5	1148
54-015(b)	No	Storage area (TRU surface storage)	5	1148
54-015(c)	No	Storage area, TRU Pad 1	5	1148
54-015(d)	No	Storage area, TRU Pad 2	5	1148
54-015(e)	No	Storage area, TRU Pad 3	5	1148
54-015(f)	No	Storage area, TRU Pad 4	5	1148
54-015(g)	No	Storage area (Pb casks near shaft 4)	5	1148
54-015(h)	Yes	Storage area (drums)	5	1148
54-015(i)	No	Storage area- forklift battery	5	1148
54-015(j)	No	Storage area (Dome #49, mixed waste sludge)	5	1148
54-015(k)	Yes	Storage area (TRU waste mound)	5	1148
54-016(a)	No	Sump	5	1148
54-016(b)	No	Sump	5	1148
54-017	Yes	Disposal pits 16,22 (MDA G) (active before 11/19/80)	5	1148
54-018	Yes	Disposal pits 27-33,35-37 (MDA G) (active after 11/19/80)	5	1148
54-019	Yes	Disposal shafts (MDA G) (active before 11/19/80)	5	1148

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
54-020	Yes	Disposal shafts (MDA G) (active after 11/19/80)	5	1148
54-021	No	Aboveground oil storage tanks (6)	5	1148
54-022	No	Transformer spill (PCB)	5	1148
55-001	No	Cement plant	4	1129
55-002(a)	No	Rad waste storage area	4	1129
55-002(b)	No	Rad waste storage area	4	1129
55-002(c)	No	Container Storage Area	4	1129
55-003	No	Containment area	4	1129
55-004	No	Evaporator	4	1129
55-005	No	Filtration Unit	4	1129
55-006	No	Glass Breaker	4	1129
55-007	No	Thermal combustion unit	4	1129
55-008	Yes	Sumps and tanks	4	1129
55-009	Yes	Sumps and tanks	4	1129
55-010	No	Solvent spills	4	1129
55-011(a)	No	Storm drain	4	1129
55-011(b)	No	Storm drain	4	1129
55-011(c)	No	Storm drain	4	1129
55-011(d)	No	Storm drain	4	1129

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
55-011(e)	No	Storm drain	4	1129
55-012	No	Container storage area	4	1129
55-013(a)	No	Storage area	4	1129
55-013(b)	No	Storage area	4	1129
57-001(a)	No	Drilling mud pits	5	1154
57-001(b)	No	Drilling mud pits	5	1154
57-001(c)	No	Drilling mud pits	5	1154
57-002	No	Landfill	5	1154
57-003	No	Storage area	5	1154
57-004(a)	No	Surface impoundment	5	1154
57-004(b)	No	Surface impoundment	5	1154
57-005	No	Pond filtration unit	5	1154
57-006	No	Drum and Contents Fenton Hill	5	1154
57-007	No	Leach Field	5	1154
59-001	Yes	Septic system	1	1114
59-002	No	Container storage area	1	1114
59-003	No	Sump	1	1114
59-004	No	Outfall	1	1114
C-59-001	No	PCB containing capacitors & Transformer	1	1114

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
60-001(a)	No	Storage area (Active storage)	1	1114
60-001(b)	No	Storage area (Active Storage)	1	1114
60-001(c)	No	Storage area (active)	1	1114
60-001(d)	No	Storage area Pesticide Shed	1	1114
60-002	Yes	Storage area	1	1114
60-003	No	Oil-water separator	1	1114
60-004(a)	No	Storage area	1	1114
60-004(b)	No	Storage area	1	1114
60-004(c)	No	Storage area	1	1114
60-004(d)	No	Storage area	1	1114
60-004(e)	No	Storage area	1	1114
60-004(f)	No	Storage area	1	1114
60-005(a)	Yes	Surface impoundment -formerly 3-029(a)	1	1114
60-005(b)	No	Drilling mud pit	1	1114
60-006(a)	Yes	Septic tank	1	1114
60-006(b)	No	Septic system	1	1114
60-006(c)	No	Septic tank	1	1114
60-007(a)	Yes	Systematic or intent. prod. release	1	1114
60-007(b)	Yes	Systematic or intent. prod. release	1	1114

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
C-60-001	No	Underground tank	1	1114
C-60-002	No	Underground tank	1	1114
C-60-003	No	One-time spill at pesticide shed	1	1114
C-60-004	No	Underground tank	1	1114
61-001	No	Storage area	1	1114
61-002	Yes	Transformer storage area	1	1114
61-003	No	Burn sites	1	1114
61-004(a)	Yes	Septic tank	1	1114
61-004(b)	No	Septic tank	1	1114
61-004(c)	No	Septic tank	1	1114
61-005	Yes	Landfill	1	1114
61-006	Yes	Waste oil tank	1	1114
61-007	Yes	Transformer site - systematic leak	1	1114
C-61-001	No	Transformer storage area- PCB leak	1	1114
C-61-002	No	Subsurface Contamination	1	1114
63-001(a)	Yes	Septic system	4	1129
63-001(b)	Yes	Septic system	4	1129
63-002	No	Container storage area	4	1129
64-001	No	Storage area	1	1114

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
69-001	Yes	Incinerator and assoc. equip.	5	1157
69-002(a)	No	Septic system	5	1157
69-002(b)	No	Septic system	5	1157
72-001	No	Firing range	2	1100
72-002	No	Firing site	2	1100
72-003(a)	No	Septic system	2	1100
72-003(b)	No	Septic system	2	1100
73-001(a)	Yes	Landfill	1	1071
73-001(b)	Yes	Surface disposal site	1	1071
73-001(c)	Yes	Landfill	1	1071
73-001(d)	Yes	Landfill	1	1071
73-002	Yes	Incinerator surface disposal	1	1071
73-003	No	Steam cleaning plant	1	1071
73-004(a)	Yes	Septic tank	1	1071
73-004(b)	Yes	Septic tank	1	1071
73-004(c)	Yes	Septic tank	1	1071
73-004(d)	Yes	Septic tank	1	1071
73-005	Yes	Surface disposal site	1	1071
73-006	Yes	Airport building outfalls	1	1071

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
73-007	No	septic tank and drainlines	1	1071
C-73-001	No	Underground tank	1	1071
C-73-002	No	Underground tank	1	1071
C-73-003	No	Underground tank	1	1071
C-73-004	No	Underground tank	1	1071
C-73-005(a)	No	excavation (unlined septic tank/outhouse trench)	1	1071
C-73-005(b)	No	excavation (unlined septic tank/outhouse trench)	1	1071
C-73-005(c)	No	excavation (unlined septic tank/outhouse trench)	1	1071
C-73-005(d)	No	excavation (unlined septic tank/outhouse trench)	1	1071
C-73-005(e)	No	excavation (unlined septic tank/outhouse trench)	1	1071
C-73-005(f)	No	excavation (unlined septic tank/outhouse trench)	1	1071
C-0-001	No	Guaje Canyon	4	1049
C-0-002	No	Rendija Canyon	4	1049
C-0-003	No	Barrancas Canyon	4	1049
C-0-004	No	Bayo Canyon	4	1049
C-0-005	No	Pueblo Canyon	4	1049
C-0-006	No	Los Alamos Canyon	4	1049
C-0-007	No	Sandia Canyon	4	1049
C-0-008	No	Mortandad Canyon	4	1049

Los Alamos Environmental Restoration Potential Release Sites (sorted by PRS number)

PRS Number	HSWA SWMU	Unit Description	Field Unit	Former OU
C-0-009	No	Canada del Buey	4	1049
C-0-010	No	Two Mile Canyon	4	1049
C-0-011	No	Pajarito Canyon	4	1049
C-0-012	No	Three Mile Canyon	4	1049
C-0-013	No	Potrillo Canyon	4	1049
C-0-014	No	Canon de Valle	4	1049
C-0-015	No	Fence Canyon	4	1049
C-0-016	No	Water Canyon	4	1049
C-0-017	No	Indio Canyon	4	1049
C-0-018	No	Ancho Canyon	4	1049
C-0-019	No	Chaquehui Canyon	4	1049

Projected Schedule and Cost for the Environmental Restoration Project at Los Alamos National Laboratory

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APPENDIX C

To be delivered at a later date.

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ACRONYMS AND ABBREVIATIONS

AEA	Atomic Energy Act
AEC	US Atomic Energy Commission
AIHA	American Industrial Hygiene Association
ANSI	American National Standards Institute
ALARA	As low as reasonably achievable
ANTI-C	Radiologic protective clothing
AOC	Area of concern
AP	Administrative procedure
AR	Administrative record
ASME	American Society of Mechanical Engineers
BUS	Business Systems Division
CAMU	Corrective action management unit
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CIO	Community Involvement and Outreach Office
CMI	Corrective measures implementation
CMS	Corrective measures study
COPC	Chemicals of potential concern
CPR	Cardiopulmonary resuscitation
CRM	Communications Records Management
CST	Chemical Science and Technology Division
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	US Department of Transportation
DQO	Data quality objective
EA	Environmental assessment
EIS	Environmental impact statement
EM	Office of Environmental Restoration and Waste Management
EPA	US Environmental Protection Agency
ER	Environmental Restoration (Program)
ESG	Environmental Studies Group
ESH	Environment, Safety, and Health Division
FIMAD	Facility for Information Management, Analysis, and Display
FPL	Field project leader
FY	Fiscal year
GIS	Geographical Information System
HASP	Health and Safety Plan
HAZMAT	Hazardous materials
HAZWOPER	Hazardous Waste Operations and Emergency Response
H&S	Health and safety
HSWA	Hazardous and Solid Waste Amendments
ICRP	International Commission on Radiological Protection
IWP	Installation work plan
Laboratory	Los Alamos National Laboratory
LANL	Los Alamos National Laboratory
LASL	Los Alamos Scientific Laboratory (the Laboratory before January 1, 1981)
MCL	Maximum contaminant level
MDA	Materials disposal area
MSA	Major Systems Acquisition
MSA AL-1	DOE Operations Office in Albuquerque

MWDF	Mixed-Waste Disposal Facility
NCRP	National Council on Radiation Protection and Measurements
NEPA	National Environmental Policy Act
NFA	No further action
NIOSH	National Institute of Occupational Safety and Health
NMED	New Mexico Environment Department
OSHA	Occupational Safety and Health Administration
OU	Operable unit
PCB	Polychlorinated biphenyl
PP&C	Project Planning and Control Team
PRS	Potential release site
PR/VSI	Preliminary Review/Visual Site Inspection
QA	Quality assurance
QAPP	Quality assurance project plan
QC	Quality control
QP	Quality procedure
RCRA	Resource Conservation and Recovery Act
RFA	RCRA facility assessment
RFI	RCRA facility investigation
RPF	Records-Processing Facility
SAL	Screening action level
SMO	Sample Management Office
SOP	Standard operating procedure
SSHASP	Site-specific health and safety plan
SWEIS	Sitewide Environmental Impact Statement
SWMU	Solid waste management unit
TA	Technical area
TSD	Treatment, storage, disposal
UC	University of California
USGS	US Geological Survey
VCA	Voluntary corrective action

APPROXIMATE CONVERSION FACTORS FOR SELECTED SI (METRIC) UNITS

Multiply SI (Metric) Unit	**by**	**To Obtain US Customary Unit**
Cubic meters (m^3)	35	Cubic feet (ft^3)
Centimeters (cm)	0.39	Inches (in.) meters
Meters (m)	3.3	Feet (ft)
Kilometers (km)	0.62	Miles (mi)
Square kilometers (km^2)	0.39	Square miles (mi^2)
Hectares (ha)	2.5	Acres
Liters (L)	0.26	Gallons (gal.)
Grams (g)	0.035	Ounces (oz)
Kilograms (kg)	2.2	Pounds (lb)
Micrograms per gram (mg/g)	1	Parts per million (ppm)
Milligrams per liter (mg/L)	1	Parts per million (ppm)
Celsius (°C)	9/5 + 32	Fahrenheit (°F)

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