PREASSESSMENT SCREEN FOR LOS ALAMOS NATIONAL LABORATORY

Prepared by

The Los Alamos National Laboratory Natural Resource Trustee Council

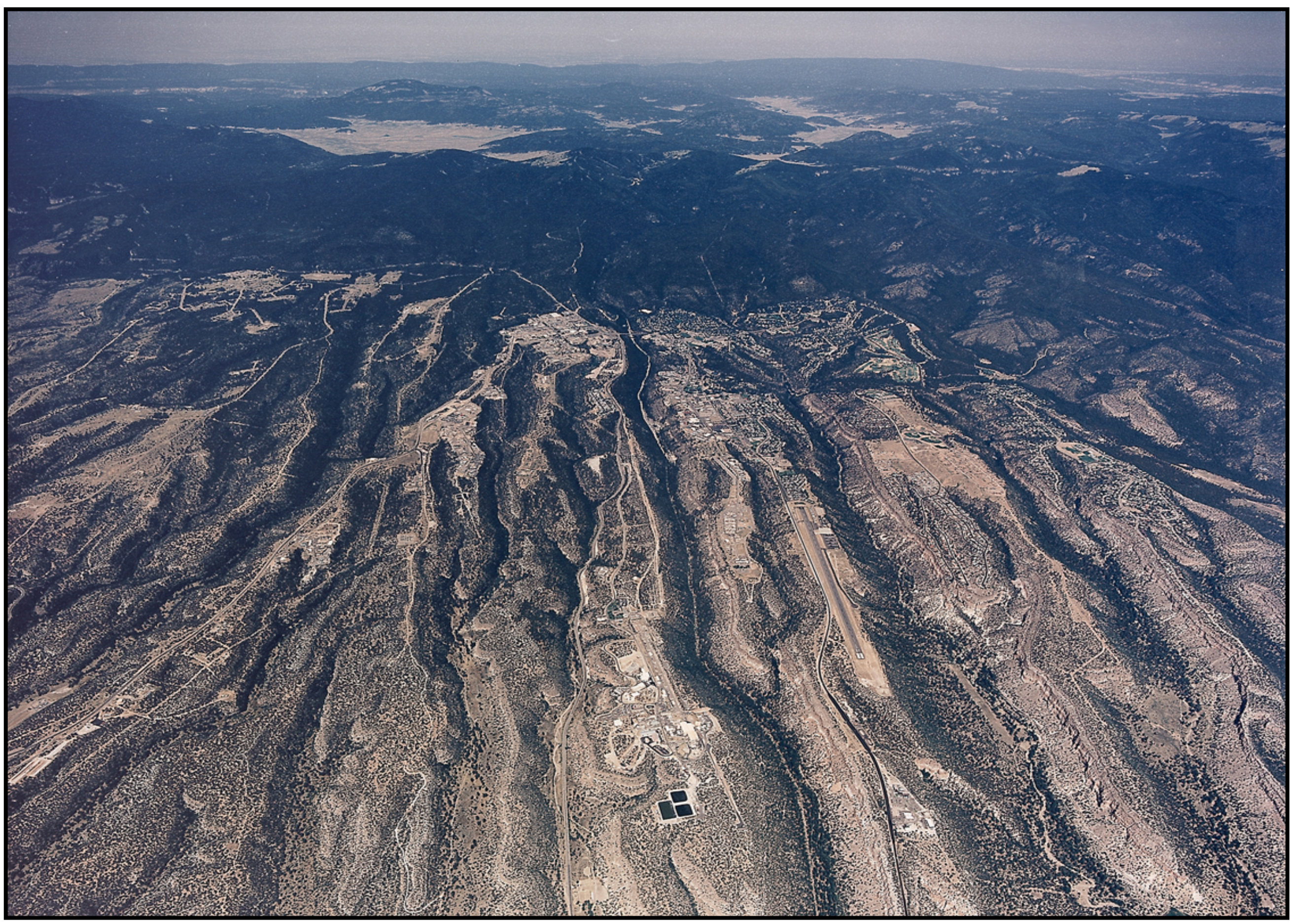

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TABLE OF CONTENTS

PREFACE

This preassessment screen document represents only a preliminary step in the natural resource damages assessment (NRDA) process. Before undertaking the often substantial commitment of time, energy, and money required to perform an injury determination, the Natural Resource Trustees use a preassessment screen (PAS) to make a preliminary determination of whether a reasonable probability exists that natural resource injuries may have occurred. In the interest of expedience and economy, a PAS often provides a cursory description of site conditions through a rapid review of readily available information.

Many data used in this PAS were drawn from the Risk Analysis Communication Evaluation Reduction (RACER) database administered by the New Mexico Community Foundation. RACER (http://www.racernm.com) is a publicly accessible central repository for Los Alamos National Laboratory- (LANL-) related environmental data collected by LANL and the New Mexico Environment Department. The RACER database currently contains nearly six million data records, most of which have been validated as conforming to accepted standards of scientific data collection and analysis. However, some of the records do not conform to these standards. The PAS may contain both kinds of data available in RACER. In addition, the data were compared to conservative screening levels, and because a particular data point in RACER exceeds a screening level used in this PAS, it does not mean that a natural resource injury has occurred, only that a more careful analysis of the data or further study may be warranted. Similarly, RACER does not identify the source of the contaminants identified in the database, only results of tested media. Some sources of environmental contamination on and around LANL do not come from activities at LANL, including substances that occur naturally in the environment.

In short, this PAS should not be interpreted as representing more than it is intended to or as reaching any conclusions regarding the existence of, or responsibility for, natural resource injuries at and around LANL. It represents a quick, limited review of a small subset of the environmental data and other information currently available for the sole purpose of determining whether a more thorough review is warranted.

EXECUTIVE SUMMARY

Los Alamos National Laboratory (LANL) is situated on approximately 27,500 acres (approximately 40 square miles) in north-central New Mexico, approximately 60 miles north of Albuquerque and 25 miles northwest of Santa Fe. Scientific research began at the site in March 1943 with the inception of Project Y of the Manhattan Project, the U.S. government's effort to develop and test nuclear weapons. Nuclear-weapons research included the handling of, use of, and experimentation with a variety of radioactive materials. These practices led to the release of radioactive wastes into the surrounding environment. In recent decades, operations at LANL have broadened beyond those pertaining primarily to nuclear weaponry development and now include more broadly categorized missions relating to national security, energy resources, environmental quality, and science (DOE 1999). Expansion of site operations to achieve these goals has led to a corresponding increase in not only the type and volume of hazardous substances and oil discharged to the environment but also to the geographic area exposed to these contaminants.

Under federal law, federal, state and tribal entities are authorized to act as trustees of natural resources on behalf of the public (Comprehensive Environmental Response, Compensation, and Liability Act of 1980 [CERCLA], as amended, 42 United States Code [USC] § 9601 *et seq*, National Oil and Hazardous Substances Pollution Contingency Plan [NCP], 40 Code of Federal Regulation [CFR] Part 300, Subpart G). In this role, Trustees may assess and recover damages for natural resource injuries that have resulted from the release of hazardous substances to the environment. Damages may include the cost of restoring the injured resources to their baseline condition (i.e., the condition that would have existed but for the release) as well as the value of interim losses pending restoration (Federal Register Volume 73, No. 192, page 573260). Damages are used to restore, rehabilitate, replace, or acquire the equivalent of injured natural resources.

Under the natural resource damage assessment (NRDA) guidelines promulgated by the U.S. Department of the Interior (DOI), the first phase of an NRDA is the preassessment (43 CFR Part 11), typically documented in a preassessment screen (PAS). The purpose of a PAS is to provide a rapid review of readily available information on hazardous substance releases and the potential impacts of those releases on natural resources, so a determination can be made as to whether "there is a reasonable probability of making a successful claim before monies and efforts are expended in carrying out an assessment" [43 CFR § 11.23(b)]. To make this determination, the authorized official must evaluate whether each of the following criteria has been met:

1) A discharge of oil or a release of a hazardous substance has occurred;
2) Natural resources for which the federal or state agency or Indian tribe may assert trusteeship under CERCLA have been, or are likely to have been, adversely affected by the discharge or release;
3) The quantity and concentration of the discharged oil or released hazardous substance is sufficient to potentially cause injury;

4) Data sufficient to pursue an assessment are readily available or are likely to be obtained at a reasonable cost; and

5) Response actions, if any, carried out or planned do not or will not sufficiently remedy the injury to natural resources without further action [43 CFR § 11.23(e)].

This PAS represents the first phase of a NRDA for the LANL site and all other areas within which natural resources may have been injured by the discharge of oil or release of hazardous substances (including radionuclides) from the site. Available information primarily derived from within the LANL site boundary supports the conclusion that the five criteria described above have been met at LANL. Specifically, various operations at LANL have resulted in the release of hazardous substances in sufficient quantities and concentrations that injuries to natural resources have, or are likely to have, occurred. Federal, state, and tribal trustees may assert trusteeship for these resources. Extensive site investigations have produced a large volume of information that provides an adequate basis for initiating an assessment, and response actions are not likely to remedy natural resource injuries without further action.

The LANL Natural Resource Trustee Council notes that the LANL site is complex. Releases of a wide variety of hazardous substances have occurred over a broad geographic area and over many decades of site operations. Hazardous substances are known to have dispersed from or migrated off the LANL sites. Thus, a range of technical and legal issues will need to be addressed in subsequent stages of the NRDA.

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SECTION 1 INTRODUCTION

ACTION

This document is a preassessment screen (PAS) for the Los Alamos National Laboratory (LANL). LANL is a federal facility that has been in operation from 1943 to the present. This PAS was prepared by the LANL Natural Resource Trustee Council (the Trustees) for the site and all other areas within which natural resources may have been injured by the discharge of oil or release of hazardous substances (including radionuclides) from the site. The Trustee Council includes the State of New Mexico, the U.S. Department of the Interior (DOI), the U.S. Department of Agriculture (USDA), the U.S. Department of Energy (DOE), and the Pueblo de San Ildefonso [designated pursuant to section 107(f)(2)(B) of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA)].[1]

PURPOSE

This document is the first step in the natural resource damage assessment (NRDA) process; it does not constitute a full assessment of damages at this site. Specifically, the purpose of the PAS is to provide a rapid review of readily available information that focuses on resources for which a federal or state agency or Indian tribe may assert trusteeship under section 107(f) or section 126(d) of CERCLA. This review is intended to ensure that a reasonable probability exists that the Trustees can make a successful claim for damages before monies and efforts are expended in carrying out a complete assessment [43 CFR 11.23(b)].

REGULATORY AUTHORITIES

This PAS concerns potential claims authorized by CERCLA, as amended, 42 United States Code (USC) § 9601 *et seq*., as amended; the Oil Pollution Act of 1990 (OPA), 33 USC.§ 2701 *et seq*.; the Clean Water Act (CWA), as amended, 33 USC § 1251 *et seq.*; and the New Mexico Natural Resources Trustee Act [New Mexico Statutes Annotated (NMSA) 1978, §§ 75-7-1 to -5 (1993)] to recover for injuries to natural resources and their supporting ecosystems.

This PAS was prepared by the Trustees for natural resources under the authority of Section 107(f) of CERCLA, as amended, 42 USC § 9607(f); the National Contingency Plan, Title 40 Code of Federal Regulations (CFR) Part 300; the DOI NRDA Regulations, 43 CFR Part 11; and other applicable Federal regulations and directives that serve to designate federal, state, and tribal natural resource trustees and that authorize the assessment and restoration of natural resource damages resulting from a discharge of oil or release of a hazardous substance.

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[1] Other Federally-recognized Pueblos may hold co-trusteeship for natural resources injured by hazardous substances released from LANL. At this time, these Pueblos have not formally joined the Trustee Council.

NATURAL RESOURCE TRUSTEES

Natural resource Trustees for this site include the following.

- The DOE acts as trustee for portions of LANL that are or have been owned and/or operated by the United States. As such, DOE has trusteeship for natural resources at LANL as a land management agency.
- The DOI acts as a trustee for natural resources and supporting ecosystems that it manages or controls. In this matter, the Bureau of Indian Affairs (BIA), U.S. Fish and Wildlife Service (USFWS), and National Park Service (NPS) act on behalf of the Secretary of DOI as trustees for natural resources under the DOI's jurisdiction. As the authorized official for the LANL NRDA and Restoration (NRDAR) effort, the BIA is delegated the authority to act on behalf of the Secretary and consults with, coordinates with, and obtains the concurrence of the USFWS and NPS.
- The USDA, acting through the Forest Service, has trusteeship for various natural and cultural resources of the Santa Fe National Forest (40 CFR § 300.600).
- The State of New Mexico, acting through the Natural Resources Trustee and the Office of Natural Resources Trustee, and the Attorney General and the Attorney General's Office, holds trusteeship for a range of natural resources potentially affected by releases from LANL (40 CFR § 600.605).
- Four federally-recognized Pueblos have been identified as holding trusteeship over various resources that may have been injured as a result of releases from LANL. These include Pueblo de San Ildefonso, Jemez Pueblo, Santa Clara Pueblo, and Cochiti Pueblo.

A Natural Resource Trustee Council has been formed to undertake this PAS. At this time, this Trustee Council includes the following entities: the DOE; the DOI, acting through the BIA, the USFWS, and NPS; the USDA, acting through the Forest Service; the State of New Mexico, acting through the Office of Natural Resources Trustees, and the Attorney General's Office; and the Pueblo de San Ildefonso. These Trustees have signed a Memorandum of Agreement (MOA) regarding the conduct of this NRDA. This MOA establishes a Natural Resource Trustee Council to perform a variety of activities, including performing a PAS, as well as "provides a framework for coordination among the Parties in accordance with the authority established under CERCLA, CWA, and OPA" (DOE et al. 2008).

POTENTIALLY RESPONSIBLE PARTIES

The primary party responsible for discharges and releases of oil or hazardous substances at this site is DOE. As noted above, DOE is also a Trustee. Other parties may be considered potentially responsible parties as additional data are reviewed.

SECTION 2 SITE DESCRIPTION AND INFORMATION ON DISCHARGES AND RELEASES

Approximately 60 miles north of Albuquerque and 25 miles northwest of Santa Fe, LANL is situated on approximately 27,500 acres (approximately 40 square miles) in north-central New Mexico (Exhibit 2-1). The LANL site is characterized by a series of narrow mesas and canyons on the western bank of the Rio Grande between the Jemez Mountains to the West and the Sangre de Cristo Mountains to the East. The Rio Grande flows southward along the eastern border of LANL into Cochiti Dam and Reservoir. Bordering LANL are the town of Los Alamos to the north, the Santa Fe National Forest to the west, Bandelier National Monument to the south, and the Pueblo of San Ildefonso, the town of White Rock, and additional Santa Fe National Forest land to the east. Originally referred to as the Los Alamos Laboratory during World War II, the site was renamed Los Alamos Scientific Laboratory in 1947 and received its current name, Los Alamos National Laboratory, in 1981 (DOE 2008; LANL 2007).

Scientific research began at the site in March 1943 with the inception of Project Y of the Manhattan Project, the U.S. government's effort to develop and test nuclear weapons. Nuclear-weapons research included the handling of, use of, and experimentation with a variety of radioactive materials. These practices led to the release of radioactive and hazardous substances into the surrounding environment. Operations at LANL have broadened beyond those pertaining primarily to nuclear weapons development and now include more broadly categorized missions pertaining to "national security, energy resources, environmental quality, and science" (DOE 1999, p. S-44). Expansion of site operations to achieve these goals has led to a corresponding increase not only in the type and volume of hazardous substances and oil discharged to the environment but also in the geographic area exposed to these contaminants.[2,3]

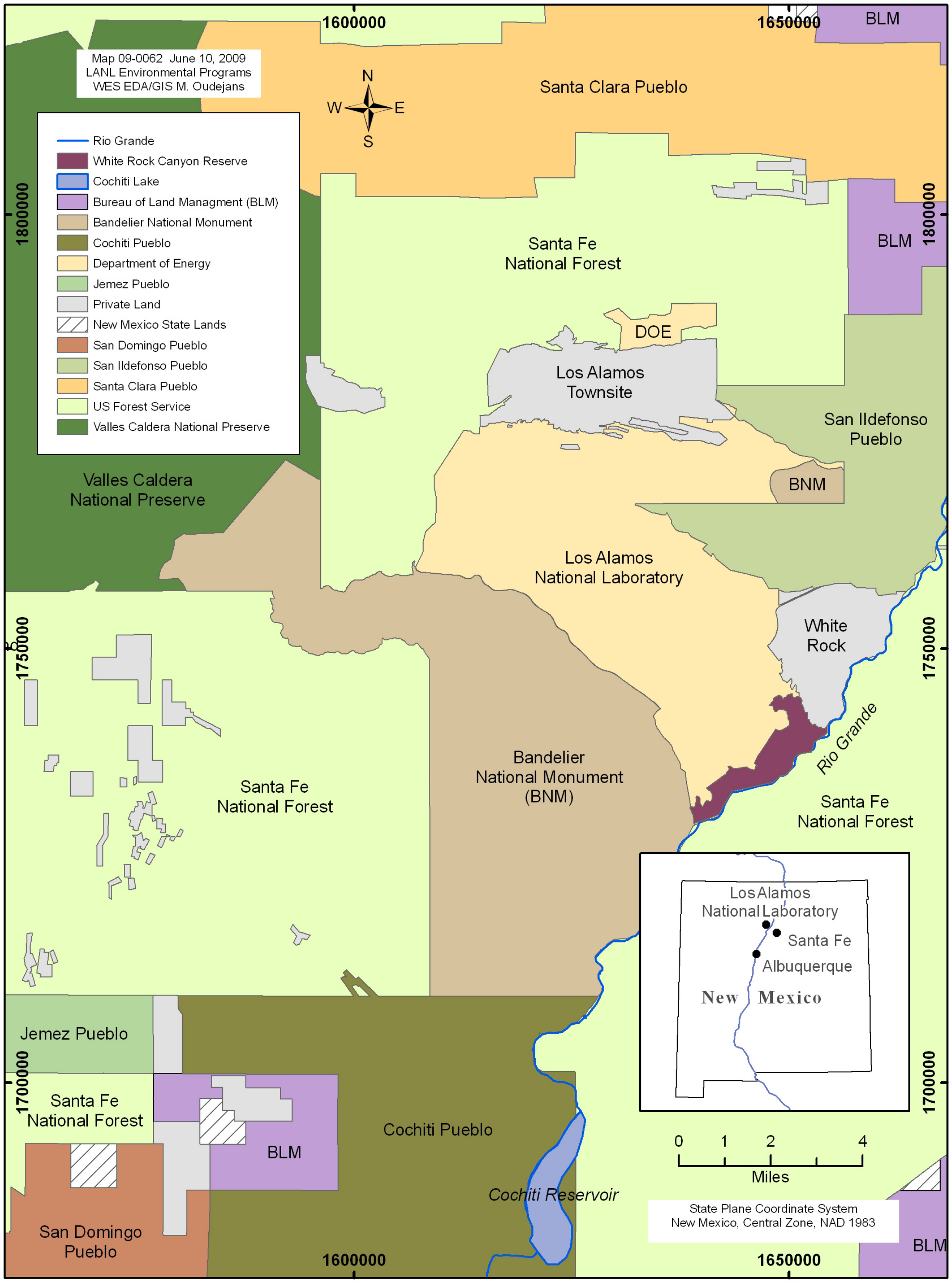
Information about the site relating to discharges or releases of hazardous substances or oil, as described in 43 CFR 11.24, is summarized below, including:

1) types of operations and related hazardous substances;
2) time, quantity, duration, and frequency of the discharge or release (historical and current);
3) hazardous substances or oil released or discharged;
4) additional hazardous substances or oil potentially discharged or released; and
5) remedial activities at the site.

[2] Hazardous waste includes those wastes defined in 40 CFR 302.4, which includes radionuclides.

[3] When LANL operations became subject to environmental laws and regulations beginning in the early 1970s, discharges to the environment became subject to permit requirements and were reduced. As part of ongoing environmental surveillance activities at the site, stable or decreasing trends in the concentrations of environmental contaminants have been observed within and around the site since the 1970s (LANL 2008c).

EXHIBIT 2-1 MAP OF LANL (2007)



Note: Exhibit does not reflect recent land transfers to San Ildefonso Pueblo or Santa Clara Pueblo from the Bureau of Land Management pursuant to Public Law 108-66 (2003). Exhibit also does not reflect that Bandelier NM was enlarged in 1961 and 1997 to include lands formerly managed by the Atomic Energy Commission and DOE. Source: (Haagenstad 2007)

The sections below outline site operations that have led to the release or discharge of hazardous contaminants or oil, describe the types and classes of contaminants released to the environment, and document when those releases occurred.

TYPES OF OPERATIONS AND RELATED HAZARDOUS SUBSTANCES

As mentioned above, LANL was the birthplace of atomic weapons research in the U.S. in the 1940s. Over the years, scientific investigations expanded into a variety of related fields. LANL is divided into a number of smaller areas called technical areas (TAs), which historically were centers for different operations.[4] A map of LANL showing the TAs is presented in Exhibit 2-2.

Operations at LANL have resulted in the release of hazardous substances to surface water, groundwater, soils, and air. In the 1940s, radioactive liquid wastes were discharged directly into Acid Canyon, a tributary to Pueblo Canyon, as a result of operations associated with the Manhattan Project. Untreated discharges continued until 1951, when a wastewater treatment plant was constructed to manage liquid wastes for TA-51. Discharges continued, though radiological contamination was somewhat reduced because of the treatment process (LANL 1996). In addition to liquid waste disposal, radioactive and hazardous wastes were commonly buried on-site, sometimes in secret locations because the wastes disposed of were classified (e.g., Material Disposal Area [MDA] F in TA-06 [DOE 2008, Appendix I]). Overall, an estimated 2,000 sites where environmental contamination is a concern have been delineated (see section on Remedial Activities below).

As on-site operations expanded, new facilities were constructed on adjacent mesa tops, creating new emissions sources. The bulk of LANL's radiological air emissions have been produced through operation of a linear proton accelerator in TA-53, constructed in the 1960s. The size and power of this facility was expanded on several occasions in the 1970s and 1980s (see below). Test firing of high explosives (HE) and munitions at LANL has also resulted in the release of contaminants to the air.

Other operations responsible for the release of hazardous substances at LANL over the past several decades include "the beryllium shop, gasoline storage and combustion, the TA-03 power plant, gas and volatile chemical usage, waste explosive burning, and dynamic testing operations" (LANL 1981, p. 41). Hazardous wastes were released in effluents as a result of routine discharges from power plant operations, boiler blowdown operations, and cooling tower operations; and hazardous wastes were generated from the detonation of HE, photography development, and printed circuit-board development (LANL 1981, p. 41).[5] Some of these activities continue today. For example, an emissions inventory report for 2005 indicates that the operation of steam plants, an asphalt plant, and a degreasing machine; the storage of oil; and beryllium machining operations have led to releases of hazardous air pollutants (LANL 2006).

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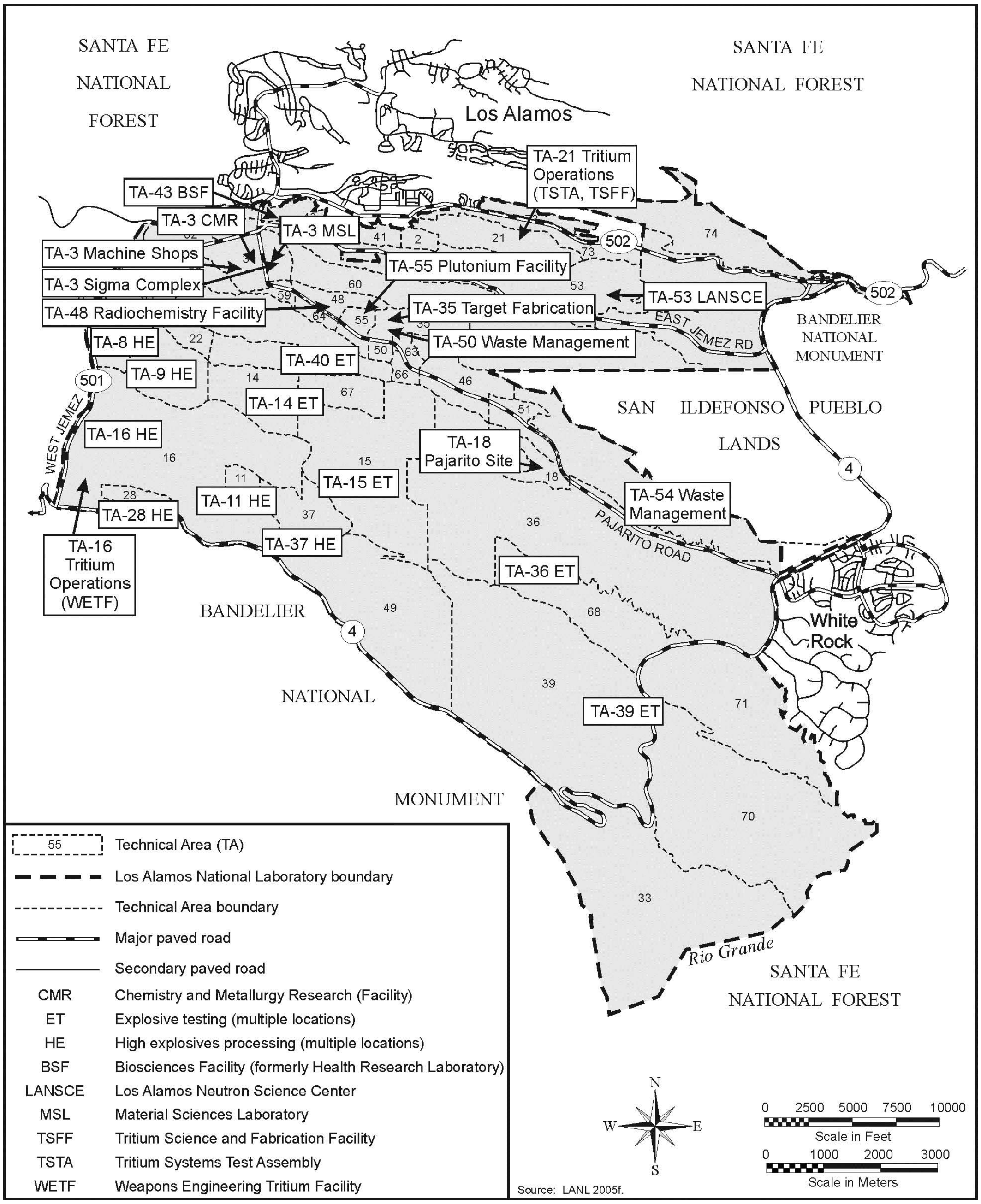
[4] Currently, LANL is divided into 48 TAs that are used for a variety of purposes. These areas include building sites, experimental areas, support facilities, roads, and utility rights-of-way, in addition to over 2,000 structures. Much of LANL consists of buffer areas for security and safety or is held in reserve for potential future use.

[5] As of 1980, there were 113 industrial discharge points and 10 sanitary sewage treatment facilities at LANL. Currently, the total number of discharge points has been reduced to 15 outfalls: 14 industrial and 1 sanitary wastewater.

EXHIBIT 2-2 MAP OF LANL SHOWING TECHNICAL AREAS AND KEY FACILITIES (2007)



Source: (DOE 2008)

The suite of scientific research, development, and industrial operations that have and continue to occur at LANL utilize a variety of hazardous chemicals and radioactive materials and generate a range of waste streams. For example, hazardous materials typically used in scientific laboratories such as solvents and acids have been released into the environment (DOE 1999). Some operations generated or released specific contaminants, which, because of the complex geographic layout and operational history of LANL, have been distributed throughout the entire site and, in some cases, throughout the local region. For example, radionuclides, metals, and HE may have been released into the environment during various steps in the design, experimentation, manufacture, or detonation of experimental weapon(s), and each of these operations was dispersed geographically throughout LANL.

As operations changed over the last several decades, the geographical centers of operations and the focus of individual TAs have changed. Eighteen of the TAs currently house 15 key facilities, and the remaining 30 TAs currently contain non-key facilities (see Exhibit 2-2, above for a map of key facilities and Exhibit 2-3, below for a listing). These key facilities represent the greatest current exposure risks (based on the hazard category characterization of each facility[6]) and have "the potential to cause significant

EXHIBIT 2-3 KEY FACILITIES AT LANL

FACILITY NAME	TA	ACRES
Plutonium Complex	TA-55	93
Tritium Facilities	TA-16 & TA-21	312
Chemical and Metallurgy Research Building	TA-03	14
Pajarito Site	TA-18	131
Sigma Complex	TA-03	11
Materials Science Laboratory	TA-03	2
Target Fabrication Facility	TA-35	3
Machine Shops	TA-03	8
High-Explosives Processing	TA-08, TA-09, TA-11, TA-16, TA-22, TA-28, TA-37	1,115
High-Explosives Testing	TA-14, TA-15, TA-36, TA-30, TA-40	8,691
Los Alamos Neutron Science Center	TA-53	751
Biosciences Facilities (formerly Health Research Laboratory)	TA-43, TA-03, TA-16, TA-35, TA-46	4
Radiochemistry Facility	TA-48	116
Radioactive Liquid Waste Treatment Facility	TA-50	62
Source: Table 1-1 from (LANL 2007)		

[6] Nuclear facilities can be categorized into one of three hazard categories: "Category 1 Hazard: Hazard analysis shows the potential for significant off-site consequences. Category 2 Hazard: Hazard analysis shows the potential for significant on-site consequences. Category 3 Hazard: Hazard analysis shows the potential for only significant localized consequences" (DOE 1999). Hazard category is based on the radiological risk associated with facility operations, not the impact of the facility on the surrounding environment from releases of hazardous substances. High hazard facilities operate using rigorous engineering and administrative controls and permits to prevent or reduce exposures from radiological releases from these facilities to prevent or reduce exposures should a radiological release occur from these facilities.

environmental impacts" (DOE 1999, p. S-19).[7] Before the mid-1980s, nuclear facilities safety was managed by the DOE and its predecessor, the Atomic Energy Commission, through a broad set of facility operation, environmental, safety, and health requirements. In 1986, DOE formalized an existing environmental, safety and health program with the establishment of DOE Order 5480, *Environmental, Safety, and Health Program for the Department of Energy*. The current hazard categorization scheme was formalized in 1992 with the establishment of DOE Standard 1027, *Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports*. Practically all of the nuclear facilities or moderate-hazard nonnuclear facilities are included as "key facilities" (DOE 1999, p. 2-24). Although operations at some of these key facilities have varied over the years (e.g., nanomaterials research in the Biosciences Facility), they are representative of the centers and types of operations conducted at LANL over the last several decades.

Each of the key facilities listed in Table 1-1 of the 2006 Environmental Surveillance report are briefly discussed below (LANL 2007; DOE 1999, 2008).[8]

- **Plutonium Complex (TA-55, 93 acres):** Principal operations at this facility have included receipt, handling, processing, and shipping of plutonium; assembly and disassembly of weapons components; and research related to nuclear fuel. This facility includes several Hazard Category 2 nuclear facilities, two low-hazard chemical facilities, and one low-hazard "energy source" facility. The facility has produced both air emissions and "radioactive liquid waste effluent" and generated hazardous waste for off-site disposal (DOE 1999, p. 2-29). For example, chemical reprocessing of actinide-contaminated materials typically result in the generation of radioactive liquid wastes from "precipitation, wash, and ion exchange elution steps" (DOE 1999, p. 2-29). Other chemical processes used on-site generate radioactive acid and caustic waste streams, or use solvents or ion-exchange steps. On-site oil and gasoline spills have also contributed to the generation of hazardous waste contaminated with petroleum hydrocarbons.
- **Tritium Facilities (TA-16 and TA-21, 312 acres):** Beginning in 1974, tritium research and processing were centered at the Delta Prime (DP) East Research Area in TA-21. In 1989, much of these operations were moved to the Hazard Category 2 Weapons Engineering Tritium Facility in TA-16 (formerly known as S-Site).[9] Operations at the DP East facility continue to be reduced; since 2003, these operations have been limited to "surveillance and maintenance and limited equipment removal" (DOE 2008, p. 2-41). This facility has produced both air emissions and effluent discharges, has generated hazardous wastes (e.g. tritium-

[7] The 2008 Final Site Wide Environmental Impact Statement for Continued Opearation of Los Alamos National Laboratory (2008 SWEIS, DOE 2008) notes "This new SWEIS impact analysis tiers from the 1999 SWEIS, as appropriate, and incorporates information from that document by reference where the information presented in that earlier document remains valid." As a result, information from both references DOE 1999 and DOE 2008 are included as appropriate. DOE 1999 is also especially relevant with regard to information on historical practices and environmental conditions at LANL.

[8] Key facilities currently operate under a variety of permits and rigorous DOE facility operating requirements. Permitted versus unpermitted releases of hazardous contaminants will be addressed in the course of the injury assessment.

[9] TA-21 was the site of a former chemistry process building from 1964 to 1974, when tritium operations began on-site.

contaminated wastes, methanol and acetone), and has experienced accidental air releases of tritium in recent history.[10]

- **Chemical and Metallurgy Research (CMR) Building (TA-03, 14 acres):** This is the only facility at LANL with the full capability to perform "special nuclear" analytical chemical and materials-science investigations and is classified as a Hazard Category 2 nuclear facility (DOE 2008, p. 2-28). The facility was constructed in 1952 and was expanded in 1960. Processes performed on-site have included analytical chemistry dedicated to processing of metals and radioactive elements, actinide research, and fabrication and processing of various materials in the research and development of weaponry and radioactive element processing. Hazardous substances used on-site include, but are not limited to, metals, organic chemicals, and radionuclides. Operations at this site have resulted in the release of hazardous air emissions (via stack emissions of chemical hoods and glove boxes), effluent discharges to Mortandad Canyon, and the generation of hazardous waste (e.g., radionuclide-contaminated waste from decontamination of ducts).
- **Pajarito Site (TA-18, 131 acres):** This facility, also known as the Los Alamos Critical Experiments Facility, sits in the bottom of a canyon near the confluence of Threemile and Pajarito Canyons and is listed as a Hazard Category 2 nuclear facility. Since 1948, this facility has been the center for critical experimentation at LANL.[11] This facility has produced hazardous wastes from operations revolving around experimentation with highly radioactive actinides (e.g., uranium-233, uranium-235, and plutonium-239) in different chemical phases and forms. Critical experiments are conducted in one of three "kivas" and are monitored from a central control building. Highly radioactive elements were stored on-site in a hillside vault.
- **Sigma Complex (TA-03, 11 acres):** This facility consists of four main buildings, two of which were historically Hazard Category 3 nuclear facilities. Originally constructed in 1958, it was expanded in the 1980s. Operations at the site have consisted primarily of research and development in materials-fabrication science (primarily into metals and ceramics). Two buildings are dedicated to the specific research and development of the elements beryllium and thorium. This facility has produced air emissions (via stack emissions from operations with depleted uranium), hazardous effluent, and has generated hazardous waste (e.g., metal sludges produced as a result of electroplating operations, aqueous waste from enriched uranium processing).
- **Materials Science Laboratory (MSL) (TA-03, 2 acres):** This facility consists of offices and a number of scientific laboratories dedicated to materials research and has been in operation since the 1990s. Laboratory operations have used a variety of hazardous substances during normal operations, including radionuclides (e.g., depleted uranium and radioactive isotopes of sodium and zirconium); metals (e.g., tantalum, tungsten); acids (e.g., hydrofluoric acid,

[10] "Effluent discharges" refers to the discharge of wastewater to the environment, typically via an outfall pipe.

[11] "Critical" experiments refer to experiments pertaining to the quantities of nuclear materials required for fission to occur.

perchloric acid); and organic chemicals (e.g., acetone, methylethyl ketone). Operations with these chemicals have produced air emissions and have generated hazardous waste.

- **Target Fabrication Facility (TFF) (formerly Ten Site) (TA-35, 3 acres):** This facility consists of three buildings dedicated to research and manufacturing of weapons and research of laser fusion. Operations have included precision machining and materials research, which generated hazardous wastes (e.g., tritium hazardous chemicals used in polymer foam development, and the production of organic coatings and resins). Liquid hazardous wastes are currently piped directly to the Radioactive Liquid Waste Treatment Facility (RLWTF). Chemical hoods have been a source of air emissions.
- **Machine Shops (TA-03, 8 acres):** This facility, originally constructed in 1953 and expanded in 1957 to machine parts made of depleted uranium, consists of two buildings: one dedicated to the use of nonhazardous materials and one to the use of hazardous materials. Both buildings have housed operations focused on the machining of specialized and/or prototype weapons components. This facility has historically generated hazardous waste and air emissions (e.g., depleted uranium and beryllium and lithium compounds).
- **High-Explosives Processing (TA-08, TA-09, TA-11, TA-16, TA-22, and TA-37; 1,115 acres):**[12] Processes at this facility have included the machining, production, testing, and research of raw, powdered, and plasticized explosives and devices. This facility was originally developed in the 1950s and has been updated periodically ever since. One building at TA-08 was historically a Hazard Category 2 nuclear building. This facility has produced air emissions (e.g., from burning of oil contaminated with HE as a means of disposal) and liquid effluents, as well as solid and liquid hazardous and radioactive wastes. HE has been disposed of on-site at a number of locations. Historically, a combustible trash incinerator operated at TA-16, which burned wastes contaminated with HE. In 1997, a HE wastewater treatment plant was constructed to treat wastewater centrally from this facility. In 1998, in TA-09, an aboveground wastewater storage tank was put into use.
- **High-Explosives Testing (TA-14, TA-15, TA-36, TA-39, and TA-40; 8691 acres):** This facility comprises the largest acreage of any of the distinct facilities within LANL, with most of the TAs corresponding to remote testing sites and the majority of facility buildings situated within TA-15. Operations consisted primarily of explosives research and munitions testing. Portions of this facility were damaged or destroyed in the Cerro Grande fire in 2000, but buildings have been rebuilt. Operations have resulted in air emissions and effluent discharges as well as the generation of hazardous and radioactive wastes. For example, contaminated shrapnel containing large quantities of uranium, beryllium, and lead, smaller amounts of mercury, bismuth, copper, cobalt, nickel, tin, and thorium, and explosives residues were released and disposed of at firing sites.

[12] TA-28 was historically part of the High Explosives Processing Facility, but explosives stored at this TA were recently moved to TA-37 for storage.

Operations also have used solvents, such as acetone, chlorinated hydrocarbons, toluene, xylene, or 1,1,1,-trichloroethane; and sulfur hexafluoride is used as an insulating gas in specialized high-voltage equipment (DOE 1999, p. 2-73).

- **Los Alamos Neutron Science Center (LANSCE, formerly the Meson Physics Facility [LAMPF] [TA-53, 751 acres]):** This facility consists of over 400 buildings and is home to the LANL linear particle accelerator (constructed in 1970) as well as other particle physics centers. The facility contains three separate Hazard Category 3 nuclear facilities. Radioactive liquid waste basins and a radioactive liquid waste treatment plant are located on-site. Historically, two contaminated sanitary waste lagoons were also located on-site and have been remediated and remain under institutional control. The site also encompasses the historical Experimental Area A, where materials irradiation studies were undertaken. Area A is inactive and currently slated for decontamination and renovation. For the last several decades, this facility has been responsible for over 90% of all radiological air emissions from LANL and has been a major source of discharged effluent and generated hazardous waste (e.g., solvents, lead, and radionuclides). This facility also produces nonradiological hazardous air emissions, including the release of large quantities of chloroform.
- **Bioscience Facilities (formerly Health Research Laboratory) (TA-43, TA-03, TA-16, TA-35, and TA-46; 4 acres):** Operations at this facility have included a wide variety of biological research activities in numerous laboratories, including laboratories categorized as Biosafety Levels 1 and 2.[13] This facility has produced a variety of hazardous wastes (e.g., radioisotope labeled compounds, and solvents).
- **Radiochemistry Facility (TA-48, 116 acres):** This facility, constructed in the 1950s, has been a center for research in the area of radiological chemistry, chemical analysis, and medical radioisotope production. Operations to support these activities have resulted in air emissions of hazardous contaminants and the generation of hazardous waste (e.g., various radionuclides, including actinides).
- **Radioactive Liquid Waste Treatment Facility (TA-50, 62 acres):** This facility (along with the Solid Radioactive and Chemical Waste Facilities discussed below) is primarily responsible for collecting, characterizing, treating, packaging, and transporting radiological and hazardous waste produced at LANL. Constructed in 1963 and expanded in 1983, it is considered a Hazard Category 2 nuclear facility and consists of various buildings and large tanks for liquid waste storage and treatment. The facility has produced both air emissions and effluent discharges (e.g., to Mortandad Canyon). Because of its role as a waste treatment facility, it has generated hazardous and radiological waste (e.g., radionuclide-contaminated wastes from lead brick decontamination processes) and acts as a transfer point for these types of wastes from other LANL facilities. From 1948 to

[13] "Biosafety level" refers to the categorization of risk at a given scientific laboratory, the type and capabilities of a facility, as well as the level of safety equipment required for work within such a facility. "Biosafety Level 1" refers to facilities where agents not thought to cause human disease are worked with. "Biosafety level 2" refers to facilities agents that may cause human disease but that have a limited potential to be transmitted are worked with.

1974, hazardous wastes were disposed of on-site, in locations now known as MDA C (see below).

- **Solid Radioactive and Chemical Waste Facility (TA-50 and TA-54, 943 acres):** These facilities, currently the primary waste-management facilities for LANL, are located at historical waste MDAs and disposal lagoons resulting from operations and disposal activities in the 1960s and contain a variety of wastes, including polychlorinated biphenyls (PCBs), radionuclides, asbestos, and oil. In general, most waste received by this facility is in solid form; liquid waste streams are handled by the RLWTF. However this facility is now responsible for tracking and disposing of waste from all LANL operations, including decontamination and on- and off-site disposal. The facility consists of over 200 buildings, half of which deal primarily with the treatment of waste. In addition, this facility consists of outdoor waste-handling operations, storage domes and platforms, and disposal pits and trenches for the on-site storage or burial of waste. Several Hazard Category 2 nuclear facilities and one Hazard Category 3 nuclear facility are on-site. Operations at this site have produced nonpoint-source air emissions, including via historical hazardous waste incineration practices. Because of its role as a waste treatment facility, it has generated hazardous waste and has acted as a transfer point for hazardous waste from other LANL facilities.

In addition to these key facilities, non-key facilities also have been responsible for generating hazardous and radiological wastes and oil. According to the 1999 Site-Wide Environmental Impact Statement for Continued Operation of Los Alamos National Laboratory (1999 SWEIS, DOE 1999), the 15 key facilities represent over 90% of all radioactive liquid waste generated, over 90% of the radioactive solid waste generated, and about 30% of the chemical waste generated at LANL (DOE 1999, p. S-19). In 2004, non-key facilities were responsible for 84% of all chemical waste, 87% of the low-level radioactive waste, 30% of the mixed low-level radioactive waste, and 54% of the transuranic waste volumes generated by all LANL facilities according to the 2008 Site-Wide Environmental Impact Statement for Continued Operation of Los Alamos National Laboratory (2008 SWEIS, DOE 2008) (DOE 2008, p. 2-66).

TIME, QUANTITY, DURATION, AND FREQUENCY OF THE DISCHARGE OR RELEASE

Environmental discharges of hazardous waste and oil at LANL have occurred since operations first began in the 1940s and continue today. Although numerous institutional pollution controls are in place at LANL, releases have occurred mainly as the result of normal operations, spills, or other releases in the form of point- or nonpoint-source discharges.

Between the mid-1940s and the 1970s, what is now the LANL site was essentially self-regulated, first by the Atomic Energy Commission and then by DOE, through a broad range of operational orders and requirements intended to minimize exposure to, and release of, hazardous substances. Since the early 1970s, site operations have also been monitored and managed under an increasing number of more stringent federal and state environmental, safety, and health regulations. Beginning in 1974, site drinking water, for example, was monitored and dually regulated by both DOE and the U.S. Environmental Protection Agency (EPA) under a DOE order and the Safe Drinking Water Act respectively. In 1978, the site industrial and sanitary liquid waste discharges were subject to regulatory permitting requirements under the National Pollutant Discharge Elimination System (NPDES).

Under the Resource Conservation and Recovery Act (RCRA), as amended by the Hazardous and Solid Waste Act in 1984, the DOE's Albuquerque Operations Office created an environmental cleanup program at what is now LANL with the intent of integrating numerous DOE orders with federal regulations to address legacy waste site characterization and remediation. In the mid-1980s, the site's radioactive air emissions became subject to stack-monitoring requirements under the National Emissions Standards for Hazardous Air Pollutants, and the site adopted specific stack-monitoring requirements in 1989. Additional regulations for toxic air pollutants were implemented in 1990 under the Clean Air Act, and in 1995 the site was issued, and became subject to, a Title V Permit for nonradioactive air emissions. In addition, industrial sites within LANL became subject to Storm Water Pollution Prevention Plan requirements under the CWA beginning in the early 1990s. Since March 2005, site environmental restoration activities and groundwater investigations and remediation have been regulated by the New Mexico Environment Department (NMED) through the March 1, 2005, Compliance Order on Consent (the Consent Order). More recently, a new LANL NPDES individual permit was issued by the EPA to address monitoring and management requirements for the majority of individual legacy contamination sites throughout LANL.

According to the 1999 SWEIS,

> The major contributors to environmental impacts of operating LANL are wastewater discharges and radioactive air emissions.
>
> - Historic discharges to Mortandad Canyon from the RLWTF have resulted in above background residual radionuclide (americium, plutonium, strontium-90, and cesium-137) concentrations, as well as nitrates in alluvial groundwater and sediments.
> - Plutonium deposits have been detected along the Rio Grande between Otowi and Cochiti Lake.
> - The principal contributors to radioactive air emissions have been and continue to be the Los Alamos Neutron Science Center and high explosives testing activities (DOE 1999, p. S-44).

Additionally, releases of plutonium have been detected in sediments within Cochiti Reservoir and below in the Rio Grande as far south as Albuquerque (Graf 1994). Once contaminants have been released to the environment, they can be remobilized and transported over distances or into new media. For example, storm events can redistribute sediment in stream beds, wind can shift contaminants in soil, and soil contamination can be relocated by percolation of precipitation and groundwater movement.

Historical effluent discharges to canyons at LANL have resulted in the contamination of surface water and sediment in canyons. Because many canyons are dry throughout the year, contaminated water readily percolates into the alluvial groundwater. Contaminated alluvial groundwater then migrates down into the intermediate and regional groundwater (see Groundwater section below). Some contaminants tend to adsorb to sediment particles, which either remain in the canyons or are transported downstream to the Rio Grande (see Surface Water and Sediment section below). This type of remobilization can result from scouring events that occur with flooding or rapid runoff associated with storm events.

The Jemez Mountains have experienced a series of wildland fires, including the Water Canyon fire (1954), the La Mesa fire (1977) that burned onto LANL lands, the Dome fire (1996), the Oso fire (1998), and most recently the Cerro Grande fire (2000). The Cerro Grande fire burned the U.S. Forest Service-administered headwaters of canyon systems passing through LANL as well as approximately 7,700 acres within LANL proper, removing organic material that previously absorbed rainfall. Increased stormwater runoff from precipitation events during the summers of 2000 and 2001 has been noted, after which watershed conditions improved relative to conditions immediately following the fire. In addition, the loss of ground cover and vegetation resulting from the fire, combined with below-average precipitation over several years, may have increased resuspension of contaminants in the air (LANL 2002). Many of the fire impacts observed immediately after the Cerro Grande fire have also been reported for other local fires.

Historical Releases or Discharge of Hazardous Substances

Hazardous substances and oil have been released into the environment as a result of normal operations and disposal activities, spills, and other discharges and releases. Historically, these contaminant releases have exposed various Trustee resources, including air, soil, surface water, sediment and groundwater in and around the site. Media-specific releases are discussed below. More detail can be found in a variety of documents, including the annual SWEIS yearbooks and SWEIS reports (see http://www.lanl.gov/environment/nepa/sweis.shtml), and the annual Environmental Sureillance Reports (see http://www.lanl.gov/environment/all/esr.shtml).

Air Contamination: Discharges of hazardous and radiological contaminants have occurred as a part of operations at LANL. Releases to the air include stack emissions (point source), fugitive emissions (nonpoint sources) and also result from detonation and burning of explosives. Although historical emissions of nonradiological air pollutants such as volatile organic compounds (VOCs) and beryllium were not monitored extensively, historical radiological air emissions were predominantly from the LANSCE facility exhaust stack 3 (ES-3) (DOE 1999).[14] The largest historical sources of criteria air pollutants are believed to be “primarily from combustion sources such as boilers, emergency generators, and motor vehicles” (DOE 1999, p. 4-88).[15] However, “laboratory, maintenance, and waste management operations” have also been identified as major sources of hazardous air emissions (e.g., solvents and pesticides) (DOE 2008, p. 4-87).

Soil Contamination: Spills, releases, deposition of contaminants released to the air (e.g., radionuclides and metals such as lead and beryllium), and improper disposal of hazardous materials have resulted in widespread on-site contamination of soils (DOE

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[14] Air emissions of beryllium were monitored only from 1989 to 1995 (DOE 1999).

[15] Criteria air pollutants are defined in the Clean Air Act and include ozone, particulate matter, carbon monoxide, nitrogen dioxide, sulfur dioxide, and lead.

2008). It is estimated that over 200 sites (out of over 2,000 potentially contaminated sites) throughout LANL will require formal remediation operations (see Remedial Actions section below; DOE 1999, LANL 2007). Localized sites of intense contamination include a number of former disposal areas, firing sites, and spill areas. Some of these areas have been grouped into MDAs for purposes of planning and organizing remedial activities. Examples of MDAs currently slated for, or are already undergoing, remediation include those briefly described below (LANL 2008a, DOE 2008).[16] A map showing these areas is included as Exhibit 2-4.

- **MDA A (TA-21, 1.25 acres):** This facility is a Hazard Category 2 nuclear facility situated on the eastern end of DP Mesa. It is currently inactive and is undergoing corrective action. In 1945, two waste disposal pits and two underground liquid waste storage tanks were constructed for the disposal of wastes contaminated with radionuclides and other "toxic chemicals" (DOE 2008, p. I-25). In the late 1950s, 55-gallon drums used to store radionuclide contaminated iodine and sodium hydroxide solutions leaked at the site, releasing plutonium to site soils. Contaminants such as uranium, plutonium-238, plutonium-239, and plutonium-240 have been detected in surface and subsurface soils. Waste stored in the two underground liquid storage tanks has not been fully characterized.
- **MDA B (TA-21, 6 acres):** This inactive former subsurface disposal site is classified as a Hazard Category 3 nuclear facility. MDA B received radiological solid and liquid process wastes from operations within TA-21 at DP East and DP West from 1944 until 1948. Descriptions include a variety of laboratory wastes contaminated with radionuclides, at least one entire truck contaminated with radionuclides as a result of the Trinity test, and organic chemicals including solvents and perchlorate.[17] In 1948, wastes disposed at this site spontaneously combusted, releasing contaminants to the air. Surface and subsurface soils have been shown to be contaminated with radionuclides (e.g., americium-241, cesium-137, plutonium-238, plutonium-239, uranium- 234, uranium-235, uranium-238, strontium-90, and tritium); organic contaminants (e.g., trichloroethylene [TCE] and trichlorethane [TCA]); and metals (e.g., arsenic, mercury, lead, and zinc).
- **MDA C (TA-50, 11.8 acres):** This Hazard Category 2 nuclear facility is a former disposal area containing legacy pits and shafts (some of which were unlined) dug up to 25 feet deep that were used from 1948 to 1968 to dispose of a variety of wastes, including uncontaminated and hazardous wastes. In some cases, wastes were burned in disposal pits, but five unintentional waste-related fires occurred at

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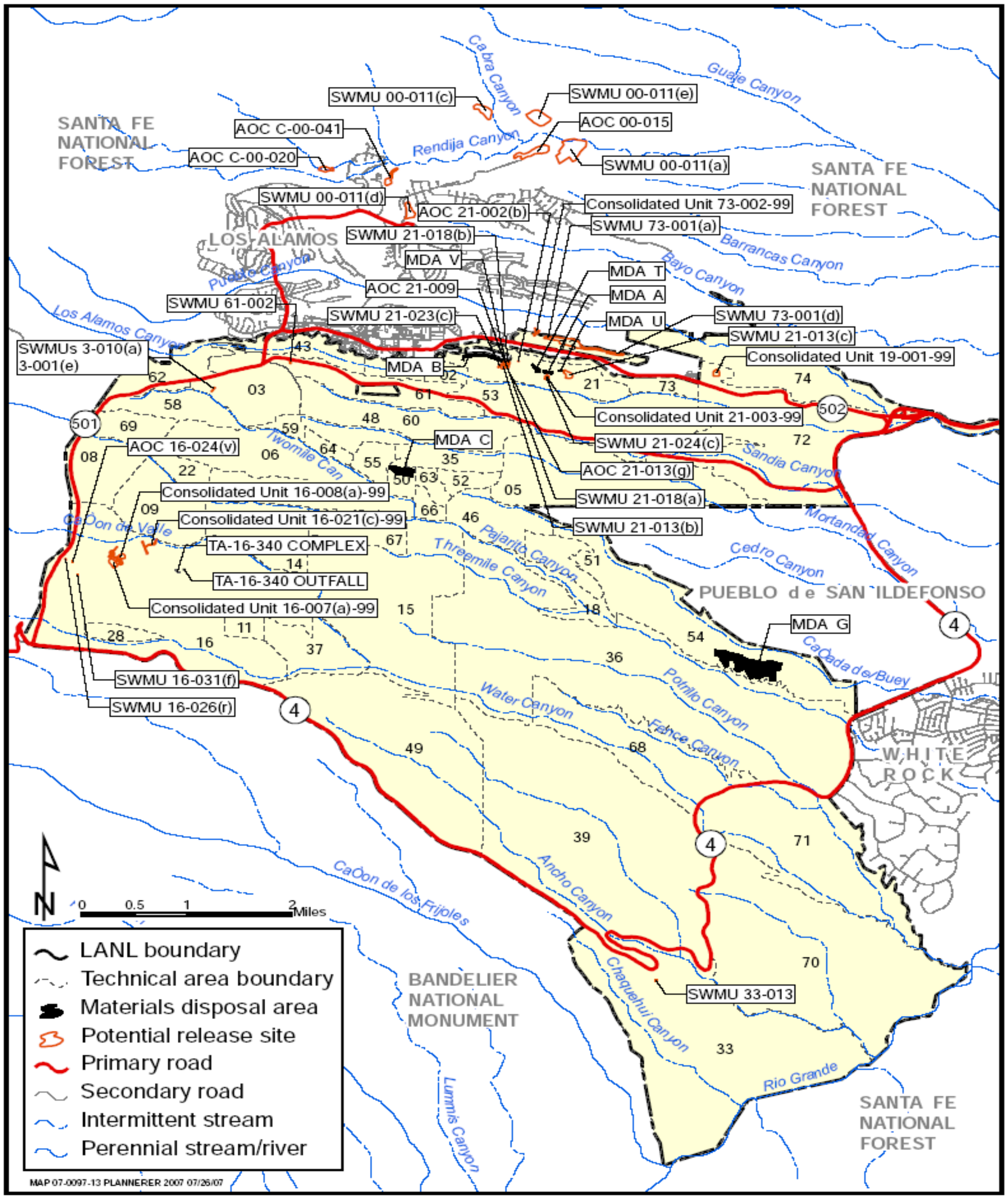
[16] A complete list of MDAs being considered for corrective actions are indicated in Tables I-1 and I-2 in Appendix I of the 2008 SWEIS (DOE 2008).

[17] The Trinity Test was the first test of a nuclear weapon, conducted on July 16, 1945, near Socorro, New Mexico.

EXHIBIT 2-4 MDAs, AOCs, AND SWMUs AT LANL WHERE REMEDIATION OR CHARACTERIZATION WORK WAS PERFORMED IN 2006



Source: Figure 9-1 from (LANL 2007)

the site from 1950 to 1958. A wide variety of hazardous contaminants and oil was disposed of in MDA C, including organic chemicals (e.g., TCE, acetone); metals (e.g., mercury, lead, beryllium); and radionuclides (e.g., americium-241, plutonium, tritium).[18] Surface and subsurface soils are contaminated with radionuclides (e.g., americium-241, plutonium); organic contaminants (e.g., PCBs, TCE, perchloroethylene [PCE]); and metals (e.g., barium, copper, lead, and silver).

- **MDA G (TA-54, 63 acres):** This disposal site located on Mesita del Buey contains a variety of landfilled waste, including asbestos, PCBs, and radiological wastes. Disposal activities were conducted at MDA G beginning in the 1950s and continue today. Surface water runoff is currently channeled to Cañada del Buey and Pajarito Canyon. Drainage channels are contaminated with radionuclides (e.g., americium-241, cobalt-60, plutonium-238, plutonium-239, tritium) and metals (e.g., beryllium, mercury, selenium). Also, VOCs and tritium are volatilizing to the air, and surface and subsurface soils are contaminated with TCE, tritium, and other radionuclides.
- **MDA T (TA-21, 2.2 acres):** This Hazard Category 2 nuclear facility operated as a waste disposal facility from 1945 to 1986. The site includes former adsorption beds (receiving liquid plutonium-contaminated wastes as well as wastewater contaminated with ammonium citrate and fluoride); waste burial shafts (containing cyanide salts and radionuclide-contaminated wastes); and two industrial wastewater treatment plants (the outfalls from which discharged to DP Canyon). Historical overflow of absorption beds led to the contamination of soils north of the site toward DP Canyon. Waste incinerators operated on-site from 1964 to 1972 to burn waste oils and organic chemicals, also likely resulting in nearby soils contamination. Surface and subsurface soils have been shown to be contaminated with americium-241, plutonium-238, plutonium-239, cadmium, copper, and nickel.
- **MDA U (TA-21, 0.2 acres):** This site operated from 1948 to 1976 to manage radioactive liquid waste and used cooling-tower water; currently it consists of inactive former adsorption beds and related infrastructure. Hazardous wastes historically discharged to these beds included polonium-210, actinium-227, plutonium, and tritium. Surface and subsurface soils are contaminated with radionuclides (e.g., americium-241, plutonium-238, plutonium-239, tritium, and actinium-227) and metals (e.g., arsenic, barium, beryllium, chromium, copper, lead, manganese, mercury, uranium, and zinc).

In addition to these sites, a number of other sites where discharges and/or releases of hazardous and/or radioactive substances to soils have occurred have been investigated and remediated. They include, but are not limited to; Solid Waste Management Unit (SWMU) 33-013; Consolidated Unit 19-001-99; SWMU 61-002; Guaje/Barrancas/ Rendija Canyons Aggregate Area; Pueblo Canyon Aggregate Area; Area of Concern (AOC) 16-024(v) and SWMUs 16-026(r) and 16-031; TA-16-340 Complex;

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[18] A waste inventory for MDA C is included in Table I-13 of Appendix I of the 2008 SWEIS (DOE 2008).

Consolidated Units 16-007(a)-99 (30s Line) and 16-008(a)-99 (90s Line); Consolidated Unit 16-021(c)-99 (260 Outfall); Consolidated Unit 73-002-99 (Airport Ashpile); SWMUs 03-010(a) and 03-001(e); and the Airport Landfill (LANL 2007).[19] Sites that are currently still under investigation include, but are not limited to, the Pueblo Canyon Aggregate Area; TA-16 340 Fish Ladder Complex; Middle Los Alamos Aggregate Area; Upper Mortandad Aggregate Area; S-Site Aggregate Area; TA-39 North Ancho Aggregate Area; the main consolidated unit at TA-33; and MDA AB at TA-49. Finally, firing sites (e.g., Firing Site E-F in TA-15) encompass large areas of surface soil contaminated with hazardous substances including beryllium, mercury, HE, depleted uranium and a number of additional radionuclides (e.g., americium-241, cesium-137).

The legacy contamination sites located near the southern boundary of LANL at TA-33 and TA-49 are of particular interest to the DOI due to their proximity to Bandelier National Monument. TA-33 is located on the mesa top above Ancho and Chaquehui Canyons just south of NM 4. TA-33 was established in 1947 as a test site for weapons experiments performed in underground chambers, on surface firing pads, and at sites equipped with large guns that fired projectiles into berms. These activities ceased in 1972. TA-33 also included a high-pressure tritium facility that operated from 1955 to late 1990. The tritium facility underwent decontamination and decommissioning in the mid-1990s. Finally, the National Radio Astronomy Observatory Very Long Baseline Array radiotelescope antenna was installed at TA-33 in 1985 and is still operational. Current activities are centered primarily at Main Site within offices, laboratories, and storage space associated with modeling and research activities. A total of 51 sites are located within TA-33. Since the early 1990s, when sites such as these were identified, LANL has performed investigation and/or remediation activities for all 51 sites at TA-33. Eight of these sites have been previously investigated and/or remediated and have been approved for no further action (NFA) or have received Certificates of Completion. The remaining 43 sites require further investigation and/or remediation. Primary contaminants at TA-33 consist of uranium, beryllium, HE, plutonium, cadmium, silver, lead, mercury, and tritium. Currently, an investigation work plan is being prepared to address the 43 sites that require further investigation and/or remediation. The investigation work plan is due to NMED by November 30, 2009, and the schedule for field investigations and/or remediation and investigation report is pending NMED approval of the work plan. According to the Consent Order, all investigations and/or remediation must be completed by August of 2014.

TA-49 is located on the mesa top above North Ancho and Water Canyons and north of NM 4. Current LANL activities at TA-49 are restricted to only a few selected LANL functions including emergency response training and detonation of small suspect packages. TA-49 is also the location of the LANL's Antenna and Pulse Power Outdoor Range User Facility, where outdoor tests that involve generating and receiving short bursts of microwaves are carried out on various materials and equipment components. The TA-49 area was originally established in the late 1950s for weapons systems safety experiments. From 1959 to 1962, intense experimental activity involving the use of HE,

[19] Additional sites that have been investigated or that are anticipated to be investigated to determine the need for corrective actions are described in detail in Appendix I of 2008 SWEIS (DOE 2008).

metals, and significant quantities of radionuclides took place in multiple underground shafts in the central portion of TA-49. After the experiments were conducted, these shafts were backfilled and capped. From 1963 to the early 1970s, TA-49 was used for various physics and atmospheric observation experiments. A total of 20 sites are located within TA-49. All are associated with historical operations at TA-49. Three of these sites have been previously investigated and/or remediated and have been approved for NFA. The remaining 17 sites require further investigation and/or remediation. Part of the TA-49 area has been designated as a Hazard Category 2 nuclear environmental site (NES) because the underground radionuclide inventory exceeds DOE Standard 1027 thresholds. Of the 20 sites within TA-49, 11 sites are located within the NES boundary, and 9 are located outside the NES boundary. In October 2007, investigation work plans for inside and outside the MDA AB NES were submitted to NMED under the Consent Order. Revisions of these work plans were submitted in January 2008 and were approved with modifications by NMED in February 2008. The associated investigation reports are due to NMED in May 2010.

Surface Water and Sediment Contamination: Radionuclide- and metals-contaminated effluents were historically discharged directly (e.g., in the case of effluent releases to Acid Canyon, Sandia Canyon, Los Alamos Canyon, Mortandad Canyon) or indirectly (e.g., to Los Alamos Canyon via the Los Alamos Meson Physics Facility [LAMPF] Lagoons and via stormwater runoff to all drainages) to the environment (LANL 1981; LANL 1996; LANL 2007). In addition, historical spills and leaks have led, and continue to lead, to contamination of sediment and surface water (e.g., PCB contamination in Sandia and Los Alamos Canyons) (LANL 2007).

According to the 1999 SWEIS,

> Nearly every on-site LANL drainage has historically received LANL liquid industrial or sanitary effluents that contribute to the flow and water quality characteristics in the drainage area. As LANL effluents move downstream, some of the metals and radionuclides from LANL outfalls bind (or adsorb) to the sediments (DOE 1999, p. 4-62).

More specifically,

> Drainages that received liquid radioactive effluents include Mortandad Canyon, Pueblo Canyon from its tributary Acid Canyon, and Los Alamos Canyon from its tributary DP Canyon….Because of the release of power plant cooling water and water from the Laboratory's Sanitary Wastewater Systems Plant, Sandia Canyon has received the largest liquid discharge volumes of any canyon in recent decades. Water Canyon and its tributary Canon de Valle have received effluents produced by high explosives (HE) processing and experimentation (LANL 2007, p. 137).

The 1999 SWEIS highlights specific operations and discharges that have resulted in contamination of surface water and sediment in canyons:

- Nuclear materials research activities that occurred during the Manhattan Project;

- An industrial liquid waste treatment plant, operated from 1952 to 1986, at TA-21;
- Discharges from former TA-45 (operated from 1951 to 1964);
- Discharges from the LANSCE sanitary sewage lagoon system;
- Discharges from the RLWTF; and
- NPDES-permitted effluent discharges (LANL 1996 as cited in DOE 1999, p. 4-67).

As of 1999, effluent from NPDES-permitted outfalls was categorized as 13% sanitary wastewater; 50% cooling and noncontact cooling water; 11% boiler, demineralizer, and photo wastewater; and 26% power-plant and HE wastewater (DOE 1999). Sanitary wastewater effluents contained metals and some radionuclides, whereas discharges from the RLTWF included these contaminants as well as small quantities of organic contaminants. Photographic and cooling wastewater contained metals, including silver and chromium, respectively. Specifically, contaminants discharged in effluents have included radionuclides (e.g., tritium, americium-241, plutonium-238); metals (e.g., arsenic, mercury, cadmium, silver, lead); and oil (DOE 1999). Because these historical discharges of industrial effluents and releases of hazardous contaminants from land surfaces within LANL, surface water, sediment, and groundwater (see Groundwater section below) have been contaminated (DOE 1999, 2008).

In many canyons, flows from anthropogenic sources dominate streams, as only a small portion of on-site streams (approximately 2% of all stream-miles) are perennial (DOE 2008). For example, as of 1999 the RLWTF discharged approximately 5.5 million gallons of effluent annually into Mortandad Canyon as surface flow; none of this flow typically reached the LANL boundary (DOE 1999). However, some contamination has traveled a great distance from its point of initial release, as it has been remobilized and washed farther downstream. For example, plutonium contamination in sediment and surface water from historic discharges to Acid Canyon have moved more than 55 km downstream on the Rio Grande to the lower Cochiti Reservoir (Gallaher and Efurd 2002, as cited in DOE 2008 and LANL 2007). The 2000 Cerro Grande fire is associated with increases in surface water runoff and downstream sediment deposition (LANL 2002). Specifically, "sediment samples collected from Cochiti Reservoir showed an increase in cesium-137, plutonium-238, and plutonium-239 concentrations from three to six times above pre-fire concentrations. These concentration increases were attributed to the increased transport of LANL-impacted sediments from Pueblo Canyon" (DOE 2008, p. 4-62).

Groundwater Contamination: Groundwater at LANL occurs in several strata: the deep regional aquifer (beginning at 600 to 1,200 feet below ground surface); perched aquifers at intermediate depths several hundred feet below the ground; and the surficial alluvial materials of canyons (LANL 2007). Typically, the deep regional aquifer serves as a source of drinking and industrial process water for LANL and surrounding communities; however, shallower waters can discharge to the surface in the form of springs.

As indicated above, effluent discharges and stormwater runoff have contributed to the release of hazardous substances into the environment. In some cases, the consequences of historical releases have been discovered only recently. Groundwater throughout LANL has been contaminated by the infiltration of hazardous substance from surface water and soils (LANL 2007; DOE 2008). For example,

- **Tritium:** Tritium has been identified in groundwater in the vicinity of Los Alamos, Pueblo, Sandia, Mortandad, Pajarito, and Lower Pajarito Canyons and Cañon de Valle. Contamination was first reported in 1992 (DOE 1999).
- **Perchlorate:** Groundwater contaminated with perchlorate has been identified in the vicinity of Pueblo, Sandia, and Mortandad Canyons.
- **Cyclonite (RDX):** Contamination of groundwater with RDX (hexahydro-1,3,5-trinitro-1,3,5-triazine) has been identified in the vicinity of Cañon de Valle and Pajarito Canyon. RDX contamination was first documented in 2006.
- **Hexavalent chromium:** Hexavalent chromium has been identified in the vicinity of Sandia and Mortandad Canyons. Sources of chromium in groundwater include discharges from electroplating and photographic processing and the use of chromate as a corrosion inhibitor in cooling water. Chromium contamination was first reported in 2005 (LANL 2007).

In addition to documented contamination of the regional aquifer, intermediate, and alluvial groundwater has been impacted both by the contaminants described above and by additional hazardous substances, including radionuclides (e.g., plutonium-239 and plutonium-240, americium-241, strontium-90); metals (e.g., beryllium, molybdenum, and arsenic); and other organic and inorganic chemicals (e.g., fluoride, phthalates, PCE, and TCE) (LANL 2007). Contamination of the shallow alluvial and intermediate aquifers presents the potential for contaminants to migrate downward into the regional aquifer via regular aquifer recharge mechanisms, as well as through fault areas or along historical shafts or boreholes (DOE 1999).

Current Releases or Discharge of Hazardous Substances

Although waste streams have been reduced over time at LANL, daily operations continue to generate large quantities of hazardous waste. Approximately 13 cubic meters of liquid hazardous waste and 1,300 cubic meters of solid hazardous waste are generated at LANL annually and disposed of in accordance with RCRA (LANL 2008b). In 2007, a total of 154,175 kilograms of RCRA hazardous waste was generated, a portion of which was the result of on-site remedial activities (LANL 2008c). Hazardous wastes generated in 2007 included metals (e.g., arsenic, lead, barium, mercury, chromium, cadmium, and selenium); organic chemicals (e.g., toluene, methanol, acetone, chloroform, chlorobenzene, and PCBs); and HE (Erpenbeck et al. 2008). In 2005, sitewide, a total of approximately 13.3 tons of VOCs and 5.4 tons of the most common U.S. hazardous air pollutants (i.e., hydrochloric acid, methanol, acetonitrile, methylene chloride, and trichloroethylene) were released into the air (LANL 2006). Approximately 1,000 curies of radioactive air emissions occur annually at LANL as a result of off-gassing from inactive facilities (corresponding to slightly less than 5% of LANL-wide radioactive air emissions [DOE 2008]).

REMEDIAL ACTIVITIES AT THE SITE

Over the last several decades, a number of facilities have been decommissioned and remediated as part of LANL operations. Table 2.1.2.5-2 of the 1999 SWEIS indicates the locations and years of decommissioning activities conducted historically at LANL. In 1989, LANL initiated the Environmental Restoration Project, designed to:

1) Protect human health and the environment from exposure to releases of wastes;
2) Meet the environmental cleanup requirements of the Hazardous and Solid Waste Amendments Module VIII of LANL's permit to operate under RCRA;
3) Conduct closure of historical treatment, storage, and disposal facilities; and
4) Decommission contaminated facilities considered to be surplus. (DOE 1999, p. 2-9)

As part of this project, "potential release sites" (PRSs) were identified and investigated. These PRSs include SWMUs and AOCs. PRSs have been contaminated with a variety of wastes, including, but not limited to,

> …chlorinated and nonchlorinated solvents such as carbon tetrachloride, methylene chloride, trichloroethane, trichloroethylene, tetrachloroethylene, benzene, toluene, acetone, chloroform, and methyl ethyl ketone (MEK); high explosive compounds such as trinitrotoluene (TNT), dinitrotoluene compounds, octahydro-1357-tetranitro-1357-tetrazocine (HMX), triaminotrinitrobenzene (TATB), and RDX; various pesticides; perchlorate; other inorganic contaminants such as nitrates, ammonia, and fluoride; various radionuclides such as tritium, and plutonium; and other wastes (NMED 2004, p. 3).

Broadly, these PRSs are:

- MDAs where radioactive or hazardous constituents have been disposed of, generally by burial within soil or underlying tuff;
- Firing sites where radioactive or hazardous constituents have been explosively dispersed;
- Outfalls where soils, sediments, water bodies, or aquifers have become contaminated with radioactive or hazardous constituents contained in discharged effluents; and
- Other areas of possible surface, subsurface, or groundwater contamination (DOE 2008, p. I-1).

Specific contaminants and locations of historical groupings of these PRSs are presented in Table 2.1.2.5-1 of the 1999 SWEIS. Under the Environmental Restoration Project, PRSs were initially grouped into operable units for the organization of remedial activities. Operable units were further grouped into field units.

In 1999 and 2000, an effort was made to consolidate sites to further facilitate the investigation and remediation of the PRSs. All sites were evaluated, and those in the same geographic proximity with similar contaminant types and migration pathways were combined. The discrete SWMUs and AOCs were grouped into consolidated units based on geographic proximity, similar operating history, and other factors. This resulted in a revised total of 1,602 consolidated and discrete SWMUs and AOCs. This deviation from the original identification system for SWMUs and AOCs resulted in a significant difference in tracking numbers from previous years.

On March 1, 2005, DOE, the University of California, and the State of New Mexico entered into the Consent Order to undertake remedial actions at LANL, with the intent of investigating and implementing any needed corrective measures by the end of 2015.[20] The Consent Order explicitly outlined the approach for conducting three broad categories of hazardous waste remedial investigations: facility-wide, canyon watershed, and TA investigations.[21] Under the canyon watershed investigations, LANL was required to group PRSs into larger aggregate areas but the Consent Order also included provisions for the discovery of newly identified sites.[22] Finally, it detailed both general and specific technical approaches to sitewide remediation.

The categories of sites currently being addressed are discussed briefly below (DOE 2008, Appendix I):

- **MDAs:** MDAs are distributed throughout various TAs, can be parts of firing sites, and can occur within canyons or on mesa tops. MDAs can encompass multiple AOCs or SWMUs. A list of some of the major MDAs (including some of those highlighted above) is presented in Tables I-1 and I-3 of the 2008 SWEIS. MDAs have been and are currently being identified as part of targeted TA investigations. Investigation and remediation of individual MDAs are generally addressed separately.
- **Firing Sites:** Remediation of firing sites is being undertaken only upon closure (or designation of inactivity) of these sites. As a result, remediation at a portion of firing sites has been "deferred." Lists of nondeferred and deferred firing site areas are presented in Tables I-5 and I-6, respectively, of the 2008 SWEIS.
- **Canyons:** Canyons investigations are in preliminary stages and have primarily included groundwater monitoring.
- **Additional Sites:** Additional sites have been identified but either have not yet been investigated or require additional investigation. A list of sites requiring continued investigation is presented in Table I-23 of the 2008 SWEIS.

To date, according to the LANL website, 1,362 of the more than 2,000 PRSs have been approved for "no further action" or "corrective actions complete," and over 80,000 cubic yards of contaminated materials have been removed (LANL 2008a). Examples of historical corrective actions include over 100 voluntary remediation projects conducted before the Environmental Restoration project was established and between 1993 and 2008 (DOE 2008):

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[20] Prior to the Consent Order, remedial actions were required under Module III of LANL's annual RCRA Hazardous Waste Facility Permit (NMED 2004).

[21] The Consent Order does not address radionuclide clean-up; it addresses only clean-up of mixed and nonradionuclide hazardous wastes. The DOE regulates clean-up of sites contaminated with only radionuclides.

[22] There are 29 aggregate areas in total. A list of aggregate areas is included in Table I-22 of Appendix I of the 2008 SWEIS (DOE 2008).

- **MDA B:** Decontamination, vegetation removal, and capping (including use of several experimental covers) were performed in 1982, and institutional controls (i.e., fencing) were installed.
- **MDA T:** In the 1980s, liquid waste stored in corrugated pipes was removed, the site was graded, and institutional controls (i.e., fencing) were installed.
- **MDA U**: Contaminated soil was removed, the MDA was capped, trenches were constructed to contain surface runoff, and institutional controls (fencing) were installed in the 1980s.

In some cases, such historical remedial activities have recently been considered inadequate. Currently, remedial actions highlighted on the LANL website have centered around decontamination and decommissioning activities TA-21. Additional detailed background information about the investigation and remediation of specific PRSs (including specific remedial investigation efforts, site histories, waste characterization information, and clean-up actions) is included in Appendix I of the 2008 SWEIS.

HAZARDOUS SUBSTANCES OR OIL RELEASED OR DISCHARGED AT LANL

As mentioned above, a wide variety of hazardous and radiological contaminants as well as oil were released in the past and are currently released into the environment as a result of LANL operations. Because of the nature of the scientific research and development and industrial activities performed on-site, hazardous chemical use (including solvents, acids, and elemental salts and compounds) has been a part of normal operations. In addition, environmental contamination has resulted from the on-site power, waste handling, and disposal facilities.

For purposes of making a preliminary identification of resources at risk, this PAS focuses on the hazardous substances and oil, as defined in section 101(14) of CERCLA, released at LANL that are persistent, pervasive, directly related to site operations, and most likely to cause adverse effects to Trustee resource. These contaminants of concern (COCs) include the following:

- **Radionuclides**: americium, cesium, plutonium, strontium, tritium, and uranium
- **Metals**: arsenic, beryllium, barium, chromium, lead, mercury, and selenium
- **Organic Compounds**: PCBs, benzo(a)pyrene, TCE, TCA
- **Inorganic Compounds**: perchlorate
- **Explosives**: RDX, TNT, HMX (octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine)
- **Oil**: petroleum hydrocarbons

ADDITIONAL OIL OR HAZARDOUS SUBSTANCES POTENTIALLY DISCHARGED OR RELEASED FROM LANL

In addition to the COCs indicated above, hazardous contaminants potentially discharged from LANL include other radioactive elements and radiation, other metals, and other hazardous compounds or chemicals not explicitly mentioned above (e.g., additional polycyclic aromatic hydrocarbons (PAHs) other than benzo[a]pyrene; additional solvents including parent and breakdown products of those listed above; depleted uranium; and other metals such as zinc, copper, and cadmium). DOE (1999) indicates that 382 hazardous chemicals out of a list of over 2000 chemicals purchased for use at LANL were evaluated in an assessment of air emissions at the facility (DOE 1999, Appendix B, Attachment 2).

ENVIRONMENTAL SETTING

As described in Section 2, LANL is located on the Pajarito Plateau. The plateau is divided into a network of mesas and over a dozen distinct canyons (DOE 2008). These canyons were formed as water drained from the Jemez Mountains to the west into the Rio Grande to the east (see Exhibit 2-1, above). The Rio Grande flows southward along the eastern border of LANL into Cochiti Dam and Reservoir. The majority of the mesas in and around LANL are composed of Bandelier Tuff, the uppermost stratum of the Pajarito Plateau deposited 1.6 to 1.2 million years ago following eruptions of the Valles and Cerro Toledo calderas. Bandelier Tuff includes ash fall, ash-fall pumice, and rhyolite tuff (LANL 2006). The Puye Formation underlies the Bandelier Tuff, followed by the Santa Fe Group.

In general, the climate in Los Alamos County is described as a temperate, semiarid mountain climate (LANL 2006). Given its desert setting, there is a wide range between day and night as well as seasonal temperatures in and around LANL. In the summer, temperatures range from 70ºF to 88ºF during the day and 50ºF to 59ºF at night. In the winter, temperatures range from 30ºF to 50ºF during the day and 15ºF to 20ºF at night.

The level of precipitation also reflects a semiarid climate. With an average of approximately 19 inches of rain per year, most of which falls in mid- to late summer, most canyons support only ephemeral streams. In addition, drought conditions existed across much of the area from 1998 through 2003. Most of the water in and around LANL is groundwater. Specifically, a large artesian aquifer lies beneath the eastern portion of the Pajarito Plateau and is recharged by precipitation falling in the Jemez Mountains.

The Parajito Plateau supports a variety of ecosystems, including five unique vegetation zones (LANL 2006). In particular, the juniper-savanna community dominates the eastern portion of the plateau along the Rio Grande. Piñon-juniper woodland dominates mid-elevation (6,200 feet–6,900 feet) mesa-tops. Higher elevation areas (6,900 feet–7,500 feet) are dominated by ponderosa pine communities. Finally, mixed conifer forests (e.g., Douglas fir, ponderosa pine, and white fir) and spruce-fir forests dominate high elevation areas (7,500 feet–9,500 feet) in the western portion of the plateau extending into the Jemez Mountains.

The Jemez Mountains are a fire-adapted landscape with ponderosa pine-mixed conifer forests that have fire-return intervals of between 10 and 25 years. Forested lands that have not experienced fire in the landscape for lengthy intervals, generally because of human manipulation of the landscape, are vulnerable to large-scale wildland fires. This pattern of large-scale wildland fires occurs throughout the western U.S. and can worsen during drought cycles. Locally, the Jemez Mountains have experienced a series of wildland fires, including the Water Canyon fire (1954), the La Mesa fire (1977) that burned onto LANL lands, the Dome fire (1996), the Oso fire (1998), and most recently the Cerro Grande fire that also burned onto LANL lands. The Southwest region of the U.S. experienced a multiyear drought cycle ending in about 2005 and has had multiple large scale bark-beetle infestations, leading to increased tree mortality throughout LANL (DOE 2008).

PRELIMINARY PATHWAY IDENTIFICATION

As mentioned above, hazardous substances and oil have been, and continue to be, released or discharged to the environment at LANL as a result of normal operations, spills, or other releases. The majority of uncontrolled releases occurred before the mid-1970s. When LANL operations began complying with newly established environmental laws and regulations in the early 1970s, discharges of hazardous substances to the environment were reduced. As part of ongoing environmental surveillance activities at the site, stable or decreasing trends in the concentrations of environmental contaminants have been observed within and around the site since the 1970s (LANL 2008c). Site-related contaminants primarily enter the environment through direct emission to air and discharge of contaminated effluent to surface water or surface water drainage areas. Spills of hazardous substances or oil typically contaminate soil, from which such contamination can migrate to other resources. For example, contaminants can be mobilized by precipitation or stormwater events and flow into surface water or percolate into groundwater. Contaminated soils may also be carried by wind and deposited in other locations, exposing additional resources. Improper disposal of contaminated waste (e.g., in inadequately contained underground disposal areas) can lead to contamination of surrounding soils and leaching of contaminants to surface water and groundwater. The specific pathway of a contaminant through the environment depends upon the physical and chemical properties of both the contaminant and the environmental media.

Evidence indicates that site-related contaminants have been transported from the location of the discharge or release throughout the environment. For example, "Contaminants that appear to be from LANL NPDES-permitted discharges at TA-16 have been detected in…springs in Pajarito and Water Canyon watersheds, indicating a hydrogeological connection" (DOE 1999, p. 4-69).[23] In addition, radionuclides and other contaminants discharged to canyons or released via indirect mechanisms (e.g., overflowing of wastewater lagoons in TA-21) have been detected in canyon sediments and in increasing concentrations downstream into the Rio Grande and Cochiti Reservoir as a result of surface water flows (DOE 2008).

Once contaminants are released to the environment, Trustee resources may be exposed to those contaminants via inhalation of contaminated air, dermal absorption, or ingestion of contaminated media (i.e., water, soil, or sediment). Biota that come into direct contact with contamination include plants and organisms that live in soils and sediments, such as earthworms and burrowing animals on land and benthic infauna and epifauna in streams.[24] Wildlife drinking from contaminated springs and streams and fish and amphibians living or reproducing in contaminated surface water are also directly exposed. Trustee resources also may be exposed to contaminants indirectly through the consumption of contaminated food items or prey. For example, fish, amphibians, birds, and mammals may consume plants and organisms that have been exposed directly to and have taken up contamination.

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[23] Contaminants in these springs included HE and VOCs (DOE 1999).

[24] Epifauna are benthic organisms that typically reside on sediment surfaces, whereas infauna are benthic organisms that typically burrow into sediment.

A variety of COCs have been measured in air, soils, surface water, sediment, and groundwater within LANL boundaries as well as in the surrounding region (see discussion Concentrations and Toxicity of Hazardous Substances below). A number of these same contaminants have also been measured directly in Trustee resources, including fish, birds, and mammals collected in the vicinity of LANL. For example, strontium-90, cesium-137, uranium-238, plutonium-238, plutonium-240, and tritium—all contaminants that have been released from site operations—have been measured at elevated levels in plant tissues within LANL. Some of these radionuclides have also been measured in honeybees on-site (e.g., uranium-238). In addition, a number of inorganic contaminants, including depleted uranium, beryllium, and silver, were widely used at LANL and have been measured in mice and bird tissues.

As part of the ongoing environmental surveillance program and Consent Order-required studies at LANL, many aspects of hazardous materials fate and transport are still under intensive investigation. These ongoing environmental monitoring studies and regulatory compliance actions are expected to result in a more refined understanding of the nature and extent of hazardous material releases, potential pathways, and potential receptors.

EXPOSED AREAS

As described above, contaminants released from LANL operations have been distributed both within the site and to areas beyond site boundaries. Distribution of contaminants from LANL and dose effects from those contaminants have typically been modeled out to 50 miles from the site, which corresponds to an area roughly 7,800 square miles in size (DOE 2008). Areas of water exposed to site-related contaminants include on- and off-site surface water and groundwater. There are approximately 85 miles of watercourses in 19 canyons in the immediate vicinity of LANL, most of which are typically dry for most of the year and only flow in response to precipitation or stormwater or snow runoff events (LANL 2007; NMED 2004). Nevertheless, the few perennial reaches and stormwater/snow runoff events in ephemeral reaches have transported contaminants off-site into at least 34 miles of the Rio Grande adjacent to the site downriver to the lower Cochiti Reservoir (Gallaher and Efurd 2002, as cited in DOE 2008 and LANL 2007). The extent of groundwater contamination has yet to be fully delineated, and new monitoring wells have been installed as recently as 2009. Generally, LANL monitors regional groundwater wells downgradient of and just southeast of the Rio Grande (LANL 2007, 2008b).

CONCENTRATIONS AND TOXICITY OF HAZARDOUS SUBSTANCES

Numerous contaminants, including the COCs listed above, have been documented at varying concentrations in environmental media in and around LANL. Sampling information contained in the RACER database and site-specific reports indicates that concentrations of numerous COCs in Trustee resources exceed criteria or threshold values indicative of injury. Representative data are summarized below. Appendix A presents the average and maximum concentrations reported in the RACER database alongside criteria or threshold values for air, surface water, sediment, soil, and groundwater.[25] In general, criteria promulgated by the EPA or the State of New Mexico are applied to evaluate the potential for injury. In circumstances where such criteria are unavailable, literature-based thresholds indicative of an adverse effect on exposed organisms in a given environmental medium are used. Although exceedance of such thresholds is not defined as injury per se in the DOI regulations, the occurrence of substances above these thresholds indicate the potential for injury. In addition, some COCs have been documented in fish and wildlife captured in the vicinity of LANL. Tissue concentrations of COCs are also presented in Appendix A.

Air Contamination

Normal operations at LANL routinely discharge hazardous contaminants to the air via point sources (e.g., ventilation and exhaust stacks) and nonpoint sources (e.g., volatilization or resuspension), as discussed above. Air resources are injured if concentrations of hazardous contaminants are shown to have exceeded promulgated ambient air quality criteria [43 CFR 11.62(d)]. Routine and targeted monitoring of air quality in and around LANL has indicated that concentrations of beryllium and lead have not exceeded such criteria.[26]

Soil Contamination

Whether deposited on soil from air or released directly to soil from spills or intentional land filling, soil resources are injured when concentrations of contaminants cause detrimental physical changes to the soil resource itself (e.g., substantial changes in soil pH or salt content, impediment of soil microbial respiration or carbon mineralization) or indirectly to Trustee resources that reside in or come into contact with soil [43 CFR 11.62(e)].

Soil samples collected on LANL property indicate that concentrations of COCs have exceeded injury thresholds. Specifically, concentrations of HE (i.e., RDX, HMX, and TNT); metals (i.e., arsenic, barium, beryllium, chromium, lead, mercury, and selenium); organic chemicals [i.e., PCBs, benzo(a)pyrene, TCA, and TCE]; and radionuclides (i.e., americium-241, cesium-137, plutonium-238, plutonium-239 and - 240, strontium-90, tritium, and the uranium-234, uranium-235, and uranium-238 isotopes) have been measured in soil samples in excess of contaminant-specific adverse-effects thresholds, indicating that injury to soil resources has likely occurred.

Some of these contaminants have also been measured at levels sufficient to cause injury to several mammal and bird species. For example, concentrations of HE have been measured in soil at concentrations sufficiently high to cause injury to the deer mouse, desert cottontail, red fox, montane shrew, American robin, and American kestrel. Concentrations of a number of metals (e.g., arsenic, barium, beryllium, chromium, lead, mercury, and selenium); organic chemicals [e.g., PCBs, benzo(a)pyrene, and TCE]; and

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[25] Baseline conditions are not addressed in this PAS. As a result, a distinction is not made between site-related contaminants versus those that may have resulted from releases off-site or which are naturally occurring. Such considerations will be addressed in the injury assessment.

[26] The original maximum concentration selected from the RACER database for lead (23.21 $\mu g/m^3$) and beryllium (0.04 $\mu g/m^3$) exceeded threshold criteria; however, the data were collected from a NMED air-sampling station near a construction haul road that did not meet EPA siting criteria. The next highest maximums for lead (1.46 $\mu g/m^3$) and beryllium (0.00069 $\mu g/m^3$) were selected from the RACER database and used as final values in this PAS; neither value exceeds thresholds.

radionuclides (e.g., americium-241, cesium-137, plutonium-238, plutonium-239, plutonium-240, tritium, uranium-234, and uranium-235); also have been measured above such thresholds for mammals and birds in soil (LANL 2008d).

Surface Water and Sediment Contamination

Surface water resources, as defined by the DOI NRDA regulations, include both surface water and bed and bank sediments. Contamination entering surface water from direct or indirect precipitation (e.g., as stormwater flow over land), from groundwater through springs, or directly through the discharge of effluent can cause concentrations of hazardous chemicals or elements to exceed injury thresholds. Surface water resources are injured if concentrations of a hazardous substance or oil exceed a promulgated water quality standard for drinking water or the protection of aquatic life, or if concentrations in surface water or sediment are sufficient to cause demonstrable harm to other Trustee resources [43 CFR 11.62(b)].

Surface water samples collected in and around LANL contain COCs in excess of promulgated water quality criteria. Specifically, COC concentrations in surface water samples taken from perennial streams[27] in and around LANL of metals (i.e., barium, beryllium, chromium, lead, mercury, and selenium); organic chemicals (i.e., benzo(a)pyrene and TCA); and radionuclides (i.e., cesium-137 and uranium-235) exceed chronic water quality criteria for the protection of aquatic life. In addition, concentrations of barium have been measured in base flows in excess of a threshold indicative of injury to the montane shrew (LANL 2008d). COC concentrations in stormwater samples of metals (i.e., arsenic, barium, beryllium, chromium, lead, and selenium); organic chemicals (i.e., PCBs and benzo(a)pyrene); and radionuclides (i.e., cesium-137, uranium-235, and uranium-235/236) exceed acute water quality criteria for the protection of aquatic life.[28] Some of these concentrations also exceed additional thresholds indicative of injury to other organisms [e.g., barium concentrations have been measured in stormwater in excess of adverse effects thresholds for the deer mouse, desert cottontail, montane shrew, occult little brown myotis bat, and the red fox (LANL 2008d)].

As recently as 2006, 8 of 10 surface water samples taken within LANL property contained gross-alpha activity greater than the New Mexico water quality standard of 15 picocuries per liter (pCi/L) for livestock watering, approximately 50% of samples contained concentrations of dissolved aluminum in excess of the acute aquatic life water quality criterion, and 2% to 8% of samples exceeded the corresponding water quality criteria for copper, zinc, mercury, and arsenic (LANL 2007).

Sediment samples collected in and around LANL also exceed concentrations above which the benthic community (including epifauna and infauna) may experience adverse effects. Specifically, concentrations of HE (i.e., HMX, RDX, and TNT); metals (i.e., arsenic, chromium, lead, and mercury); organic chemicals (i.e., PCBs and benzo(a)pyrene); and radionuclides (i.e., americium-241, cesium-137, plutonium-238, plutonium-238 and -240, and uranium-234) in sediment samples taken in and around

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[27] Perennial streams flow year-round.

[28] Stormwater concentrations of PCBs were compared to a chronic criterion, as no acute criterion is available.

LANL exceed corresponding sediment-quality guidelines and screening levels. A number of these contaminants have been found at concentrations in sediment sufficient to cause injury to upper-trophic level organisms that may feed on sediment-dwelling organisms or that come in direct contact with sediment. For example, mercury and RDX have been measured in sediment at concentrations above thresholds indicative of injury to the violet-green swallow, an insectivorous bird (LANL 2008d). These exceedances indicate injury to surface water resources from site-related contaminants has likely occurred.

In addition to contaminant concentrations in sediment sufficient to adversely affect biota exposed to that sediment, site-related contaminants have adversely affected benthic communities. Benthic communities at LANL have likely been exposed to COCs, both through their diet and via direct contact with contaminated sediment and water because these communities occur downstream of various waste effluent outfalls within the site (Cross 1994; Cross 1995; Bennett 1994; Henne 2004).

Site-specific aquatic invertebrate studies indicate potential injury to LANL benthos from exposure to COCs. Various metrics of macroinvertebrate community composition [e.g., abundance, diversity, richness, and number of ephemeroptera, plecoptera, and trichoptera (EPT) taxa[29]] can be used to evaluate benthic community status. For example, macroinvertebrate communities at LANL are degraded, particularly sites near outfalls that discharge industrial and sanitary waste effluent to Sandia Canyon (Bennett 1994; Cross, 1994) and areas within TA-11, TA-13, TA-16, TA-25, and TA-37 (Cross 1995). In Sandia Canyon, macroinvertebrate communities near outfalls were characterized by low diversity, poorly developed community structure and a lower percentage of good water quality indicator species than sites further downstream.[30] Similar results were found for macroinvertebrate communities near outfalls in TA-11, TA-13, TA-16, TA-25, and TA-37 (Cross 1995). Here the physicochemical parameters at most outfalls fell within the normal range of natural waters in the area, but the macroinvertebrate community was characterized by low biodiversity and severely stressed communities composed of a restricted number of taxa (Cross 1995).

Groundwater Contamination

Although a moderate amount of attention has been placed upon groundwater resources in and around LANL because this resource is a source of drinking and industrial-process water, contamination has not been fully delineated, and monitoring efforts are ongoing. However, groundwater monitoring in recent years has indicated that concentrations of several COCs exceed promulgated drinking water standards.[31] COCs measured in groundwater in excess of applicable injury thresholds include metals (arsenic, barium, beryllium, chromium, lead, mercury, and selenium) and organic chemicals

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[29] EPT taxa refer to the number of taxa in the insect orders ephemeroptera (mayflies), plecoptera (stoneflies) and trichoptera (caddisflies), three of the more sensitive macrobenthic groups.

[30] Sites near the outfalls had 8 to 10 taxa at sites near the outfalls versus 16 or 17 taxa at sites further downstream; sites near the outfalls have 10% to13% t of good water quality indicators whereas downstream sites had 20% to 50%-plus good water-quality indicators.

[31] In circumstances where groundwater discharges to surface water, ambient water quality criteria for the protection of aquatic life may be suitable for use as an injury threshold.

[benzo(a)pyrene and TCA]. These exceedances indicate that injury to groundwater has likely occurred.

Contamination of Birds and Mammals

Some COCs have also been measured in a variety of wildlife tissue in and around LANL, and a number of studies aimed at assessing adverse impacts to birds and mammals potentially caused by hazardous-waste contamination have been performed. Potential injury to birds and mammals is discussed below.

Birds. Studies have documented the exposure of birds to site-related hazardous substances as well as the adverse effects incurred by avian resources likely resulting from that exposure. Multiple foraging guilds, including piscivorous, insectivorous, omnivorous, and carnivorous birds, are exposed to contaminants of concern through consumption of contaminated prey, incidental ingestion of contaminated soil, sediment, and/or water, and via contact with radioactive material. For example, recent breeding bird surveys indicate that birds forage and breed in areas characterized by a large number of potential hazardous substance and oil release sites (e.g., Mortandad Canyon), and elevated levels of metals including arsenic (up to 900 mg/kg wet weight), silver (up to 600 mg/kg wet weight), and mercury (up to 0.15 mg/kg wet weight) have been reported in bird tissue between 2000 and 2006 (Jewell 2001; Colestock and Fair 2001; Fair 2001; Fresquez et al. 2007).[32]

Potential adverse effects in birds resulting from exposure to COCs include reductions in growth and reproductive success, adverse physiological changes, and increased mortality. LANL bird studies indicate that these effects may be occurring as a result of exposure to on-site contaminants. For example, Fair et al. (2003) showed reduced survival of nestling flycatchers in areas within foraging distance of known potential contaminant release sites on the LANL. This was evident from a significantly lower survivorship function associated with nest boxes located within foraging distance to PRS ($\chi^2 = 5.58$, $P = 0.018$).

Fair and Meyers (2002) also found eggshell thinning and smaller eggs in bluebirds at the Sandia wetland, a LANL site that contains elevated concentrations of PCBs. A modified RATCLIFFE (Ratcliffe 1967, cited in Fair and Myers 2002) shell-thickness index[33] was used to evaluate eggshell thinning. Bluebirds at the Sandia wetland had a thinner eggshell thickness index value and eggs were smaller than at reference locations.

Mammals. Studies have documented the exposure of mammals to site-related hazardous substances, as well as the adverse effects incurred by mammals likely resulting from that exposure. Mammals are exposed to contaminants of concern through consumption of contaminated prey, incidental ingestion of contaminated soil, sediment, and/or water, and contact with radioactive material. Potential adverse effects in mammals resulting from exposure to contaminants of concern include reductions in growth and reproductive

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32 These birds were caught near the dual-axis radiographic hydrodynamic test (DARHT) facility. Contaminants are likely site related because bird tissue concentrations were more than an order of magnitude greater than corresponding regional statistical reference levels (RSRLs), which are upper-bound background concentrations (mean plus two standard deviations) derived from birds collected from regional areas to represent fallout and natural sources.

33 The modified RATCLIFFE index used here was [shell weight (g) * 100/length * breadth (mm)].

success, adverse physiological changes, and increased mortality. For example, on-site investigations report the following:

- Gophers at LANL Area G had tritium concentrations of 9.1 rad per day (Gonzales et al. 2000). This is more than nine times the 0.1 rad per day safe limit from the International Atomic Energy Agency (IAEA) (1992).
- Rock squirrels from a radioactive waste lagoon area at TA-53 had significantly higher tritium concentrations compared to rock squirrels from a control site at the Santa Fe National Forest (Hansen et al. 1999).
- Mice from waste MDA G at TA-54 had higher levels of radionuclides than mice from background sites (Fresquez et al. 2005), although the estimated average dose was below the DOE dose limit of 0.1 rad per day.
- Mean concentrations of radionuclides (i.e., americium-241, plutonium-238, plutonium-239, strontium-90, and cesium-137) in small mammal carcasses were found to be significantly higher at a site in Mortandad Canyon, a liquid waste disposal site at LANL, relative to background concentrations (Bennett et al. 1996).
- Recent sampling of small mammals at Sandia Canyon (a LANL site known to have high levels of PCBs and other COCs) showed a large proportion of nonreproductive females and nonscrotal males (Bennett and Robinson 2008). While this study did not include comparison with reference site mammals, the lack of reproductive adults in this area warrants further investigation.

POTENTIALLY AFFECTED RESOURCES

Natural resources and their supporting ecosystems that have been or potentially have been affected by the discharge or release of the hazardous substances include those resources exposed to site-related contaminants above relevant criteria or adverse effects thresholds. These include, but are not limited to, the following:

- Air
- Surface water, including ephemeral, perennial streams, and reservoirs (e.g., Cochiti Reservoir)
- Sediment, including benthic infauna and epifauna
- Groundwater
- Soils, including microorganisms and soil-dwelling invertebrates
- Vegetation, including the five unique vegetation zones (juniper-savanna, piñon-juniper, ponderosa pine, mixed conifer forests, and spruce-fir) and over 900 species of plants
- Biota utilizing habitat that has been exposed to site-related contaminants may include “57 species of mammals; 200 species of birds, including 112 species known to breed in Los Alamos County; 28 species of reptiles; 9 species of amphibians; over 1,200 species of arthropods; and 12 species of fish (primarily

found in the Rio Grande, Cochiti Reservoir, and the Rito de los Frijoles)" (LANL 2002, p.5).

- Threatened and endangered species, including approximately 20 plant and animal species designated as threatened species, endangered species, or species of concern at the federal and/or state level (LANL 2002, p. 5). Examples include the Mexican spotted owl and southwestern willow flycatcher.

POTENTIALLY AFFECTED RESOURCE SERVICES

Potentially affected natural resources for which a federal, state, or tribal entity may assert trusteeship provide a broad range of resource services. These include, but are not limited to, the following:

- Habitat for trustee wildlife species, including foraging, shelter, breeding and rearing areas, migratory pathways, and other ecological components contributing to survival.
- Other ecological and biological services provided by natural resources.
- Subsistence and recreational harvest of fish and wildlife.
- Subsistence and traditional gathering of plants for ceremonial, medicinal, and economic purposes. Gathering of soils and sediments for traditional and economic purposes.
- Contact recreation (e.g., swimming, hiking, wildlife viewing, educational activities).
- Sources of potable water.
- Sources of water for irrigation and other nonpotable purposes.
- Sacred places and areas of traditional practice.
- Archaeological resources.
- Option, existence, and bequest values.

SECTION 4 STATUTORY EXCLUSIONS FROM LIABILITY

As described throughout this document, discharges and releases of hazardous substances and oil from operations at LANL are associated with a wide range of activities that occurred over a broad geographic area and over many decades. In some cases, these discharges and releases may meet the criteria listed above for exclusion from liability. Despite uncertainties regarding potential exclusions from liability for specific discharges and releases, the Trustees believe it is reasonable to proceed with this assessment. The Trustees will address exclusions from liability in the course of completing the assessment as each release and component of the damage claim is considered in detail. The DOI regulations require that natural resource Trustees determine whether the natural resource damages being considered are barred by specific defenses or exclusions from liability under CERCLA or CWA (43 CFR §11.24). Specifically, the Trustees shall determine whether the damages:

(i) Resulting from the discharge or release were specifically identified as an irreversible and irretrievable commitment of natural resources in an environmental impact statement or other comparable environmental analysis, that the decision to grant the permit or license authorizes such commitment of natural resources, and that the facility or project was otherwise operating within the terms of its permit or license, so long as, in the case of damages to an Indian Tribe occurring pursuant to a Federal permit or license, the issuance of that permit or license was not inconsistent with the fiduciary duty of the United States with respect to such Indian Tribe; or

(ii) And the release of a hazardous substance from which such damages resulted have occurred wholly before enactment of CERCLA; or

(iii) Resulted from the application of a pesticide product registered under the Federal Insecticide, Fungicide, and Rodenticide Act, 7 U.S.C. 135–135k; or

(iv) Resulted from any other federally permitted release, as defined in section 101(10) of CERCLA; or

(v) Resulting from the release or threatened release of recycled oil from a service station dealer described in section 107(a)(3) or (4) of CERCLA if such recycled oil is not mixed with any other hazardous substance and is stored, treated, transported or otherwise managed in compliance with regulations or standards promulgated pursuant to section 3014 of the Solid Waste Disposal Act and other applicable authorities.

The DOI regulations state that a natural resource damage assessment shall not be continued for potential injuries meeting one or more of these criteria, which are exceptions to liability provided in sections 107(f), (i), and (j) and 114(c) of CERCLA.

The Trustees must also determine whether the discharge meets one or more of the exclusions provided in section 311 (a)(2) or (b)(3) of the CWA:

> (a)(2) “discharge” includes, but is not limited to, any spilling, leaking, pumping, pouring, emitting, emptying or dumping, but excludes (A) discharges in

> compliance with a permit under section 402 of this Act *[42 USC § 1342]*, (B) discharges resulting from circumstances identified and reviewed and made a part of the public record with respect to a permit issued or modified under section 402 of this Act *[42 USC § 1342]*, and subject to a condition in such permit, (C) continuous or anticipated intermittent discharges from a point source, identified in a permit or permit application under section 402 of this Act *[42 USC § 1342]*, which are caused by events occurring within the scope of relevant operating or treatment systems, and (D) discharges incidental to mechanical removal authorized by the President under subsection (c) of this section.

> (b)(3) The discharge of oil or hazardous substances (i) into or upon the navigable waters of the United States, adjoining shorelines, or into or upon the waters of the contiguous zone [or under other specified Acts]…in such quantities as may be harmful as determined by the President under paragraph (4) of this subsection, is prohibited, except (A) in the case of such discharges into the waters of the contiguous zone or which may affect natural resources belonging to, appertaining to, or under the exclusive management authority of the United States (including resources under the Magnuson-Stevens Fishery Conservation and Management Act of 1976), where permitted under the Protocol of 1978 Relating to the International Convention for the Prevention of Pollution from Ships, 1973, and (B) where permitted in quantities and at times and locations or under such circumstances or conditions as the President may, by regulation, determine not to be harmful. Any regulations issued under this subsection shall be consistent with maritime safety and with marine and navigation laws and regulations and applicable water quality standards.

As described throughout this document, discharges and releases of hazardous substances and oil from operations at LANL are associated with a wide range of activities that occurred over a broad geographic area and over many decades. In some cases, these discharges and releases may meet the criteria listed above for exclusion from liability. Despite uncertainties regarding potential exclusions from liability for specific discharges and releases, the Trustees believe it is reasonable to proceed with this assessment. The Trustees will address exclusions from liability in the course of completing the assessment as each release and component of the damage claim is considered in detail.

SECTION 5 PREASSESSMENT SCREEN CRITERIA

Five criteria are specified in the DOI regulations that must be met before a Trustee can proceed with a natural resource damage assessment [43 CFR §11.23(e)]. This section addresses whether these criteria are satisfied at the LANL site. The criteria are as follows:

1) **A discharge of oil or a release of a hazardous substance has occurred.** As documented in this PAS, various hazardous substances, including radionuclides, metals, and other hazardous substances (e.g., PCBs, PAHs, HE, solvents) have been discharged or released to the environment from LANL operations.

2) **Natural resources for which a Federal or state agency or Indian Tribe may assert trusteeship under CERCLA have been or are likely to have been adversely affected by the discharge or release**. Natural resources over which the state and federal agencies and Indian tribes may assert trusteeship have been adversely impacted by the release of hazardous substances from LANL. Existing data indicate that hazardous substance concentrations in groundwater, soils, sediments, and surface waters have been or are currently sufficient to adversely affect resources for which federal, state, and tribal entities hold trusteeship.

3) **The quantity and concentration of the discharged oil or released hazardous substance is sufficient to potentially cause injury, as that term is used in this part, to those natural resources.** As discussed in Section 3, existing information indicates that hazardous substances have or are present at concentrations sufficient to cause injury to trust natural resources.

4) **Data sufficient to pursue an assessment are readily available or likely to be obtained at reasonable cost.** Environmental monitoring and research have been ongoing at LANL for many years. As a result, large amount of existing information is available for this site. While additional information may be required prior to completion of the assessment, these data are likely to be obtained at a reasonable cost.

5) **Response actions, if any, carried out or planned do not or will not sufficiently remedy the injury to natural resources without further action**. A range of response actions, under various authorities, have been undertaken and or are planned at the LANL site. These actions have and will, to an extent, minimize or eliminate exposure of trust resources to hazardous substances. However, hazardous substances have been and continue to be present at concentrations sufficient to cause injury. Thus, the Trustees believe that additional actions to restore, replace, and rehabilitate injured natural resources may be necessary.

SECTION 6 PREASSESSMENT SCREEN DETERMINATION

Based on the information described in this PAS, the Trustees conclude

- the criteria prerequisites for proceeding with a natural resource damage assessment have been met;
- a reasonable probability exists of developing a successful claim for injuries and damages to natural resources resulting from releases of hazardous substances from LANL; and
- a full assessment can be conducted for a reasonable cost (i.e., assessment costs are expected to be less than the damages recovered).

Therefore, the Trustees determine it is prudent to proceed with a NRDA at this site.

TRUSTEE SIGNATURES PREASSESSMENT SCREEN

For the United States Department of Energy

_________________________________ ______________

Frank Marcinowski Date

Deputy Assistant Secretary
for Regulatory Compliance

_________________________________ 10/03/09

Donald Winchell Date

Manager, Los Alamos Site Office

TRUSTEE SIGNATURES PREASSESSMENT SCREEN

For the United States Department of the Interior

______________________________ 1/6/2010

for Vicki Forrest, Deputy Director for Trust Services, Bureau of Indian Affairs

Date

TRUSTEE SIGNATURES PREASSESSMENT SCREEN

For the USDA Forest Service

C. L. Newman Jr. — 11-20-09

Corbin L. Newman, Jr. — Date

Regional Forester, Southwestern Region

TRUSTEE SIGNATURES PREASSESSMENT SCREEN

For the State of New Mexico

Jim Baca 10/27/09

Jim Baca
Trustee, State of New Mexico
Office of Natural Resources Trustee

Date

10/28/09

Seth Cohen
Assistant Attorney General
New Mexico Attorney General's Office

Date

TRUSTEE SIGNATURES PREASSESSMENT SCREEN

For the Pueblo de San Ildefonso

______________________________ 11/9/09

Leon T. Roybal, Governor — Date

______________________________ 11/9/09

Paul Rainbird, 1st Lt. Governor — Date

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GLOSSARY

Actinides (also known as actinoids): the series of elements on the periodic table with atomic numbers that range from 89 (actinium) to 103 (lawrencium); a list that includes uranium and plutonium.

Alluvial groundwater: groundwater present in alluvium.

Alluvium: sediment deposited by flowing water, as in a riverbed, flood plain, or delta.

Carnivorous: organisms that typically consume animal tissue.

Critical: the quantity of a radioactive material required to sustain an equilibrium fission reaction.

Depleted uranium: uranium that has less than 0.7% (by weight) uranium-235 (the quantity found in natural uranium), so that it contains more uranium-238 than does natural uranium.

Epifauna: benthic organisms that typically reside on sediment surfaces.

Fission: the process of splitting the nucleus of a heavy atom into two lighter nuclei; accompanied by the release of neutrons, gamma rays, and energy.

Fusion: the process of joining two light nuclei to form one atom; accompanied by the release of energy.

Gross alpha activity: the total quantity of alpha particles emitted by a radioactive element.

Hazard Category Nuclear Facility: Nuclear facilities can be categorized into one of three Hazard Categories defined as such: "Category 1 Hazard: Hazard analysis shows the potential for significant off-site consequences. Category 2 Hazard: Hazard analysis shows the potential for significant on-site consequences. Category 3 Hazard: Hazard analysis shows the potential for only significant localized consequences." Hazard Category is based on the radiological risk associated with facility operations, not the impact of the facility on the surrounding environment from releases of hazardous substances. High-hazard facilities operate using rigorous engineering and under administrative controls and permits to prevent or reduce exposures from radiological releases from these facilities.

High Explosives: compounds that undergo rapid chemical reaction to produce large amounts of heat and energy.

Infauna: benthic organisms that typically dwell and burrow into sediments.

Insectivorous: organisms that typically consume insects.

Institutional Control: nonengineered instruments (e.g. legal or administrative) that minimize the potential for human exposure by limiting the use of a land or resource.

Ion-Exchange: a chemical process by which one ion displaces another ion at an ionic binding site.

Irradiate: to expose to ionizing radiation.

Macroinvertebrate: typically larger organisms that may be seen with the eye (e.g. worms).

Nanomaterials: very small elements or compounds that are one to 100 nanometers in size.

Omnivorous: refers to organisms that consume both plant and animal tissue.

Oxidation state: the charge that an atom in a compound or ion would have if the compound or ion existed entirely of monatomic ions.

Pisciverous: organisms that typically consume fish.

Polymer: a molecule formed by the joining of a chain of smaller molecules of the same form.

Radioactive: the property of certain elements, the nuclei of which spontaneously transform; a process that is normally accompanied by the emission of ionizing radiation.

Radioisotope: a particular isotope of a radionuclide.

Radionuclides: radioactive elements.

Solvents: liquid hydrocarbons that readily dissolve other organic chemicals.

Transuranic elements: elements on the periodic table with atomic numbers greater than that of Uranium (92).

Tuff: rock consisting of consolidated volcanic ash.

LIST OF ACRONYMS

AOC	area of concern
BIA	Bureau of Indian Affairs
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act of 1980
CFR	Code of Federal Regulations
CMR	Chemical and Metallurgy Research
COC	contaminants of concern
CWA	Clean Water Act
DDE	dichlorodiphenyldichloroethylene
DDT	dichloro-Diphenyl-Trichloroethane
DOE	Department of Energy
DOI	Department of the Interior
DP	Delta Prime
EPA	Environmental Protection Agency
EPT	ephemeroptera, plecoptera, and trichoptera taxa
ES	emissions stack
HE	high explosives
HMX	octahydro-1357-tetranitro-1357-tetrazocine
IAEA	International Atomic Energy Agency
LAMPF	Meson Physics Facility
LANL	Los Alamos National Laboratory
LANSCE	Los Alamos Neutron Science Center
MDA	material disposal area
MEK	methyl ethyl ketone
MOA	memorandum of agreement
MSL	Materials Science Laboratory
NCP	National Contingency Plan
NES	Nuclear Environmental Site
NFA	no further action
NMED	New Mexico Environment Department

NMSA	New Mexico Statutes Annotated
NPDES	National Pollutant Discharge Elimination System
NPS	National Park Service
NRDA	Natural Resource Damage Assessment
NRDAR	Natural Resource Damage Assessment and Restoration
OPA	Oil Pollution Act of 1990
PAS	preassessment screen
PCB	polychlorinated biphenyl
PCE	perchloroethylene
PRP	Potentially Responsible Party
PRS	potential release site
RACER	Risk Analysis Communication Evaluation Reduction
RCRA	Resource Conservation and Recovery Act
RDX	hexahydro-1,3-dinitroso-1,3,5-triazine
RLWTF	Radioactive Liquid Waste Treatment Facility
SWEIS	site-wide environmental impact statement
SWMU	solid waste management unit
SWWS	Sanitary Wastewater Systems
TA	technical area
TATB	triaminotrinitrobenzene
TCA	trichlorethane
TCE	trichloroethylene
TFF	Targeted Fabrication Facility
TNT	trinitrotoluene
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
USC	United States Code
VOC	volatile organic compound

APPENDIX A

CONCENTRATIONS OF CONTAMINANTS OF CONCERN IN ENVIRONMENTAL MEDIA IN AND AROUND LOS ALAMOS NATIONAL LABORATORY

EXHIBIT A-1: CONTAMINANTS OF CONCERN IN AIR AND CORRESPONDING INJURY THRESHOLDS

CONTAMINANT	SAMPLE SIZE	MAXIMUM	MEAN	THRESHOLD	THRESHOLD DESCRIPTION	SOURCE
METALS (µg/m3)						
Arsenic	125	0.00	0.00	NA	NA	NA
Barium	244	0.11	0.02	NA	NA	NA
Beryllium	1,807	0.00069	0.00	0.01	EPA National Emission Standards for Hazardous Air Pollutants	40 CFR 61
Chromium	184	1.37	0.02	NA	NA	NA
Lead	184	1.46	0.01	1.50	EPA National Ambient Air Quality Standard	EPA 1990
Selenium	125	0.48	0.00	NA	NA	NA
ORGANICS (µg/m3)						
Trichloroethane [1,1,1-]	129	0.80	0.21	NA	NA	NA
Trichloroethene	129	0.24	0.13	NA	NA	NA
RADIONUCLIDES (aCi/m3)						
Americium-241	4,909	71,791,046.88	104,290.52	Emissions of radionuclides to the ambient air from Department of Energy facilities shall not exceed those amounts that would cause any member of the public to receive in any year an effective dose equivalent of 10 mrem/yr	National Emission Standards of Radionuclides Other than Radon from DOE Facilities	40 CFR 61
Cesium-134	3,157	60,149,261.72	174,815.48			
Cesium-137	3,159	58,208,949.22	168,830.86			
Plutonium-238	5,648	50,069.93	2.98			
Plutonium-239+ Plutonium-240	5,648	84,800.00	80.24			
Strontium-90	211	94.23	1.59			
Tritium	30,233	11,267,767,578.13	32,003,494.60			
Uranium-234	4,275	360,199.03	197.03			
Uranium-235	4,280	118,867.93	-229.43			
Uranium-238	4,279	18,905.46	-259.97			

Notes:
1. Shaded cells indicate exceedance of corresponding threshold or criteria.
2. NA = not applicable because no published injury threshold is available.
3. The original maximum concentration selected from the RACER database for lead (23.21 µg/m^3) and beryllium (0.04 µg/m^3) exceeded threshold criteria, however, the data were collected from a NMED air sampling station near a construction haul road that did not meet EPA siting criteria. The next highest maximums for lead (1.46 µg/m^3) and beryllium (0.00069 µg/m^3) were selected from the RACER database and used as final values in this PAS; neither value exceed thresholds.

EXHIBIT A-2: LANL CONTAMINANTS OF CONCERN IN SURFACE WATER BASEFLOW AND CORRESPONDING INJURY THRESHOLDS

CONTAMINANT	SAMPLE SIZE	MAXIMUM	MEAN	THRESHOLD	THRESHOLD DESCRIPTION	SOURCE
HIGH EXPLOSIVES (µg/L)						
HMX	375	198.00	15.57	330,000.00	Secondary Continuous Concentration	
RDX	375	818.00	53.65	190,000.00		
TNT	374	46.00	2.63	90,000.00	Chronic Water Quality Criterion for aquatic organisms	Talmage et al. 1999
METALS (µg/L)						
Arsenic	749	110.00	4.86	150.00	Chronic Ambient Aquatic Life Water Quality Criteria	EPA 2005
Barium	748	**6,530.00**	**220.08**	3.80	ESL-Aquatic community organisms	LANL 2008
Beryllium	782	**1,200.00**	3.54	5.30		
Chromium VI	745	**5,000.00**	**14.43**	11.00	Chronic Ambient Aquatic Life Water Quality Criteria	EPA 2005
Lead	753	**100.00**	**4.39**	2.50		
Mercury	673	**6.50**	0.08	0.77		
Selenium	623	**34.00**	3.12	5.00		
ORGANICS (µg/L)						
Aroclor-1254	415	100.00	2.04	0.01	Chronic Surface Water Quality Standard for Aquatic Life	NMED 2000
Benzo(a)pyrene	578	**96.00**	**6.16**	0.01	ESL-Aquatic community organisms	LANL 2008
Trichloroethane [1,1,1-]	533	**100.00**	3.81	62.00		
Trichloroethene	533	350.00	3.63	350.00		
RADIONUCLIDES (pCi/L)						
Americium-241	1,185	597.00	7.21	11,800.00	RESL	NMED 2000
Cesium-134	265	57.70	0.21	17,500.00		
Cesium-137	1,297	**3,130.00**	19.24	3,120.00		
Plutonium-238	1,383	216.00	0.52	11,800.00		
Plutonium-239+ Plutonium-240	1,381	1,266.00	1.57	25,400.00		
Strontium-85	183	10.75	-7.90	NA	NA	NA
Strontium-90	897	700.00	13.54	28,600.00	RESL	NMED 2000
Tritium	1,125	8,400,000.00	9,773.85	333,000,000.00		
Uranium-234	584	32.30	0.57	40,000.00		
Uranium-235	374	**96.30**	2.85	24.00	ESL-Algae	LANL 2008
Uranium-235+ Uranium-236	342	6.78	0.06	47.00		
Uranium-238	686	406.00	12.33	45,500.00	RESL	NMED 2000
OTHER (µg/L)						
Perchlorate	624	29,000.00	199.35	35,000.00	ESL-Montane shrew	LANL 2008

Notes:
1. ESL = environmental screening level.
2. RESL = radioecological screening level.
3. Shaded cells indicate exceedence of corresponding threshold or criteria.
4. NA = not applicable because no published injury threshold is available.

EXHIBIT A-3: LANL CONTAMINANTS OF CONCERN IN STORMWATER AND CORRESPONDING INJURY THRESHOLDS

CONTAMINANT	SAMPLE SIZE	MAXIMUM	MEAN	THRESHOLD	THRESHOLD DESCRIPTION	SOURCE
HIGH EXPLOSIVES (µg/L)						
HMX	373	1,100.00	17.40	330,000.00	Secondary Continuous Concentration	
RDX	364	2,970.00	31.15	190,000.00		
TNT	354	16.20	0.51	570,000.00	Acute Water Quality Criterion for aquatic organisms	Talmage et al. 1999
METALS (µg/L)						
Arsenic	2,192	**600.00**	6.01	340.00	Acute Ambient Aquatic Life Water Quality Criteria	EPA 2005
Barium	1,819	**21,900.00**	**134.54**	3.80	ESL-Aquatic community organisms	
Beryllium	1,845	**31.70**	0.95	5.30		LANL 2008
Chromium VI	2,174	**272.00**	2.57	16.00	Acute Ambient Aquatic Life Water Quality Criteria	
Lead	2,193	**600.00**	3.37	65.00		
Mercury	294	1.00	0.07	1.40		
Selenium	2,143	**130.00**	2.72	5.00	Chronic Ambient Aquatic Life Water Quality Criteria	EPA 2005
ORGANICS (µg/L)						
Aroclor-1254	750	**17.00**	**0.32**	0.01	Chronic Surface Water Quality Standard for Aquatic Life	New Mexico 2000
Benzo(a)pyrene	293	**960.00**	**11.73**	0.01	ESL-Aquatic community organisms	LANL 2008
Tetrachloroethane [1,1,1,2-]	32	5.00	1.88	NA	NA	NA
Tetrachloroethene	48	5.00	1.44	120.00	ESL-Aquatic community organisms	LANL 2008
RADIONUCLIDES (pCi/L)						
Cesium-134	635	14.00	-0.31	17,500.00	RESL	NMED 2000
Cesium-136	55	6.74	-0.87	NA	NA	NA
Cesium-137	1,675	**31,440.00**	-1.97	3,120.00	RESL	NMED 2000
Plutonium-238	2,253	685.00	3.35	11,800.00		
Plutonium-239+ Plutonium-240	2,214	775.00	9.88	25,400.00		
Strontium-85	305	73.00	-9.19	NA	NA	NA
Strontium-90	1,652	273.00	4.47	28,600.00	RESL	NMED 2000
Tritium	1,361	36,000.00	310.86	333,000,000.00		
Uranium-234	1,563	643.00	11.92	40,000.00		
Uranium-235	714	**120.00**	6.23	24.00	ESL-Algae	LANL 2008
Uranium-235+ Uranium-236	1,352	**65.50**	0.68	47.00		
Uranium-238	1,936	2,220.00	30.28	45,500.00	RESL	NMED 2000
OTHER (µg/L)						
Perchlorate	347	24.00	3.33	35,000.00	ESL-Montane shrew	LANL 2008

Notes:
1. ESL = environmental screening level.
2. RESL = radioecological screening level.
3. Shaded cells indicate exceedance of corresponding threshold or criteria.
4. NA = not applicable because no published injury threshold is available.

EXHIBIT A-4: LANL CONTAMINANT OF CONCERN IN GROUNDWATER AND CORRESPONDING INJURY THRESHOLDS

CONTAMINANT	SAMPLE SIZE	MAXIMUM	AVERAGE	THRESHOLD	THRESHOLD DESCRIPTION	SOURCE
HIGH EXPLOSIVES (µg/L)						
HMX	2,108	364.00	2.24	NA	NA	NA
RDX	2,102	264.00	4.89	NA	NA	NA
TNT	2,107	80.00	0.39	NA	NA	NA
METALS (µg/L)						
Arsenic	6,000	**1,840.00**	8.10	10.00		
Barium	5,963	**21,100.00**	216.58	2000.00		
Beryllium	5,791	**1,030.00**	3.49	4.00		
Chromium VI	6,179	**7,700.00**	16.98	100.00		
Lead	6,062	**18,500.00**	14.54	15.00		
Mercury	5,711	**200.00**	0.13	2.00		
Selenium	5,776	**957.00**	5.00	50.00	MCL	EPA 2003
ORGANICS (µg/L)						
Aroclor-1254	1,541	25.00	0.25	NA	NA	NA
Benzo(a)pyrene	2,205	**2,000.00**	**4.84**	0.20	MCL	EPA 2003
Total Petroleum Hydrocarbons Diesel Range Organics	258	542.00	87.01	NA	NA	NA
Trichloroethane[1,1,1-]	2,498	**1,400.00**	10.88	200.00	MCL	EPA 2003
Trichloroethene	2,503	350.00	3.54	NA	NA	NA
RADIONUCLIDES (pCi/L)						
Americium-241	4,574	797.00	3.57	NA	NA	NA
Cesium-134	827	56.50	0.72	NA	NA	NA
Cesium-137	4,477	3,000.00	7.92	NA	NA	NA
Plutonium-238	4,638	123.00	0.08	NA	NA	NA
Plutonium-239+Plutonium-240	4,635	34,200.00	44.07	NA	NA	NA
Strontium-85	590	72.30	-8.40	NA	NA	NA
Strontium-90	4,419	2,170.00	12.71	NA	NA	NA
Tritium	5,220	12,000,000.00	6,949.56	NA	NA	NA
Uranium-234	2,937	138.00	1.10	NA	NA	NA
Uranium-235	1,145	324.00	4.78	NA	NA	NA
Uranium-235+Uranium-236	1,829	7.79	0.07	NA	NA	NA
Uranium-238	3,280	326.00	7.88	NA	NA	NA
OTHER (µg/L)						
Perchlorate	5,153	90,000.00	62.87	NA	NA	NA

Notes:
1. MCL = maximum contaminant level.
2. Shaded cells indicate exceedance of corresponding threshold or criteria.
3. NA = not applicable because no published injury threshold is available.

EXHIBIT A-5: LANL CONTAMINANTS OF CONCERN IN SEDIMENT AND CORRESPONDING INJURY THRESHOLDS

CONTAMINANT	SAMPLE SIZE	MAXIMUM	MEAN	THRESHOLD	THRESHOLD DESCRIPTION	SOURCE
HIGH EXPLOSIVES (mg/kg [dry])						
HMX	1,627	**137,000.00**	**1,058.75**	0.47	Sediment Quality Benchmark for Sediment-Associated Organisms	Talmage et al. 1999
RDX	1,625	**29,600.00**	**213.48**	1.30		
TNT	1,623	**4,570.00**	**12.00**	9.20		
METALS (mg/kg [dry])						
Arsenic	5,311	**66.90**	2.31	9.79	Threshold Effect Concentration for benthic invertebrates	MacDonald et al. 2000
Barium	5,384	40,300.00	375.07	48.00	ESL-Aquatic community organisms	LANL 2008
Beryllium	5,245	71.00	0.57	73.00	ESL-Occult little brown myotis bat	
Chromium	5,362	**5,040.00**	18.95	43.40	Threshold Effect Concentration for benthic invertebrates	MacDonald et al. 2000
Lead	5,364	**6,960.00**	23.60	35.80		
Mercury	5,333	**272.00**	**0.37**	0.18		
Selenium	5,260	440.00	1.00	0.90	ESL-Occult little brown myotis bat	LANL 2008
ORGANICS (mg/kg [dry])						
Aroclors (Mixed)	136	**13.90**	**0.47**	0.06	Threshold Effect Concentration for benthic invertebrates	MacDonald et al. 2000
Benzo(a)pyrene	4,326	**250.00**	**0.68**	0.15		
Tetrachloroethane [1,1,1,2-]	1,373	0.10	0.00	NA	NA	NA
Total Petroleum Hydrocarbons Diesel Range Organics	506	18,000.00	359.12	NA	NA	NA
Total Petroleum Hydrocarbons Gasoline Range Org.	120	2,000.00	67.11	NA	NA	NA
Trichloroethene	1,431	0.10	0.00	1.60	ESL-Aquatic community organisms	LANL 2008
RADIONUCLIDES (pCi/g [dry])						
Americium-241	6,817	**750.00**	2.91	71.00	RESL	NMED 2000
Cesium-134	2,550	1.95	0.03	234.00		
Cesium-137	5,551	**2,530.00**	10.98	1,370.00		
Plutonium-238	6,212	**338.34**	1.16	71.11		
Plutonium-239+ Plutonium-240	6,173	**1,360.00**	5.40	95.47		
Strontium-85	1,863	0.56	-7.26	NA	NA	NA
Strontium-90	4,417	273.00	1.80	737.44	RESL	NMED 2000
Tritium	2,366	224.55	0.93	28,100.00		
Uranium-234	2,695	**63.20**	1.50	32.45		
Uranium-235	4,689	5.00	0.15	33.51		
Uranium-235/ Uranium-236	58	0.17	0.05	NA	NA	NA
Uranium-235+ Uranium-236	767	0.41	0.07	68.42	RESL	NMED 2000
Uranium-238	3,296	**51.50**	2.00	34.98		
OTHER (mg/kg [dry])						
Perchlorate	658	67.30	1.16	NA	NA	NA

Notes:
1. ESL = environmental screening level.
2. RESL = radioecological screening level.
3. Shaded cells indicate exceedance of corresponding threshold or criteria.
4. NA = not applicable because no published injury threshold is available.

EXHIBIT A-6: LANL CONTAMINANTS OF CONCERN IN SOIL AND CORRESPONDING INJURY THRESHOLDS

CONTAMINANT	SAMPLE SIZE	MAXIMUM	MEAN	THRESHOLD	THRESHOLD DESCRIPTION	SOURCE
HIGH EXPLOSIVES (mg/kg [dry])						
HMX	5,405	**70,900.00**	**99.23**	27.00	ESL-Deer mouse	LANL 2008
RDX	5,376	**118,000.00**	**159.84**	100.00	Screening Benchmark for terrestrial plants	Talmage et al. 1999
TNT	5,353	**102,000.00**	**85.90**	30.00		
METALS (mg/kg [dry])						
Arsenic	19,257	**633.00**	4.20	18.00	Eco-SSL-Plants	
Barium	19,267	**110,000.00**	223.00	330.00	Eco-SSL-Soil Invertebrates	
Beryllium	18,626	**472.00**	0.90	21.00	Eco-SSL-Mammalian Wildlife	
Chromium	19,359	**14,100.00**	14.92	130.00	Eco-SSL-Mammalian Wildlife	
Lead	19,473	**132,000.00**	**72.32**	11.00	Eco-SSL-Avian Wildlife	EPA 2008a
Mercury	16,367	**50,110.00**	**4.21**	0.01	ESL-American robin	LANL 2008
Selenium	18,989	**18,000.00**	**9.65**	0.52	Eco-SSL-Plants	EPA 2008a
ORGANICS (mg/kg [dry])						
Aroclor-1254	5,357	**435.00**	**0.51**	0.04	ESL-American robin	
Benzo(a)pyrene	14,589	**3,800.00**	1.27	53.00	ESL-Montane shrew	LANL 2008
Total Petroleum Hydrocarbons Diesel Range Organics	961	246,000.00	1,069.48	NA	NA	NA
Total Petroleum Hydrocarbons Gasoline Range Org.	504	16,000.00	89.92	NA	NA	NA
Total Recoverable Petroleum Hydrocarbons	34	5,100.00	585.56	NA	NA	NA
Trichloroethane[1,1,1-]	7,934	**183.00**	0.09	260.00		
Trichloroethene	7,964	**5,790.00**	1.56	42.00	ESL-Montane shrew	LANL 2008
RADIONUCLIDES (pCi/g)						
Americium-241	16,736	**19,982.00**	**29.86**	9.81		
Cesium-134	4,921	14.60	0.04	169.00		
Cesium-137	11,538	**1,709.80**	3.69	254.00		
Plutonium-238	12,549	**6,929.00**	3.53	16.70		
Plutonium-239+Plutonium-240	12,438	**230,600.00**	**212.97**	30.20	RESL	NMED 2000
Strontium-85	4,347	16.00	0.03	NA	NA	NA
Strontium-90	10,769	**1,220.00**	2.59	32.50		
Tritium	11,716	**610,485.00**	125.56	16,200.00		
Uranium-234	9,073	**72,472.20**	37.79	110.00		
Uranium-235	16,132	**4,646.60**	2.61	117.00		
Uranium-238	9,035	**1,687.30**	3.06	118.00	RESL	NMED 2000
OTHER (mg/kg [dry])						
Perchlorate	5,088	31.00	0.04	NA	NA	NA

Notes:
1. ESL = environmental screening level.
2. Eco-SSL = ecological soil screening level.
3. RESL = radioecological screening level.
4. Shaded cells indicate exceedance of corresponding threshold or criteria.
5. NA = not applicable because no published injury threshold is available.

EXHIBIT A-7: LANL CONTAMINANTS OF CONCERN IN MAMMALS

CONTAMINANT	SAMPLE SIZE	MAXIMUM	MEAN
RADIONUCLIDES (pCi/g [dry] unless otherwise noted)			
Americium-241	130	0.004	0.000
Americium-243	12	0.510	0.318
Cesium-137	130	0.610	0.028
Tritium[1]	108	12500.000	545.648
Plutonium-238	130	0.009	0.000
Plutonium-239	12	0.007	0.002
Plutonium-239+Plutonium-240	118	0.002	0.000
Plutonium-242	12	0.518	0.327
Strontium-90	130	8.824	0.823
Uranium-232	12	0.575	0.351
Uranium-234	12	0.850	0.171
Uranium-235	12	0.047	0.010
Uranium-238	12	2.000	0.292

Note:
1. Tritium concentrations are in pCi/L.

EXHIBIT A-8: LANL CONTAMINANTS OF CONCERN IN FISH

CONTAMINANT	SAMPLE SIZE	MAXIMUM	MEAN
METALS (mg/kg [wet])			
Arsenic	14	0.550	0.274
Barium	14	1.900	0.464
Beryllium	14	0.100	0.086
Chromium	14	1.360	0.374
Mercury	20	0.350	0.205
Lead	14	0.870	0.148
Selenium	14	1.360	0.584
RADIONUCLIDES (pCi/g [dry] unless otherwise noted)			
Americium-241	42	0.002	0.000
Americium-243	10	0.442	0.367
Cesium-137	42	0.380	-0.011
Tritium[1]	23	1090.000	90.000
Plutonium-238	42	0.001	0.000
Plutonium-239	10	0.001	0.000
Plutonium-242	10	0.395	0.365
Strontium-90	42	0.440	0.073
Uranium-232	10	0.415	0.397
Uranium-234	10	0.150	0.066
Uranium-235	10	0.009	0.004
Uranium-238	10	0.098	0.039

Note:
1. Tritium concentrations are in pCi/L.

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