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Environmental Surveillance at Los Alamos during 1999

30th Anniversary Edition

Los Alamos
NATIONAL LABORATORY

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Cerro Grande Fire

On May 4, 2000, the National Park Service at Bandelier National Monument set a prescribed fire that subsequently burned out of control. The Cerro Grande wildfire was one of the largest in New Mexico state history and burned about 43,000 acres of forest and residential land, including about 7,500 acres of the Los Alamos National Laboratory site. The Laboratory was closed for two-and-a-half weeks, and the towns of Los Alamos and White Rock were evacuated for several days. The fire was fully contained by June 6 and declared out on July 20. One-hundred twelve Laboratory structures and 235 residential structures were either damaged or destroyed. An estimated 37 million trees were lost in the fire. The human and environmental impacts from this devastating wildfire are still being felt and evaluated.

This annual environmental report focuses on issues and impacts from Laboratory operations in 1999. Its scheduled publication date of October 1, 2000, was delayed largely by the fire and post-fire monitoring and mitigation activities. The next edition, *Environmental Surveillance at Los Alamos during 2000*, will be published in October 2001 and will include surveillance data and analyses of the fire's impacts and its aftermath.

At this time, the Laboratory is conducting an extensive environmental monitoring and sampling program to evaluate the effects of the Cerro Grande fire at the Laboratory and especially to evaluate if public and worker health and the environment were adversely impacted by the fire on Laboratory land. Just as importantly, the program will identify changes in pre-fire baseline conditions that will aid in evaluating any future impacts the Laboratory may have, especially those resulting from contaminant transport off-site.

The program involves a number of different organizations within the Laboratory, as well as coordination with outside organizations and agencies. The primary Laboratory organizations involved are the Hazardous Materials Response Group (ESH-10), the Air Quality Group (ESH-17), the Water Quality and Hydrology Group (ESH-18), the Ecology Group (ESH-20), the Integrated Geosciences Group (EES-13), the Environmental Sciences Group (EES-15), and the Environmental Restoration Project (ER). In addition, the US Department of Energy Radiological Assistance Program (USDOE/RAP) also performed environmental measurements during the Cerro Grande fire.

External organizations participating in the program include the New Mexico Environment Department (NMED), San Ildefonso Pueblo, Santa Clara Pueblo, Cochiti Pueblo, Jemez Pueblo, Los Alamos County, the US Army Corps of Engineers (USACE), the US Environmental Protection Agency (USEPA), the US Fish and Wildlife Service, the US Forest Service, the US Geological Survey (USGS), and the US Park Service (Bandelier National Monument). The Department of Energy has an Agreement-in-Principle in place with NMED that provides for independent oversight monitoring of the Laboratory's activities. The NMED DOE Oversight Bureau (NMED/DOB) performs this monitoring, which involves routine air, water, soil, and sediment sampling and measuring external radiation fields in the environment. All routine monitoring will continue, as well as NMED's special sampling to address specific concerns that the Cerro Grande fire and its aftermath raised.

Through this monitoring and sampling plan, the Laboratory will determine what special sampling is needed as a result of the fire. This special sampling will take place in addition to the extensive and ongoing Environmental Surveillance and Compliance Program the Laboratory routinely operates and maintains. Under the ongoing program, the Laboratory collects more than 11,000 environmental samples each year from more than 450 sampling stations in and around the Laboratory. Many of these sampling and measurement activities are included in this document.

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Environmental Surveillance Program:

Air Quality (Group ESH-17)
505-665-8855

Water Quality and Hydrology (Group ESH-18)
505-665-0453

Hazardous and Solid Waste (Group ESH-19)
505-665-9527

Ecology (Group ESH-20)
505-665-8961

Los Alamos
NATIONAL LABORATORY
Los Alamos, New Mexico 87545

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APPENDIXES

Environmental Surveillance at Los Alamos reports are prepared annually by the Los Alamos National Laboratory (the Laboratory), Environment, Safety, and Health Division, as required by US Department of Energy Order 5400.1, *General Environmental Protection Program*, and US Department of Energy Order 231.1, *Environment, Safety, and Health Reporting*.

These annual reports summarize environmental data that comply with applicable federal, state, and local environmental laws and regulations, executive orders, and departmental policies. Additional data, beyond the minimum required, are also gathered and reported as part of the Laboratory's efforts to ensure public safety and to monitor environmental quality at and near the Laboratory.

Chapter 1 provides an overview of the Laboratory's major environmental programs. Chapter 2 reports the Laboratory's compliance status for 1999. Chapter 3 provides a summary of the maximum radiological dose a member of the public could have potentially received from Laboratory operations. The environmental data are organized by environmental media (Chapter 4, air; Chapter 5, water; and Chapter 6, soils, foodstuffs, and biota) in a format to meet the needs of a general and scientific audience. A glossary and a list of acronyms and abbreviations are in the back of the report. Appendix A explains the standards for environmental contaminants, Appendix B explains the units of measurements used in this report, and Appendix C describes the Laboratory's technical areas and their associated programs.

We've also enclosed a booklet, *Overview of Environmental Surveillance during 1999* that briefly explains important concepts, such as radiation, and provides a summary of the environmental programs, monitoring results, and regulatory compliance.

Inquiries or comments regarding these annual reports may be directed to

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This report is also available on the World Wide Web at
http://lib-www.lanl.gov/pubs/la-13775.htm

This report presents environmental data and analyses that characterize environmental performance and addresses compliance with environmental laws at Los Alamos National Laboratory (LANL or the Laboratory) during 1999. Using comparisons with standards and regulations, this report concludes that environmental effects from Laboratory operations are small and did not pose a threat to the public, Laboratory employees, or the environment in 1999.

Laboratory operations were in compliance with all environmental regulations. All newly proposed activities at the Laboratory that could impact the environment were evaluated through the National Environmental Policy Act (NEPA) to determine potential impacts. In 1999, the Laboratory sent 159 National Environmental Policy Act Environmental Review Forms to the Department of Energy (DOE) for review. A Site-Wide Environmental Impact Statement (SWEIS) and the first annual SWEIS Yearbook were completed under DOE's compliance strategy for NEPA. The Laboratory also completed an Environmental Impact Statement assessing the conveyance and transfer of certain land tracts under the administrative control of DOE within Los Alamos and Santa Fe Counties. DOE and LANL began planning and developing an Integrated Resources Management Plan in 1999 to integrate existing resource management plans and the development of other management plans with LANL site planning and mission activities.

In this report, we calculate potential radiological doses to members of the public who may be exposed to Laboratory operations. The 1999 Effective Dose Equivalent (EDE) was 0.32 mrem. We calculated this dose using EPA-approved methods for air compliance. A maximum dose considering all pathways (not just air) was 0.6 mrem (see Section 3.C.2). Health effects from radiation exposure have been observed in humans only at doses in excess of 10 rem. We conclude that the doses calculated here, which are in the mrem (one one-thousandth of a rem) or lower range, would cause no adverse human health effects. The total dose from background radiation, greater than 99% of which is from natural sources, is about 360 mrem in this area and can vary by 10 mrem from year to year.

Air surveillance at Los Alamos includes monitoring emissions, ambient air quality, direct penetrating radiation, and meteorological parameters to determine the air quality impacts of Laboratory operations. The ambient air quality in and around the Laboratory meets all Environmental Protection Agency (EPA) and DOE standards for protecting the public and workers.

During 1999, a greatly reduced run cycle at Los Alamos Neutron Science Center resulted in radioactive air emissions that were less than one-fourth of 1998 emissions. Tritium emissions doubled over 1998 emissions, primarily as a result of tritium facility deactivation work. Plutonium emissions were higher in 1999 because of increased plutonium powder operations.

We investigated several instances of elevated air concentrations in 1999 that resulted from routine Laboratory operations and, in one case, from construction activity in the Los Alamos town-site that resuspended contaminants from the original Laboratory Technical Area (TA)-1. None of these elevated air concentrations exceeded DOE or EPA protection standards for workers or the public.

An evaluation of alternate direct penetrating radiation measurement systems supports the conclusion that our thermoluminescent dosimeters overrespond by about 50% to low-energy gamma radiation; therefore, actual doses were smaller than those reported.

Sixteen gross alpha measurements and one gross beta measurement exceeded the DOE derived concentration guidelines (DCG) for public dose values in water runoff samples in 1999. The DOE DCGs for public dose are determined assuming that two liters per day of water are consumed each year. This assumption will not be met for runoff, which is present only a few days each year.

In 1998, LANL found high-explosives constituents in the regional aquifer at TA-16 in the southwest portion of the Laboratory at concentrations above the EPA Health Advisory guidance values for drinking water, although water from these wells is not used for drinking water. Continued testing of water supply wells in 1999 showed that these compounds are not present in Los Alamos County drinking water. Trace levels of tritium are present in the regional aquifer in a few areas where liquid waste discharges occurred, notably beneath Los Alamos, Pueblo, and Mortandad Canyons. The highest tritium level found in a regional aquifer test well was about 2% of the drinking water standard. Nitrate concentrations in a test well were about half the drinking water standard. In 1999, we detected no radionuclides other than naturally occurring uranium in Los Alamos County or San Ildefonso Pueblo water supply wells. Gross beta and americium-241 exceeded drinking water DCGs in alluvial groundwater samples. Alluvial groundwater is not used for drinking water. We found above background levels of plutonium and americium in sediments.

Most radionuclide concentrations in soils collected from on-site and perimeter areas were nondetectable and/or within the upper range of background concentrations. We also analyzed soils for trace elements, and most constituents, with the exception of lead in perimeter soils, were within background mean concentrations; lead concentrations, however, were well below LANL screening action levels.

We collected samples of foodstuffs and associated biota (produce, eggs, milk, fish, elk, deer, beef cattle, herbal tea, piñon, honey, and wild spinach) from Laboratory and/or surrounding perimeter areas, including several Native American Pueblo communities, to determine the impact of LANL operations on the human food chain. All radionuclides in foodstuffs and biota collected from the Laboratory and perimeter locations were low and, for the most part, were indistinguishable from worldwide fallout and/or natural sources. Plutonium-238 concentrations in produce collected from all perimeter sites, although low, were statistically higher than background concentrations and were higher than in past years.

Special studies included ecological risk assessments; organics in fish collected from the Rio Grande; depleted uranium effects on aquatic organisms; resource use, activity patterns, and disease analysis of elk; and polychlorinated biphenyl (PCB) concentrations in small mammals around the Laboratory. We also monitored reptiles, amphibians, and forest fire (fuel) risk to the Los Alamos region.

The 1999 strontium-90 data LANL collected in sediments, surface water, and groundwater are not valid because the analytical laboratory failed to properly apply the analytical technique. The data at every location for 1999 are questionable, and this represents the loss of an entire year’s monitoring data for strontium-90. We present the data in this report for documentary purposes only. If taken at face value, the 1999 strontium-90 values would indicate unusually high levels in sediments, surface water, and groundwater. LANL has resolved the analytical laboratory problems and will continue monitoring strontium-90 at all locations in 2000. In 1999, the New Mexico Environment Department (NMED) collected split samples at many wells where LANL data appeared to show unusually high strontium-90 values. NMED samples show only one detection of strontium-90, supporting our conclusion that the 1999 strontium-90 data are not valid.

1. Introduction

1. Introduction

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Abstract

This report presents environmental data that characterize environmental performance and addresses compliance with environmental standards and requirements at Los Alamos National Laboratory (LANL or the Laboratory) during 1999. The Laboratory routinely monitors for radiation and for radioactive and nonradioactive materials at Laboratory sites, as well as at sites in the surrounding region. LANL uses the monitoring results to determine compliance with appropriate standards and to identify potentially undesirable trends. This information is then used for environmental impact analyses, site planning, and annual operational improvements. The Laboratory collected data in 1999 to assess external penetrating radiation and concentrations of chemicals and radionuclides in stack emissions, ambient air, surface waters and groundwaters, the drinking water supply, soils and sediments, foodstuffs, and biota. Using comparisons with standards and regulations, this report concludes that environmental effects from Laboratory operations are small and do not pose a threat to the public, Laboratory employees, or the environment. Laboratory operations were in compliance with all environmental regulations.

Among many significant strides forward in cooperative resource management, the Pajarito Plateau Watershed Partnership was established, and the Department of Energy dedicated the White Rock Canyon Reserve.

A. Laboratory Overview

1. Introduction to Los Alamos National Laboratory

In March 1943, a small group of scientists came to Los Alamos for Project Y of the Manhattan Project. Their goal was to develop the world's first nuclear weapon. Although planners originally expected that the task would be completed by a hundred scientists, by 1945, when the first nuclear bomb was tested at Trinity Site in southern New Mexico, more than 3,000 civilian and military personnel were working at Los Alamos Laboratory. In 1947, Los Alamos Laboratory became Los Alamos Scientific Laboratory, which in turn became Los Alamos National Laboratory (LANL or the Laboratory) in 1981. The Laboratory is managed by the Regents of the University of California (UC) under a contract that is administered through the Department of Energy (DOE) Los Alamos Area Office (LAAO) and the Albuquerque Operations Office.

The Laboratory's original mission to design, develop, and test nuclear weapons has broadened and evolved as technologies, US priorities, and the world community have changed. Los Alamos National Laboratory enhances global security by

- ensuring the safety and reliability of the US nuclear weapons stockpile,
- reducing threats to US security with a focus on weapons of mass destruction,
- cleaning up the wastes created from weapons research and development during the Cold War, and
- providing technical solutions to energy, environment, health, infrastructure, and security problems (LANL 1999a).

In its Strategic Plan (1999–2004), Los Alamos National Laboratory expresses its vision as follows:

> Los Alamos National Laboratory is a key national resource for the development and integration of leading-edge science and technology to solve problems of national and global security.

The Laboratory will continue its role in defense, particularly in nuclear weapons technology, and will increasingly use its multidisciplinary capabilities to solve important civilian problems, including initiatives in the areas of health, national infrastructure, energy, education, and the environment (LANL 1999a).

2. Geographic Setting

The Laboratory and the associated residential and commercial areas of Los Alamos and White Rock are located in Los Alamos County, in north-central New Mexico, approximately 60 miles north-northeast of Albuquerque and 25 miles northwest of Santa Fe (Figure 1-1). The 43-square-mile Laboratory is situated on the Pajarito Plateau, which consists of a series of finger-like mesas separated by deep east-to-west oriented canyons cut by intermittent streams. Mesa tops range in elevation from approximately 7,800 feet on the flanks of the Jemez Mountains to about 6,200 feet above the Rio Grande Canyon.

Most Laboratory and community developments are confined to mesa tops. The surrounding land is largely undeveloped, and large tracts of land north, west, and south of the Laboratory site are held by the Santa Fe National Forest, Bureau of Land Management, Bandelier National Monument, General Services Administration, and Los Alamos County. San Ildefonso Pueblo borders the Laboratory to the east.

The Laboratory is divided into technical areas (TAs) that are used for building sites, experimental areas, support facilities, roads, and utility rights-of-way (see Appendix C and Figure 1-2). However, these uses account for only a small part of the total land area; much land provides buffer areas for security and safety and is held in reserve for future use.

3. Geology and Hydrology

The Laboratory lies at the western boundary of the Rio Grande Rift, a major North American tectonic feature. Three major local faults constitute the modern rift boundary, and each is potentially seismogenic. Recent studies indicate that the seismic surface rupture hazard associated with these faults is localized (Gardner et al., 1999). Most of the finger-like mesas in the Los Alamos area (Figure 1-3) are formed from Bandelier Tuff, which includes ash fall, ash fall pumice, and rhyolite tuff. The tuff is more than 1,000 feet thick in the western part of the plateau and thins to about 260 feet eastward above the Rio Grande. It was deposited by major eruptions in the Jemez Mountains' volcanic center about 1.2 to 1.6 million years ago.

On the western part of the Pajarito Plateau, the Bandelier Tuff overlaps onto the Tschicoma Formation, which consists of older volcanics that form the Jemez Mountains. The tuff is underlain by the conglomerate of the Puye Formation in the central plateau and near the Rio Grande. The Cerros del Rio Basalts interfinger with the conglomerate along the river. These formations overlie the sediments of the Santa Fe Group, which extend across the Rio Grande Valley and are more than 3,300 feet thick.

Surface water in the Los Alamos area occurs primarily as short-lived or intermittent reaches of streams. Perennial springs on the flanks of the Jemez Mountains supply base flow into upper reaches of some canyons, but the volume is insufficient to maintain surface flows across the Laboratory site before they are depleted by evaporation, transpiration, and infiltration.

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

The regional aquifer of the Los Alamos area is the only aquifer in the area capable of serving as a municipal water supply. Water in the regional aquifer is under artesian conditions under the eastern part of the Pajarito Plateau near the Rio Grande (Purtymun and Johansen 1974). The source of most recharge to the aquifer appears to be infiltration of precipitation that falls on the Jemez Mountains. The regional aquifer discharges into the Rio Grande through springs in White Rock Canyon. The 11.5-mile reach of the river in White Rock Canyon between Otowi Bridge and the mouth of Rito de los Frijoles receives an estimated 4,300 to 5,500 acre-feet annually from the aquifer.

4. Ecology and Cultural Resources

The Pajarito Plateau is a biologically diverse and archaeologically rich area. This diversity is illustrated by the presence of over 900 species of vascular plants; 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). No fish species have been found within LANL boundaries. Roughly 20 plant and animal species are designated as

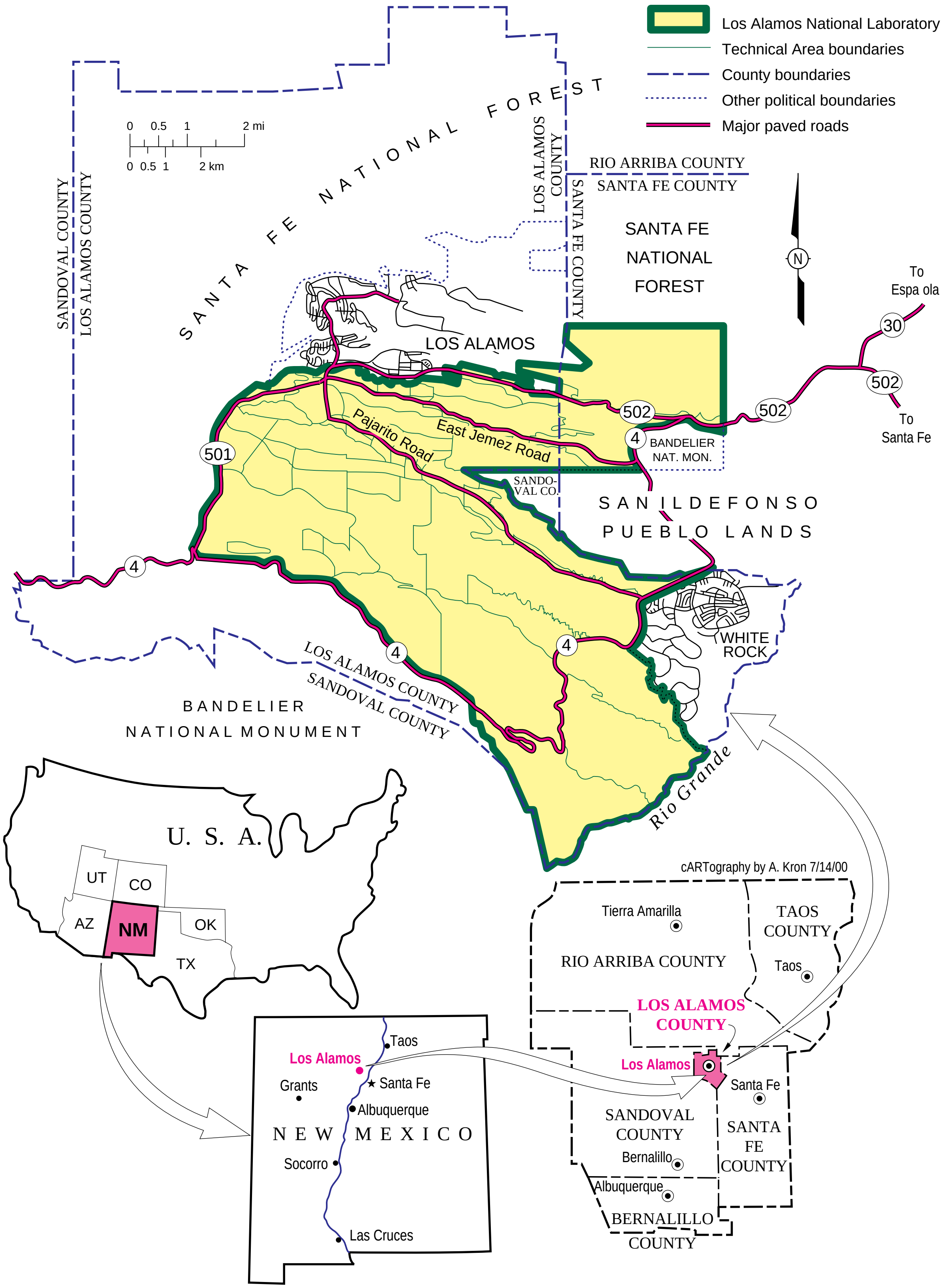

Figure 1-1. Regional location of Los Alamos National Laboratory.

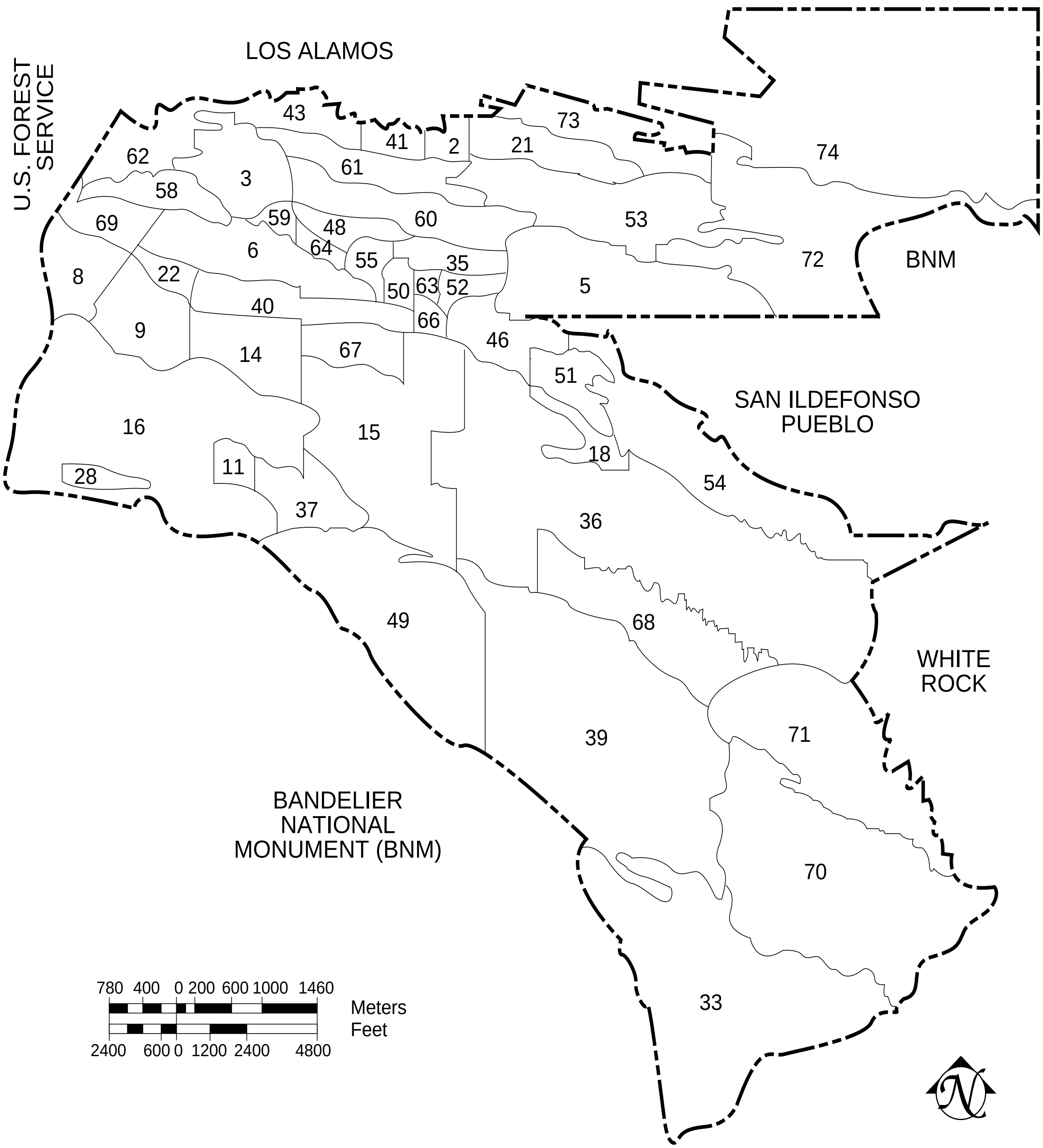

Figure 1-2. Technical Areas of Los Alamos National Laboratory in relation to surrounding landholdings.

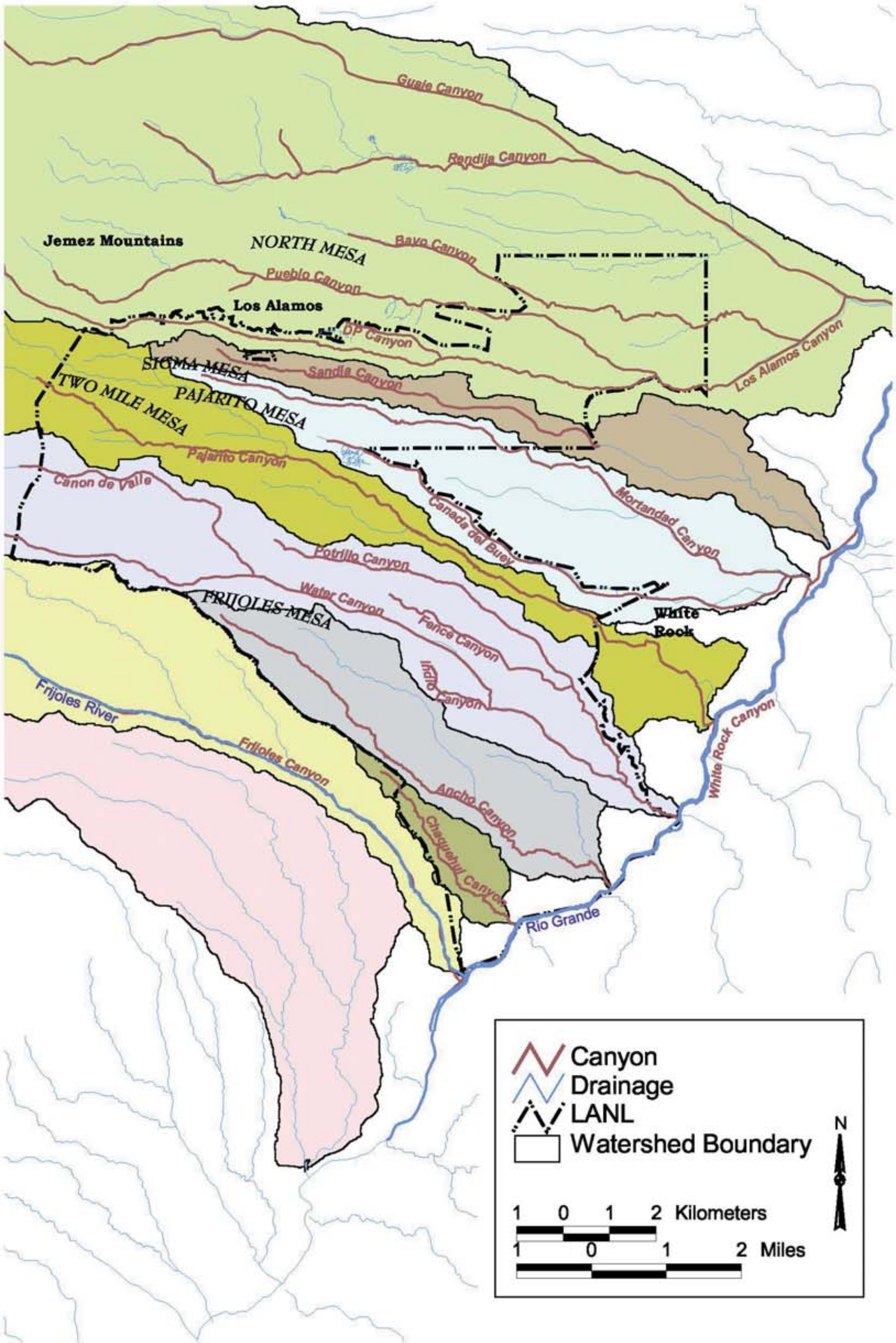

Figure 1-3. Major canyons and mesas.

threatened species, endangered species, or species of concern at the federal and/or state level.

Approximately 70% of DOE land in Los Alamos County has been surveyed for prehistoric and historic cultural resources, and about 1,550 sites have been recorded. More than 85% of the ruins date from the 14th and 15th centuries. Most of the sites are found in the piñon-juniper vegetation zone, with 80% lying between 5,800 and 7,100 feet in elevation. Almost three-quarters of all ruins are found on mesa tops. Buildings and structures from the Manhatten Project and the early Cold War period (1943–1963) are being evaluated for eligibility to the Natural Register of Historic Places.

B. Management of Environment, Safety, and Health

1. Introduction

The Laboratory's environmental, safety, and health (ES&H) goal is to accomplish its mission cost effectively, while striving for an injury-free workplace, protecting worker and public health, minimizing waste streams, and avoiding unnecessary adverse impacts to the environment from its operations.

2. Integrated Safety Management

Throughout the Laboratory, the goal of Integrated Safety Management (ISM) is the systematic integration of ES&H into work practices at all levels. Safety and environmental responsibility involve every worker. Management of ES&H functions and activities is an integral, visible part of the Laboratory's work-planning and work-execution processes.

In 1998, the Laboratory Director issued an ES&H policy that stated that "safety is first at LANL." One of the "six zeroes" adopted under Director Browne is "zero environmental incidents." ISM is the Laboratory's management system for performing work safely and for protecting employees, the public, and the environment. The term "integrated" indicates that the safety management system is a normal and natural element in performing the work; safety isn't a workplace addition, it is how the Laboratory does business.

The ISM system provides the framework for an environmental management system with the following objectives (LANL 1999b):

- conduct Laboratory operations in full compliance with all environmental laws and regulations;
- prevent adverse environmental impacts and enhance environmental protection; and
- adopt proactive approaches to achieve environmental excellence. For example, it is better to minimize waste generation, wastewater discharges, air emissions, ecological impacts, and cultural impacts than to have to cleanup problems.

3. Environment, Safety, & Health Division

The Environment, Safety, & Health (ESH) Division is primarily a Laboratory support organization that provides a broad range of technical expertise and assistance in areas such as worker health and safety, environmental protection, facility safety, nuclear safety, hazardous materials response, ES&H training, occurrence investigation and lessons learned, and quality. ESH Division is in charge of performing environmental monitoring, surveillance, and compliance activities to help ensure that Laboratory operations do not adversely affect human health and safety or the environment. The Laboratory conforms to applicable environmental regulatory requirements and reporting requirements of DOE Orders 5400.1 (DOE 1988), 5400.5 (DOE 1990), and 231.1 (DOE 1995).

ESH Division has responsibility and authority for serving as the central point of institutional contact, coordination, and support for interfaces with ESH regulators, stakeholders, and the public, including the DOE, the Defense Nuclear Facilities Safety Board, the New Mexico Environmental Department (NMED), and the Environmental Protection Agency (EPA). ESH Division provides line managers with assistance in preparing and completing environmental documentation such as reports required by the National Environmental Policy Act (NEPA) of 1969 and the federal Resource Conservation and Recovery Act (RCRA) and its state counterpart, the New Mexico Hazardous Waste Act (HWA), as documented in Chapter 2 of this report. With assistance from Laboratory Counsel, ESH Division helps to define and recommend Laboratory policies for applicable federal and state environmental regulations and laws and DOE orders and directives. ESH Division is responsible for communicating environmental policies to Laboratory employees and makes appropriate environmental training programs available. The environmental surveillance program resides in four groups in ESH Division—Air Quality (ESH-17), Water Quality and Hydrology (ESH-18), Hazardous and Solid Waste (ESH-19), and Ecology (ESH-20)—that initiate and promote Laboratory programs for environmental assessment and are responsible for environmental surveillance and regulatory compliance.

The Laboratory uses approximately 600 sampling locations for routine environmental monitoring. The maps in this report present the general location of monitoring stations. For 1999, over 250,000 analyses for chemical and radiochemical constituents were performed on more than 12,000 environmental samples. Samples of air particles and gases, water, soils, sediments, foodstuffs, and associated biota are routinely collected at monitoring stations and then analyzed. The results of these analyses help identify impacts of LANL operations on the environment. ESH personnel collect and analyze additional samples to obtain information about particular events, such as major surface water runoff events, nonroutine releases, or special studies. See Chapters 2, 3, 4, 5, and 6 of this report for methods and procedures for acquiring, analyzing, and recording data. Appendix A presents information about environmental standards.

a. Air Quality. ESH-17 personnel assist Laboratory organizations in their efforts to comply with federal and state air quality regulations. ESH-17 personnel report on the Laboratory's compliance with the air quality standards and regulations discussed in Chapter 2 and conduct various environmental surveillance programs to evaluate the potential impact of Laboratory emissions on the local environment and public health. These programs include measuring direct penetrating radiation, meteorological conditions, and stack emissions and sampling for ambient air contaminants. Chapter 4 contains a detailed exploration of the methodologies and results of the ESH-17 air monitoring and surveillance program for 1999. Personnel from ESH-17 monitor meteorological conditions to assess the transport of contaminants in airborne emissions to the environment and to aid in forecasting local weather conditions. Chapter 4 summarizes meteorological conditions during 1999 and provides a climatological overview of the Pajarito Plateau.

Dose Assessment. ESH-17 personnel calculate the radiation dose assessment described in Chapter 3, including the methodology and assessments for specific pathways to the public.

b. Water Quality and Hydrology. ESH-18 personnel provide environmental monitoring activities to demonstrate regulatory compliance and to help ensure that Laboratory operations do not adversely affect public health or the environment.

ESH-18 provides technical and regulatory support for the Laboratory to achieve compliance with the following major state and federal regulations: Clean Water Act, National Pollutant Discharge Elimination System (NPDES), and Section 404/401 Dredge and Fill Permitting; Safe Drinking Water Act; New Mexico Drinking Water Regulations; New Mexico Water Quality Control Commission Regulations; Federal Insecticide, Fungicide, and Rodenticide Act; and New Mexico Pesticide Control Act. Surveillance programs and activities include groundwater, surface water, and sediments monitoring; water supply reporting for Los Alamos County; and the Groundwater Protection Management Program. Chapter 2 contains documentation on the Laboratory's compliance status with water quality regulations. Chapter 5 summarizes the data ESH-18 personnel collected and analyzed during routine monitoring.

c. Hazardous and Solid Waste. ESH-19 personnel provide services in developing and monitoring permits under hazardous and solid waste rules, RCRA/HWA, Solid Waste Act (SWA), and letters of authorization for landfilling polychlorinated biphenyls (PCB) solids contaminated with radionuclides under the Toxic Substances Control Act (TSCA); providing technical support, regulatory interpretation, and Laboratory policy on hazardous, toxic, and solid waste issues and underground storage tank regulations to Laboratory customers; and documenting conditions at past waste sites. Chapter 2 presents the Laboratory's compliance status with hazardous and solid waste regulations.

d. Ecology. Personnel in ESH-20 investigate and document biological and cultural resources within the Laboratory boundaries; prepare environmental reports, including Environmental Assessments required under NEPA; and monitor the environmental impact of Laboratory operations on soil, foodstuffs, and associated biota. Chapter 2 documents the 1999 work in the areas of NEPA reviews and biological and archaeological reviews of proposed projects at the Laboratory. Chapter 6 contains information on the results and trends of the soil, foodstuff, and biota monitoring programs and related research and development activities.

e. Site-Wide Environmental Impact Statement Project Office. The Site-Wide Environmental Impact Statement (SWEIS) Project Office was established in October 1994 to provide a single point-of-contact to support DOE and its contractor in the agency's preparation of a SWEIS for the Laboratory. Although work began in 1995, the major accomplishments were primarily in 1997, 1998, and 1999. The effort culminated with the issuance of a final SWEIS in January 1999, a Record of Decision in September 1999, and a Mitigation Action Plan in October 1999.

In 1999, the SWEIS Project Office was renamed the Site-Wide Issues Program Office (SWIPO). The SWIPO functions as the land transfer (see Section 1.B.5 for more information) point-of-contact for LANL. During 1999, the SWIPO developed the initial scenarios, costs, and schedules for cleaning up and transferring all 10 tracts of land within the time frame allocated by Congress. In addition, SWIPO outlined each major step DOE would have to accomplish and provided input to all major deliverables required under Public Law 105-119.

4. Environmental Management Program

a. Waste Management. Waste management activities focus on minimizing the adverse effects of chemical and radioactive wastes on the environment, maintaining compliance with regulations and permits, and ensuring that wastes are managed safely. Wastes generated at the Laboratory are divided into categories based on the radioactive and chemical content. No high-level radioactive wastes are generated at the Laboratory. Major categories of waste managed at the Laboratory are low-level radioactive waste, transuranic (TRU) waste, hazardous waste, mixed low-level waste, and radioactive liquid waste.

The Waste Management Program has made significant accomplishments in several areas, including mixed low-level waste work-off, retrieval of TRU waste from earth-covered storage, and TRU waste characterization, certification, and shipment.

Mixed Low-Level Waste Work-Off. In 1994, LANL had the equivalent of about 3,000 55-gallon drums of mixed low-level waste (waste that is both hazardous and radioactive) in storage because no capability existed at either LANL or other locations in the United States for proper treatment and disposal of the waste. At that time, NMED approved a plan called the Mixed Waste Site Treatment Plan for development and operation of treatment technologies and facilities at LANL. The original estimate called for completing the treatment and disposal of the mixed low-level waste in storage in 2006.

In cooperation with DOE/LAAO, a team worked to evaluate ways to reduce costs and accelerate the schedule. The team identified new treatment capabilities that were being developed commercially and at other DOE sites, and decisions were made to use those capabilities rather than to continue with new facilities at LANL. NMED also approved these efforts. In addition, efforts began to perform extensive characterization of waste that was only suspected of being both hazardous and radioactive. More than 75% of the mixed low-level waste in storage at LANL since 1994 has been treated and disposed of, and it is expected that this task will be completed three years earlier than originally projected, with about $14 million in cost savings.

Transuranic Waste Inspectable Storage Project. The Transuranic Waste Inspectable Storage Project (TWISP) has been established to retrieve 187 fiberglass-reinforced plywood crates and 16,641 metal drums containing solid-form, TRU waste from three earth-covered storage pads. This waste is being retrieved under a compliance order from NMED because it was not possible to inspect the waste as required by the state hazardous waste regulations. After the waste is retrieved, any damaged containers are over-packed in new containers. The containers are vented and have high-efficiency particulate air (HEPA) filters installed in drum lids. The waste is then placed in structures that can be inspected.

After several years of preparation, DOE granted start-up authority for TWISP in March 1997. Retrieval operations have been completed on the first two waste storage pads. We now expect to complete the project one to two years ahead of schedule, which will result in cost savings of about $12 million. The skills employed, technology used, and lessons learned will also assist other DOE sites in planning and performing similar projects.

Transuranic Waste Characterization, Certification, and Shipment. TRU waste must be characterized and certified to meet the Waste Acceptance Criteria at the Waste Isolation Pilot Plant (WIPP) in Carlsbad, New Mexico. LANL was the first DOE site to be granted authorization from DOE to certify TRU waste in September 1997. Activities for characterization and certification of TRU waste have begun, and LANL made the first shipment of TRU waste to WIPP in March 1999. During 1999, LANL completed 17 shipments to WIPP.

b. Pollution Prevention. The Laboratory's Environmental Stewardship Office (ESO) manages the Laboratory's pollution prevention program. Section 2.B.1.i provides specific waste minimization accomplishments. See Section 2.E.3 for descriptions of successful pollution prevention projects. Other waste management activities that reduce waste generation include the following:

- Continuing financial incentives for waste reduction and innovative pollution prevention ideas and accomplishments such as the annual Pollution Prevention Awards and Generator Set Aside Fee funding;
- Developing databases to track waste generation and pollution prevention/recycling projects;
- Providing pollution prevention expertise to Laboratory organizations in source reduction, material substitution, internal recycle/reuse, lifetime extension, segregation, external recycle/reuse, volume reduction, and treatment; and
- Providing guidance to divisions within the Laboratory for minimizing waste and pollution through application of the Green Zia tools. Green Zia is a pollution prevention program administered by NMED.

In 1999, the ESO published *The Los Alamos National Laboratory 1999 Environmental Stewardship Roadmap*, in accordance with the Hazardous and Solid Waste Amendments Module VIII of the RCRA Hazardous Waste Permit and 40 CFR 264.73. This document is available at *http://eso.lanl.gov/info/publications/default.htm* on the World Wide Web.

One of the six Laboratory excellence goals has an environmental focus: zero environmental incidents. The roadmap document describes the Laboratory's current operations and the improvements that will eliminate the sources of environmental incidents.

The stewardship solution for zero incidents is to eliminate the incident source. This goal is being accomplished by continuously improving operations to achieve

- zero waste,
- zero pollutants released,
- zero natural resources wasted, and
- zero natural resources damaged.

c. Environmental Restoration Project. The Environmental Restoration (ER) Project at the Laboratory complements the Laboratory's environmental surveillance program by identifying and characterizing potential threats to human health, the area's ecology, and the environment from past Laboratory operations. The ER Project's mission is to mitigate those threats, where necessary, through cleanup actions that comply with applicable environmental regulations. Cleanup actions may include covering and containing a source of contamination to prevent its spread, placing controls on future land use, and excavating and/or treating the contamination source. Often these sources are places where wastes were improperly disposed in the past or where the disposal practices of the past would not meet the standards of today. As a result, contamination may have spilled or leaked into the environment from such places (called potential release sites or PRSs) over time, with the possibility of causing hazards to human health and/or the environment. The ER Project then must confirm or deny the existence of these hazards.

The ER Project reorganized its activities during 1999 according to the natural watersheds across the Laboratory in which the various PRSs are located. Each watershed is made up of one or more pieces (called aggregates), each containing several PRSs that will be investigated, assessed, and remediated (if necessary) as a group. This watershed approach ensures that drinking water sources and sensitive natural resources will be protected as it accounts for potential cumulative impacts of multiple contaminant sources located on mesa tops and slopes.

An exposure scenario serves as the basis for assessing a site for potential risk to human health and defines the pathways by which receptors are exposed. A human health exposure scenario is determined by the current and future land use of the site. Standard land-use scenarios the ER Project uses to determine exposure to human health receptors include

- residential,
- industrial,
- recreational, and
- resource user.

Mirenda and Soholt (1999) fully describe standard land-use scenarios. The Laboratory Site Development Plan (LANL 1995) is used to determine which Laboratory lands fall into the industrial and recreational categories of land use, both currently and in the future. Industrial land use affects Laboratory workers and is prescribed by the 30-year planning horizon for the Laboratory's mission and the continued operation of present-day facilities. Buffer zone land use may affect recreational users and is based on present and future access to Laboratory property, as prescribed in the Laboratory's Site Development Plan.

The ER Project is also in the process of developing a set of pathways that would appropriately describe how members of neighboring pueblos use Laboratory lands and environs.

The ER Project makes cleanup decisions on the basis of ecological risks and risks to the environment, in addition to human-health risks. While human-health risk can be evaluated over a relatively small area, ecological risk assessment requires an understanding of the nature and extent of contamination across much larger areas. Decisions that are protective of water resources in general also require an understanding of the presence and movement of contamination within an entire watershed.

The ER Project at the Laboratory is structured primarily according to the requirements of the Hazardous and Solid Waste Amendments to RCRA, which refer to these cleanup activities as "corrective actions." Module VIII of the Laboratory's Hazardous Waste Facility Permit contains the corrective action provisions. The EPA and NMED regulate the Laboratory's corrective action program under RCRA. In addition, the Comprehensive Environmental Response, Compensation, and Liability Act specifies requirements for cleaning up sites that contain certain hazardous substances not covered by RCRA and for identifying and reporting historical contamination when federal agencies such as DOE transfer surplus property to other agencies or the public. DOE has oversight for those PRSs at the Laboratory that are not subject to RCRA and for the Laboratory's decommissioning program for surplus buildings and facilities. Additional information about the ER Project and the new watershed approach is presented at *http://erproject.lanl.gov* on the World Wide Web. See Chapter 2 for summaries of ER Project activities performed in 1999.

5. Land Conveyance and Transfer under Public Law 105-119

On November 26, 1997, Congress passed Public Law 105-119. Section 632 of the Act directed the Secretary of Energy to identify parcels of land at or near the Laboratory for conveyance and transfer to one of two entities: either Los Alamos County or the Secretary of the Interior (to be held in trust for San Ildefonso Pueblo). Pursuant to this legislation, DOE determined that an Environmental Impact Statement (EIS) would be required under NEPA to satisfy the requirements for review of environmental impacts of the conveyance or transfer of each of the ten tracts of land (4,800 acres) slated for transfer. DOE may retain portions of other tracts because of current or future national security mission needs or the inability to complete restoration and remediation for the intended use within the time frame prescribed in the Act. The Final Conveyance and Transfer (CT) EIS is dated October 1999 (DOE 1999).

Public Law 105-119 also required DOE to evaluate those environmental restoration activities that would be required to support land conveyance and transfer and to identify how this cleanup could be achieved within the ten-year window established by law. The resultant report, the *Environmental Restoration Report to Support Land Conveyance and Transfer under Public Law 105-119*, was dated August 1999. In addition, Congress required DOE to issue a Combined Data Report that summarized the material contained in the CT EIS and Environmental Restoration Report. The Combined Data Report to Congress was released in January 2000, and the official notification that these documents were available from the EPA appeared in February 2000.

6. Cooperative Resource Management

Interagency Wildfire Management Team. The Interagency Wildfire Management Team continues to be a vehicle for addressing wildfire issues of mutual concern to the regional land management agencies. The team collaborates in public outreach activities, establishes lines of authority to go into place during a wildfire, provides cross-disciplinary training, and shares the expertise that is available from agency to agency. The result of this collaboration has been an increased coordination of management activities between agencies and a heightened response capability in wildfire situations. In addition to DOE and UC/LANL, regular participants of the Interagency Wildfire Management Team include representatives of the Los Alamos County Fire Department, Santa Fe National Forest, Bandelier National Monument, San Ildefonso Pueblo, NM State Forester's Office, and NMED Oversight Bureau.

During 1999, under a Memorandum of Understanding between DOE/LAAO and the National Park Service, Bandelier National Monument constructed a

2,500-square-foot building at TA-49. Bandelier uses this building as a cache for storing fire tools and equipment as well as for stationing fire personnel and Bandelier fire engines. UC/LANL constructed a helipad close to the building to provide helicopter support during a fire or other emergency. The helipad contains an area for the setup of a 5,000-gallon storage tank. The fire cache and helipad were opened for use in a multiagency dedication ceremony on December 7, 1999.

East Jemez Resource Council. In 1999, the East Jemez Resource Council remains a highly effective means of improving interagency communication and cooperation in the management of resources on a regional basis. The council established the Cultural Resources and the LANL Biological Resources Working Groups. These council working groups give resource specialists a forum for a more detailed and technical assessment of resource-specific issues and solutions. The working groups report on progress and issues during the quarterly council meetings. The council is also providing a forum for soliciting regional agency and stakeholder input during the development of the LANL Biological Resources Management Plan, Ecological Risk Assessment Project, and the Comprehensive Site Plan. Council participants include Bandelier National Monument, Santa Fe National Forest, NMED, New Mexico State Forestry Division, US Fish and Wildlife Service, NM Department of Game and Fish, San Ildefonso Pueblo, Santa Clara Pueblo, Cochiti Pueblo, DOE, and UC/LANL.

Cochiti Lake Ecological Resources Team. In 1999, the Cochiti Lake Ecological Resources Team completed a final Memorandum of Understanding between the US Army Corps of Engineers, Bandelier National Monument, DOE/LAAO, US Geological Survey, US Fish and Wildlife Service, NM Game and Fish, Cochiti Pueblo, US Forest Service, and UC/LANL. The Cochiti Lake Ecological Resources Team assisted the US Army Corps of Engineers in evaluating the role Cochiti Lake may play in the protection of the Rio Grande silvery minnow. The team serves as an interagency forum for discussing issues pertaining to the status or management of physical, biological, and recreational resources in the vicinity of Cochiti Lake and White Rock Canyon.

White Rock Canyon Reserve. In late July 1999, Secretary of Energy Richardson tasked the DOE Albuquerque Field Office and LAAO to assess New Mexico lands DOE administers to determine what land might be suitable for designation and use as a wildlife reserve. The Reserve's objective is to conserve, protect, and enhance the habitat for the plants and animals that inhabit the site or use the site intermittently. Using a specific set of mission and environmental criteria, DOE and UC/LANL selected a portion of White Rock Canyon that consists of approximately 1,000 acres in the eastern portion of LANL along the Rio Grande and adjacent to Bandelier National Monument and Santa Fe National Forest lands. The area is relatively remote and biologically diverse and contains threatened or endangered species habitat as well as a variety of cultural resources. Secretary Richardson officially dedicated the White Rock Canyon Reserve on October 30, 1999. Bandelier National Monument will manage the reserve with programmatic and technical assistance from DOE and UC/LANL.

Pajarito Plateau Watershed Partnership. In 1999, regional landowners and managers with a common interest in the quality of water in north central New Mexico's Pajarito Plateau Watershed established the Pajarito Plateau Watershed Partnership. The partnership's mission is to work together to protect, improve, and/or restore the quality of water in the Pajarito Plateau Watershed. Toward this end, the partnership is preparing a multiagency program and plan to identify and resolve the primary regulatory and stakeholder issues affecting water quality in the watershed. Partnership members include Bandelier National Monument, San Ildefonso Pueblo, Santa Clara Pueblo, Los Alamos County, NMED, Santa Fe National Forest, DOE, and UC/LANL.

7. Community Involvement

The Laboratory continues to encourage public access to information about environmental conditions and the environmental impact of operations at the Laboratory. Although the Community Relations Office has the responsibility to help coordinate activities between the Laboratory and northern New Mexico, many organizations at the Laboratory are actively working with the public. Frequently, the subject of these interactions is related to environmental issues because of the Laboratory's potential impact on local environment, safety, and health.

Some examples of how the Laboratory distributes and makes environmental information available to the public are listed below.

Outreach Centers

During 1999, the Community Relations Office operated outreach centers in Los Alamos (505-665-4400), Española (505-753-3682), and Santa Fe (505-

982-3771). The Los Alamos center includes a reading room with access to Laboratory documents. Approximately 200 people visited the reading room last year. Access to environmental information is available at all the outreach centers.

Environmental Restoration Project's Communications and Outreach Team

The Communications and Outreach Team of the ER Project works actively with the public. The team coordinates public involvement activities such as public meetings, tours, media, and general outreach activities for issues concerning the ER Project and the CT EIS. In 1999, the team produced a Web site on the ER Project—*http://erproject.lanl.gov* on the World Wide Web.

Bradbury Science Museum

Because many of the Laboratory's facilities are not accessible to the public, the Bradbury Science Museum provides a way for the public to learn about the kinds of work the Laboratory does, whether it is showing how lasers assess air pollution or demonstrating ecology concepts. In 1999, the museum hosted approximately 103,000 visitors.

Inquiries

In 1999, the Community Relations Office—with the assistance of a wide variety of Laboratory organizations—responded to more than 400 public inquiries, many of which had an environmental theme. These inquiries came to the Community Relations Office by letter, phone, fax, e-mail, and personal visits.

To learn more about the Community Relations Office and the Laboratory's community involvement efforts, you can read the Community Relations Office Annual Report at http://www.lanl.gov/orgs/cr/final.pdf on the World Wide Web.

8. Public Meetings

The Laboratory holds public meetings to inform residents of surrounding communities about environmental activities and operations at the Laboratory. During 1999, the Laboratory held three public meetings as part of a continuing series called the "Community Environmental Meetings." The first of these meetings, titled "Environmental Monitoring," was held in April 1999 in Española. A second meeting, "High-Explosives Contamination in the Groundwater," took place in June 1999. The third meeting, "Cancer Trends in Los Alamos," was held in Los Alamos in July 1999.

The ER Project also sponsored public meetings during 1999. Topics included quarterly status reports on the progress of the program groundwater monitoring and wells, water quality, the CT EIS, contaminants found in Acid Canyon, and contaminants found at Area P.

In addition, the ER Project began a series of Availability Sessions in December 1999. These sessions take place once a month, and DOE and ER Project staff discuss current project issues and activities with the public in an informal one-on-one setting.

During 1999, the ER Project conducted or coordinated 30 tours of Laboratory facilities and sites for DOE, EPA, and NMED regulators, the Citizens' Advisory Board (CAB), and tribal and local governments and environmental staffs.

9. Tribal Interactions

During 1999, executive and staff meetings were held with Cochiti Pueblo, Jemez Pueblo, San Ildefonso Pueblo, Santa Clara Pueblo, and DOE and Laboratory personnel. Subjects for the meetings included DOE-funded environmental programs, environmental restoration, environmental surveillance, cultural resource protection, emergency response, and other environmental issues.

The Laboratory's Tribal Relations Team continues to work with tribes on hazardous material shipment through pueblo lands. Technical assistance was provided for development of emergency management plans and improvement of procedures for incident notification. Additional interactions included

- a briefing and tour for tribal officials on the R-25 well, where traces of high explosives were found in deep groundwater;
- a briefing and tour of the Dual Axis Radiographic Hydrodynamic Test (DARHT) facility because of the tribes' concern about impacts from the facility on pueblo lands, adjacent areas, and local cultural resource sites; and
- preliminary work with tribal environmental staff on a formal initiative with the four Accord tribes to develop risk assessment approaches to appropriately evaluate human-health risks that might occur as a result of traditional cultural use of their lands and resources.

The ER Project conducted monthly meetings with tribal officials to discuss topics of mutual concern:

land conveyance and transfer; risk assessment techniques and specifically the Native American Risk Scenario human-health risk assessment technique; and the reorganization of the ER Project with its emphasis on the watershed approach.

10. A Report for Our Communities

In October 1999, ESH Division published 20,000 copies of the annual report, *For the Seventh Generation: Environment, Safety, and Health at Los Alamos National Laboratory: A Report to Our Communities 1998–1999 Volume III* (ESH 1999). This report gives the Laboratory, its neighbors, and other stakeholders a snapshot of some of the Laboratory ESH programs and issues.

Feature articles in this volume include

The Land Ethic and Environmental Monitoring

WIPP's First Shipment—A Historic Event

Preventing Waste, Saving the Future

Know Fuel, Know Fire

Tapping the Earth Below

DARHT: Understanding Environmental Issues

This report is available from the Laboratory's Outreach Centers and reading room. It is also available at *http://lib-www.lanl.gov/la-pubs/00416768.pdf* on the World Wide Web.

11. Citizens' Advisory Board

The Northern New Mexico Citizens' Advisory Board on Environmental Management was formed in 1995 to provide opportunities for effective communications between the diverse multicultural communities of northern New Mexico, the DOE, the Laboratory, and state and federal regulatory agencies on environmental restoration, environmental surveillance, and waste management activities at the Laboratory. More information on the CAB is available at *http://www.nnmcab.org* on the World Wide Web.

C. Assessment Programs

1. Overview of Los Alamos National Laboratory Environmental Quality Assurance Programs

Quality is the extent to which an item or activity meets or exceeds requirements. Quality assurance includes all the planned and systematic actions and activities necessary to provide adequate confidence that a facility, structure, system, component, or process will perform satisfactorily. Each monitoring activity ESH Division sponsors has its own Quality Assurance Plan and implementing procedures. These plans and procedures establish policies, requirements, and guidelines to effectively implement regulatory requirements and to meet the requirements for DOE Orders 5400.1 (DOE 1988), 5400.5 (DOE 1990), and 5700.6C (DOE 1991). Each Quality Assurance Plan must address the criteria for management, performance, and assessments.

The ESH groups performing environmental monitoring activities either provide their own quality assurance support staff or can obtain support for quality assurance functions from the Quality Assurance Support Group (ESH-14). ESH-14 personnel perform quality assurance and quality control audits and surveillance of Laboratory and subcontractor activities in accordance with the Quality Assurance Plan for the Laboratory and for specific activities, as requested. The Laboratory's Internal Assessment Group (AA-2) manages an independent environmental appraisal and auditing program that verifies implementation of environmental requirements. The Quality and Planning Program Office manages and coordinates the effort to become a customer-focused, unified Laboratory.

2. Overview of University of California/ Department of Energy Performance Assessment Program

During 1999, UC and DOE evaluated the Laboratory based on mutually negotiated ES&H performance measures. The performance measure rating period runs from July to June. The performance measures are linked to the principles and key functions of ISM. The performance assessment program is a process-oriented approach intended to enhance the existing ISM system by identifying performance goals.

Performance measures include the following categories:

- environmental performance;
- radiation protection of workers;
- waste minimization, affirmative procurement, and energy and natural resources conservation;
- management walkarounds;
- hazard analysis and control;

- maintenance of authorization basis; and
- injury/illness prevention.

Specific information on the categories and the assessment scoring can be obtained at *http://drambuie.lanl.gov/~eshiep/* on the World Wide Web.

3. Environment, Safety, & Health Panel of the University of California President's Council on the National Laboratories (UC-ES&H)

The UC-ES&H Panel met at the Laboratory July 27–29, 1999, and discussed the following topics:

- status of LANL special provisions (Contract Clause 5.14),
- WIPP shipments & packaging operations,
- biotechnology & biosafety issues,
- Pajarito Canyon Site (TA-18) operations and programmatic future,
- occurrence review of the personal burn injury during welding operations at the Engineering and Sciences Applications Division,
- environment—how does it fit into ISM, and
- community, Native American, and public comment issues.

The UC-ES&H Panel has forwarded its observations and recommendations on these topics to the Laboratory Director and the Chair of the UC President's Council on the National Laboratories.

4. Division Review Committee

The ES&H Division Review Committee reviewed 31 research projects in 1999. The primary purpose of the meeting was to perform the Science & Technology Assessment of ESH Division. The Division Review Committee based its evaluation on the four criteria provided by the UC President's Council on the National Laboratories:

- quality of science and technology,
- relevance to national needs and agency missions,
- support of ES&H performance at LANL facilities, and
- programmatic performance and planning.

The committee assigned an overall grade of excellent to the performance of the division for science and technology. Of the 31 projects evaluated, nine were truly outstanding, and twelve were in the excellent range. The outstanding projects were

- automated chemical inventory tracking system on the World Wide Web;
- service life modeling for organic vapor air-purifying respiratory cartridges;
- pressure effects and deformation of waste containers;
- Monte Carlo bioassay simulators;
- use of absolute humidity and radiochemical analysis of water vapor samples to correct underestimated atmospheric tritium concentrations;
- Monte Carlo simulation of analytical uncertainty in radiochemical data sets with trends;
- radionuclides and trace elements in fish collected from canyons;
- resource use, activity patterns, and disease analysis of Rocky Mountain elk at Los Alamos;
- hydrogeological characterization of Pajarito Plateau through the implementation of the Hydrogeologic Work Plan.

5. Cooperative and Independent Monitoring by Other State and Federal Agencies

The Agreement-in-Principle between DOE and the State of New Mexico for Environmental Oversight and Monitoring provides technical and financial support for state activities in environmental oversight and monitoring. The requirements of the agreement are carried out by the DOE Oversight Bureau of the NMED. The Oversight Bureau holds public meetings and publishes reports on its assessments of Laboratory activities. Highlights of the Oversight Bureau's activities are reported in Section 2.C.2 and are available at *http://www.nmenv.state.nm.us/*.

Environmental monitoring at and near the Laboratory involves other state and federal agencies such as the Defense Nuclear Facilities Safety Board, the Agency for Toxic Substances and Disease Registry, the Bureau of Indian Affairs, the US Geological Survey, the US Fish and Wildlife Service, the US Forest Service, and the National Park Service.

6. Cooperative and Independent Monitoring by the Surrounding Pueblos

DOE and UC have signed agreements with the four surrounding pueblos. The main purposes of these agreements are to build more open and participatory relationships, to improve communications, and to cooperate on issues of mutual concern. The agreements allow access to monitoring locations at and near the Laboratory and encourage cooperative sampling activities, improve data sharing, and enhance communications on technical subjects. The agreements also provide frameworks for grant support that allow development and implementation of independent monitoring programs.

D. References

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2. Compliance Summary

2. Compliance Summary

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Abstract

Los Alamos National Laboratory (LANL or the Laboratory) staff frequently interacted with regulatory personnel during 1999 on Resource Conservation and Recovery Act and New Mexico Hazardous Waste Act requirements and compliance activities. During 1999, the Laboratory continued to work on the application process to renew its Hazardous Waste Facility permit. The Laboratory received Compliance Orders (COs) for the 1997 and 1998 New Mexico Environment Department (NMED) annual inspections. The NMED has not yet begun the process to negotiate and resolve the apparent findings or the proposed civil penalties. The Environmental Restoration Project reorganized its activities during 1999 according to the natural watersheds that cross the Laboratory.

During 1999, the Laboratory performed over 300 air quality reviews for new and modified projects, activities, and operations to identify all applicable air quality requirements; none of these projects required permits. The Environmental Protection Agency's (EPA's) effective dose equivalent (EDE) to any member of the public from radioactive airborne releases from a DOE facility is limited to 10 mrem/yr. The 1999 EDE was 0.32 mrem.

In 1999, the Laboratory was in compliance with its National Pollutant Discharge Elimination System (NPDES) permit liquid discharge requirements in 100% of the samples from its sanitary effluent outfalls and in 98.6% of the samples from its industrial effluent outfalls. The Laboratory was in compliance with its NPDES permit liquid discharge requirements in 99.2% of the water quality parameter samples collected in the period from August 1, 1998, through July 31, 1999, at sanitary and industrial outfalls. Concentrations of chemical, microbiology, and radioactive constituents in the drinking water system remained within federal and state drinking water standards.

The Laboratory continued an ongoing study of the hydrogeology and stratigraphy of the region through drilling as stated in the Hydrogeologic Workplan. Water samples from one well showed contamination previously unknown.

In 1999, the Laboratory sent 159 National Environmental Policy Act (NEPA) Environmental Review Forms to the Department of Energy (DOE) for review. A Site-Wide Environmental Impact Statement was completed under DOE's compliance strategy for NEPA. An Environmental Impact Statement assessing the conveyance and transfer of certain land tracts under the administrative control of DOE within Los Alamos and Santa Fe Counties was completed. DOE and LANL began planning and developing an Integrated Resources Management Plan in 1999 to integrate existing resource management plans and the development of other management plans with LANL site planning and mission activities. Laboratory archaeologists evaluated 749 proposed actions for possible effects on cultural resources and conducted 18 new field surveys to identify cultural resources. Laboratory biologists reviewed 409 proposed activities and projects for potential impact on biological resources including federally listed threatened and endangered species; of these, 52 projects required additional habitat evaluation surveys.

To Read About . . . **Turn to Page . . .**

2. Compliance Summary

A. Introduction

Many activities and operations at Los Alamos National Laboratory (LANL or the Laboratory) use or produce liquids, solids, and gases that may contain nonradioactive hazardous and/or radioactive materials. Laboratory policy implements Department of Energy (DOE) requirements by directing its employees to protect the environment and meet compliance requirements of applicable federal and state environmental protection regulations.

Federal and state environmental laws address handling, transport, release, and disposal of contaminants, pollutants, and wastes, as well as protection of ecological, archaeological, historic, atmospheric, soil, and water resources, and environmental impact analyses. Regulations provide specific requirements and standards to ensure maintenance of environmental qualities. The Environmental Protection Agency (EPA) and the New Mexico Environment Department (NMED) are the principal administrative authorities for these laws. DOE and its contractors are also subject to DOE-administered requirements for control of radionuclides. Table 2-1 presents the environmental permits or approvals these organizations issued and the specific operations and/or sites affected.

B. Compliance Status

1. Resource Conservation and Recovery Act

a. Introduction. The Laboratory produces a variety of hazardous wastes, most in small quantities relative to industrial facilities of comparable size. The Resource Conservation and Recovery Act (RCRA), as amended by the Hazardous and Solid Waste Amendments (HSWA) of 1984, creates a comprehensive program to regulate hazardous wastes from generation to ultimate disposal. The HSWA emphasize reducing the volume and toxicity of hazardous waste. The applicable federal regulation, 40 Code of Federal Regulations (CFR) 268, requires treatment of hazardous waste before land disposal.

EPA or an authorized state issues RCRA permits to regulate the storage, treatment, or disposal of hazardous waste and the hazardous component of radioactive mixed waste. A RCRA Part A permit application identifies (1) facility location, (2) owner and operator, (3) hazardous or mixed wastes to be managed, and (4) hazardous waste management methods and units (RCRA hazardous waste management areas). A facility that has submitted a RCRA Part A permit application for an existing unit manages hazardous or mixed wastes under transitional regulations known as the Interim Status Requirements pending issuance (or denial) of a RCRA Hazardous Waste Facility permit (the RCRA permit). The RCRA Part B permit application consists of a detailed narrative description of all facilities and procedures related to hazardous or mixed waste management, including contingency response, training, and inspection plans. The State of New Mexico issued LANL's current Hazardous Waste Facility Permit to DOE and the University of California (UC) in November 1989.

In 1996, EPA adopted new standards, under the authority of RCRA, as amended, commonly called "Subpart CC" standards. These standards apply to air emissions from certain tanks, containers, less-than-90-day storage facilities, and surface impoundments that manage hazardous waste capable of releasing volatile organic compounds (VOCs) at levels that can harm human health and the environment.

b. Resource Conservation and Recovery Act Permitting Activities. NMED signed the original RCRA Hazardous Waste Facility Permit for the waste management operations at Technical Areas (TAs) 50, 54, and 16 on November 8, 1989, authorizing Laboratory facilities and procedures for 10 years. In 1999, the permit was administratively continued beyond the expiration date until NMED issues a new permit (as allowed by the permit and by New Mexico Administration Code, Title 20, Chapter 4, Part 1, as revised January 1, 1997 [20 NMAC 4.1], Subpart IX, 270.51),

Table 2-1. Environmental Permits or Approvals under Which the Laboratory Operated during 1999

Category	Approved Activity	Issue Date	Expiration Date	Administering Agency
RCRA Hazardous Waste Facility	Hazardous and mixed waste storage and treatment permit	November 1989	November 1999 Administratively continued	NMED
	RCRA General Part B renewal application	submitted January 15, 1999		
	RCRA mixed waste Revised Part A application	submitted April 1998	– – –	NMED
	TA-50/TA-54 permit renewal application	submitted January 15, 1999		
HSWA	RCRA Corrective Activities	March 1990	December 1999 Administratively continued	NMED
TSCA[a]	Disposal of PCBs at TA-54, Area G	June 25, 1996	June 25, 2001	EPA
CWA/NPDES[b], Los Alamos	Discharge of industrial and sanitary liquid effluents	August 1, 1994	October 31, 1998[c]	EPA
	Storm water associated with industrial activity	December 23, 1998	October 1, 2000	EPA
	DARHT Facility	October 2, 1998	July 7, 2003	EPA
	Guaje Well Field Improvements	October 2, 1998	July 7, 2003	EPA
	Fire Protection Improvements	October 2, 1998	July 7, 2003	EPA
	Strategic Computing Complex	May 21, 1999	July 7, 2003	EPA
	Norton Power Line Project	June 1, 1999	July 7, 2003	EPA
	TA-9-15 Gas Pipeline Replacement Project	August 22, 1999	July 7, 2003	EPA
CWA Sections 404/401 Permits	F.U. 4 Stream Crossing Restoration	July 24, 1997	July 24, 1999	COE[d]/NMED
	Guaje Canyon/Utility Line Discharges	September 9, 1997	September 9, 1999	COE/NMED
	Guaje Canyon/Road Crossings	September 9, 1997	September 9, 1999	COE/NMED
	Guaje Canyon/Headwaters and Isolated Water	September 9, 1997	September 9, 1999	COE/NMED
	Pueblo Canyon/Wetland/Riparian Activities	September 8, 1997	September 8, 1999	COE/NMED
	Pueblo Canyon/Headwaters and Isolated Water	September 18, 1997	September 18, 1999	COE/NMED
	LA Canyon, Ancho Canyon, DP Canyon/Fire Protection Improvement Project	November 14, 1997	November 14, 1999	COE/NMED
	Sandia Canyon/Survey Activities	March 4, 1998	March 4, 2000	COE/NMED
	Guaje Canyon/Bank Stabilization	March 2, 1998	March 2, 2000	COE/NMED
	Three Mile Canyon/Headwaters and Isolated Waters	July 14, 1998	January 28, 1999	COE/NMED
	Lab-wide Gaging Stations/Sci. Meas. Devices	August 28, 1998	August 28, 2000	COE/NMED

Table 2-1. Environmental Permits or Approvals under Which the Laboratory Operated during 1999 (Cont.)

Category	Approved Activity	Issue Date	Expiration Date	Administering Agency
CWA Sections 404/401 Permits (Cont.)	Norton Transmission Line Replacement	March 4, 1999	March 4, 2001	COE/NMED
	Wetland Characterization	May 25, 1999	May 25, 2001	COE/NMED
	Sewer Line Crossing, Upper Sandia Canyon	May 27, 1999	May 27, 2001	COE/NMED
	Lab-wide Gaging Stations/Sci. Meas. Devices Part 2	June 15, 1999	June 15, 2001	COE/NMED
	TA-9 to TA-15 Natural Gas Line Replacement	June 17, 1999	June 17, 2001	COE/NMED
	TA-48 Wetlands Improvement	July 9, 1999	July 9, 2001	COE/NMED
	TA-72 Firing Range Maintenance	July 13, 1999	July 13, 2001	COE/NMED
	Gas Line Leak Repair, LA Canyon	July 16, 1999	When repair completed	COE/NMED
Groundwater Discharge Plan, Fenton Hill	Discharge to groundwater	June 5, 1995	June 5, 2000	NMOCD[e]
Groundwater Discharge Plan, TA-46 SWS Facility[f]	Discharge to groundwater	January 7, 1998	January 7, 2003	NMED
Groundwater Discharge Plan, Sanitary Sewage Sludge Land Application	Land application of dry sanitary sewage sludge	June 30, 1995	June 30, 2000	NMED
Groundwater Discharge Plan, TA-50, Radioactive Liquid Waste Treatment Facility	Discharge to groundwater	submitted August 20, 1996 approval pending		NMED
Air Quality Operating Permit (20 NMAC[g] 2.70)	LANL air emissions	not yet issued[h]		NMED
Air Quality (20 NMAC 2.72)	Portable Rock Crusher	June 16, 1999	None	NMED
Air Quality (NESHAP)[i]	Beryllium machining at TA-3-39	March 19, 1986	None	NMED
	Beryllium machining at TA-3-102	March 19, 1986	None	NMED
	Beryllium machining at TA-3-141	October 30, 1998	None	NMED
	Beryllium machining at TA-35-213	December 26, 1985	None	NMED
	Beryllium machining at TA-55-4	March 11, 1998	None	NMED

Table 2-1. Environmental Permits or Approvals under Which the Laboratory Operated during 1999 (Cont.)

Category	Approved Activity	Issue Date	Expiration Date	Administering Agency
Open Burning (20 NMAC 2.60) Operational Burning	Burning of jet fuel and wood for ordnance testing, TA-11 Burning of HE-contaminated[j] materials, TA-14 Burning of HE-contaminated materials, TA-16 Burning of scrap wood from experiments, TA-36 Fuel Fire Burn of wood or propane TA-16, Site 1409	August 18, 1997	December 31, 2002	NMED
Open Burning (20 NMAC 2.60) Prescribed Burning	Wood pile at TA-16	August 12, 1999	August 12, 2000	NMED
Open Burning (20 NMAC 2.60) Prescribed Burning	West Jemez Fuel Break Maintenance	February 26, 1999	December 31, 1999	NMED

[a]Toxic Substances Control Act.
[b]National Pollutant Discharge Elimination System.
[c]Administratively extended by EPA.
[d]Corps of Engineers.
[e]New Mexico Oil Conservation Division.
[f]Sanitary Wastewater Systems (SWS) Facility.
[g]New Mexico Administrative Code.
[h]Application submitted to NMED December 1995.
[i]National Emission Standards for Hazardous Air Pollutants.
[j]High-explosive.

subject to the timely submittal of permit renewal applications.

In 1998, the Laboratory received guidance from NMED on the permit renewal development strategy and the format for the permit renewal applications. NMED requested that the Laboratory submit (1) a General Part B permit application to serve as a general resource document and as the basis for Laboratory facility-wide portions of the final permit; (2) TA-specific permit applications to provide detail on specific waste management units, resulting in individual chapters of the final permit; and (3) revisions of previously submitted permit applications reflecting the new format.

The Laboratory submitted a General Part B and TA-50- and TA-54-specific permit renewal applications to NMED on January 15, 1999. The TA-16 incinerator, originally permitted in 1989, was shut down, and a closure plan was submitted in October. With these actions, the Laboratory met the submittal requirement for the waste management units active in 1989 or added to the permit later.

Several permit applications for waste management units being managed under the requirements of 20 NMAC 4.1, Subpart VI, were also developed or reformatted from previous applications and submitted to NMED in 1999, including units at TA-3, -14, -15, and -36. The Laboratory submitted a revised permit application for the expansion of the TA-54 West Outside Storage Area in support of mixed waste transportation in October. The Laboratory received approval of an upgrade to the TA-16-388 Open Burn Pad on May 12, 1999. A supplemental information package for TA-54 Storage Dome 375 was submitted in September. NMED approved the TA-54 Decontamination and Volume Reduction System on December 6, 1999.

NMED implemented the new permit fee regulations (20 NMAC 4, Part 2, Hazardous Waste Fees, December 31, 1998) in 1999. These regulations require identification of all active and inactive waste management sites at the Laboratory. The Laboratory submitted a negotiated Annual Unit Audit and the required fees to NMED in September.

The Laboratory closed one active waste management unit in 1999 and submitted the final report and certification for closure of the TA-21, Building 61, container storage area to NMED on February 26, 1999. NMED approved the closure on June 28, 1999.

The Laboratory also submitted closure plans for other waste management units in 1999:

- TA-54, Storage Shafts 145 and 146, on November 4, 1999, and
- TA-50, container storage buildings 137 and 138 and storage pads 139 and 140, on August 17, 1999.

c. Resource Conservation and Recovery Act Corrective Action Activities. Solid waste management units (SWMUs) can be subject to both the HSWA Module VIII corrective action requirements and the closure provisions of RCRA. The corrective action process occurs concurrently with the closure process, thereby satisfying both sets of regulations. See previous LANL environmental reports (ESP 1999, ESP 1998, ESP 1997, ESP 1996) for the history of RCRA closures.

Implementation of clean closure of the TA-16 material disposal Area P landfill began in 1998. The first activity was digging test pits in the landfill to characterize waste types and volumes. Pieces of high-explosives (HE) materials that could be detonated were detected in some of the pits, requiring extensive modification of the Site-Specific Health and Safety Plan. Excavation of Area P began in February 1999. By the end of 1999, remote excavation of soil and debris from the West Lobe of Area P was complete. Approximately 24,320 yd^3 of soil and debris were excavated. Remote excavation of the East Lobe began in December 1999. Section 2.F.2 contains additional information about Area P.

The Environmental Restoration (ER) Project submitted the closure plan for the TA-16-387 flash pad in August 1999. The flash pad is an open burn structure within an area referred to as the Burning Ground at TA-16. The flash pad treated HE-contaminated waste by burning combustible wastes and “flashing” noncombustible wastes to remove the hazardous characteristic of reactivity and to ensure that the waste has no remaining associated safety hazards before disposal. TA-16-387 will be closed concurrently with Area P.

The closure plan for the TA-16-394 burn tray went to NMED in November 1999. The burn tray is also located within the Burning Ground at TA-16. The burn tray burned HE-contaminated oils, solvents, and water mixed with oils and solvents. It is no longer needed to treat hazardous waste.

d. Other Resource Conservation and Recovery Act Activities. The Hazardous and Solid Waste Group (ESH-19) began the self-assessment program in 1995 in cooperation with waste management coordinators to assess the Laboratory's performance in properly storing and handling hazardous and mixed waste to meet federal and state regulations, DOE orders, and Laboratory policy. ESH-19 communicates findings from individual self-assessments to waste generators, waste management coordinators, and management to help line managers implement appropriate corrective actions to ensure continual improvement in LANL's hazardous waste program. In 1999, ESH-19 completed 1,358 quarterly self-assessments.

As part of the self-assessment program, ESH-19 performed independent hazardous waste management system evaluations for five divisions during 1999. These evaluations are similar to International Organization for Standardization (ISO) 14000 environmental management system audits. The management systems ESH-19 reviewed included organizational structure; environmental commitment; formality of program; internal and external communication; staff resources, training, and development; environmental planning and risk management; program evaluation, reporting, and corrective action; and hazardous chemical management and waste minimization. The program is voluntary; the driver for these evaluations is division management's desire to improve RCRA performance.

e. Resource Conservation and Recovery Act Compliance Inspection. NMED did not conduct an annual hazardous waste compliance inspection at the Laboratory in 1999.

f. Mixed Waste Federal Facility Compliance Order. The Laboratory met all 1999 Site Treatment Plan deadlines and milestones. In October 1995, the State of New Mexico issued a Federal Facility Compliance Order to both DOE and UC requiring compliance with the Site Treatment Plan. That plan documents the development of treatment capacities and technologies or use of off-site facilities for treating mixed waste generated at LANL stored beyond the one-year time frame (Section 3004[j] of RCRA and 40 CFR Section 268.50). The Laboratory treated and disposed of over 650 m^3 of mixed waste through FY99.

g. Underground Storage Tanks. The Laboratory had two underground storage tanks (USTs) (as defined by 40 CFR Part 280) in operation during 1999. The Laboratory closed (removed or permanently took out of service) all other USTs by December 22, 1998, the EPA upgrade/closure deadline. The two operating USTs are designated as TA-16-197 and TA-15-R312-DARHT.

TA-16-197 is a 10,000-gal. UST for unleaded gasoline at a single-pump fueling station for fueling Laboratory service vehicles located at and around TA-16. TA-15-R312-DARHT is a 10,000-gal. UST that captures and stores any accidental releases from an equipment room located at the Dual-Axis Radiographic Hydrodynamic Test (DARHT) facility. If a pipe breaks or a leak occurs in the equipment room, all fluids enter floor drains that discharge to the UST. This tank is normally empty and is only used as a secondary containment system during an accidental spill. Substances that could potentially enter the tank are mineral oil and glycol.

Both USTs are double-walled with double-wall piping. Both tanks have leak-detection systems. TA-16-197 has a cathodic corrosion protection system. TA-15-R312-DARHT is a fiberglass tank that does not require a corrosion protection system. NMED conducted its annual UST inspection on April 16, 1999 (see Table 2-2). USTs TA-16-197 and TA-15-R312-DARHT complied with all applicable UST regulations.

Former UST TA-2-1, a tank containing diesel fuel, was removed and permanently closed on October 29, 1998. During the removal, low levels of petroleum contamination (300 ppm total recoverable petroleum hydrocarbons [TRPH]) were found at a sample location below the tank fill line. On April 6, 1999, three additional samples were collected from a location under the former fill line. The TRPH result (440 ppm) from one of the samples was above the 100 ppm standard of the NM UST regulations. The Laboratory and NMED agreed to defer further investigation/cleanup activities at the TA-2-1 UST site until the LANL Decontamination & Decommissioning (D&D) investigation and remediation activities take place in 2006. The sampling results, the good condition of the removed UST, and the history of the site indicate that significant amounts of petroleum contamination are not present at the site.

h. Solid Waste Disposal. The Laboratory has a commercial/special-waste landfill located at TA-54, Area J, that is subject to NM Solid Waste Management Regulations (NMSWMR). In December 1998, the NMED Solid Waste Bureau requested a permit for the facility, which has been operating under a Notice of Intent since the NMSWMR were issued in 1995. Area J is closing in 2000 because the Laboratory decided not to retrofit Area J with a liner and other equipment needed to meet the regulations. The Laboratory submitted a closure plan to NMED in May

Table 2-2. Environmental Inspections and Audits Conducted at the Laboratory during 1999

Date	Purpose	Performing Agency
November 3, 1999	TA-54, Area J, Commercial/Special	NMED/SWQB[a]
July 12, 1999	NPDES Storm Water Program Inspection	EPA/NMED
April 16, 1999	Underground Storage Tank Inspection	NMED

[a] New Mexico Environment Department/Surface Water Quality Bureau.

1999. NMED has not yet approved the plan, and no closure activities took place during 1999. Generators of commercial/special waste will individually arrange to ship their wastes off-site to a New Mexico Special Waste landfill when Area J closes. The amount of soil and concrete needing disposal from Area P is expected to decrease significantly before Area J closes. After closure, soil will be landfilled at a facility in Rio Rancho, and concrete will be shipped to Santa Fe for recycling.

In 1999, the TA-54, Area J, landfill received and disposed of 5,236 yd^3 of solid waste in its pits and shafts. The increase in the amount of waste (up from 55.5 yd^3 in 1998) is due to a large volume of soil and concrete received from cleanup efforts at TA-16, Area P. The asbestos transfer station at Area J transferred 363 yd^3 of asbestos to both in- and out-of-state special-waste landfills. In 1999, LANL completed the required Solid Waste Facility annual report for 1998. Personnel from the NM Solid Waste Bureau inspected Area J on November 3, 1999, and found no violations of the NMSWMR.

LANL also disposes of sanitary solid waste (trash), concrete/rubble, and construction and demolition debris at the Los Alamos County landfill on East Jemez Road. DOE owns the property and leases it to Los Alamos County under a special-use permit. Los Alamos County owns and operates this landfill and is responsible for obtaining all related permits for this activity from the state. The landfill is registered with NMED Solid Waste Bureau. The Laboratory contributed 23% (11,799 tons) of the total volume of trash landfilled at this site during 1999, with the residents of Los Alamos County and the City of Española contributing the remaining 77%. Laboratory trash landfilled included 2,570 tons of trash, 8,331 tons of concrete/rubble, and 577 tons of construction and demolition debris. During 1999, the Laboratory also sent 256 tons of brush for composting and 65 tons of metal for recycling to the county landfill.

i. Waste Minimization and Pollution Prevention. To comply with the HSWA Module of the RCRA Hazard Waste Facility permit, RCRA Subtitle A, DOE Order 5400.1, Executive Order (EO) 12856, Federal Compliance with Right-to-Know Laws and Pollution Prevention Requirements, and other regulations, the Laboratory must have a waste minimization and pollution prevention program. A copy of that Laboratory program, the *1999 Environmental Stewardship Roadmap*, is located at *http://eso.lanl.gov/info/publications/default.htm* on the World Wide Web.

Section 1003 of the Waste Disposal Act cites the minimization of the generation and land disposal of hazardous wastes as a national objective and policy. All hazardous waste must be handled in ways that minimize the present and future threat to human health and the environment. The Waste Disposal Act promotes process substitution; materials recovery, recycling, and reuse; and treatment as alternatives to land disposal of hazardous waste.

The *1999 Annual Report on Waste Generation and Waste Minimization Progress as Required by DOE Order 5400.1* provides the amounts of routine, nonroutine, and total RCRA-hazardous, low-level, and mixed low-level wastes Laboratory operations generated during 1999. A copy of this report and additional information about waste minimization can be found at *http://twilight.saic.com/WasteMin* on the World Wide Web. DOE defines routine/normal waste generation at LANL as waste generated from any type of production, operation, analytical, and/or research and development (R&D) laboratory operations; treatment, storage, and disposal (TSD) operations; work for others; or any other periodic and recurring work that is considered ongoing in nature.

Nonroutine/off-normal waste generation is defined as one-time operations waste such as wastes produced from ER Project activities, including primary and secondary wastes associated with removal and remediation operations, and wastes associated with the legacy waste program cleanup and D&D operations.

In 1999, source reduction and recycling activities reduced the following amounts of waste:

Transuranic (TRU) waste	7.33 m^3
Low-level radioactive waste	1,236.96 m^3
Mixed low-level radioactive waste	30.54 m^3
Sanitary solid waste	1,993.98 metric tons
State-regulated waste	163.42 metric tons
Toxic Substances Control Act (TSCA) waste	0.45 metric tons
RCRA waste	146.57 metric tons

j. Greening of the Government Executive Order. The Laboratory purchases products made with recovered materials in support of EO 13101, "Greening the Government Through Waste Prevention, Recycling, and Federal Acquisition," signed by President Clinton on September 14, 1998, and to comply with RCRA. EPA designates the categories of these items, referred to as Affirmative Procurement. Based on past reports, the Laboratory purchases the largest number of items in three categories: paper, toner cartridges, and plastic desktop accessories whenever available. The Laboratory submits a summary report to DOE after each fiscal year end and is required to report quarterly to UC on the Affirmative Procurement Rate.

In January 2000, the Federal Register released the Recovered Materials Advisory Notice III (RMAN III). The RMAN III contains the EPA's recommendations for purchasing 18 new Affirmative Procurement items including furnishings and construction materials. The Laboratory is working to incorporate these items into the Just-in-Time online catalog purchasing database.

k. Resource Conservation and Recovery Act Training. The RCRA training program is a required component of and is described in the RCRA Hazardous Waste Facility Permit. The Laboratory training program is in compliance and, with the exception of refresher courses that undergo annual revisions, experienced only minor modifications and revisions in 1999 to reflect regulatory, organizational, and/or programmatic changes.

During 1999, 247 workers completed RCRA Personnel Training, 433 workers completed RCRA Refresher Training, and 616 workers completed Waste Generation Overview. Of the 433 workers who required RCRA Refresher Training during 1999, 332 met this requirement through completing hazardous waste operations (HAZWOPER) Refresher for Treatment, Storage, and Disposal Workers that includes the RCRA Refresher as part of the eight-hour requirement.

The Environment, Safety, and Health Training Group (ESH-13) completely revised the following RCRA courses during 1999.

RCRA Refresher Training

HAZWOPER: Refresher for Environmental Restoration Workers

HAZWOPER: Refresher for Treatment, Storage, and Disposal Workers

ESH-13 updated the following courses during 1999:

Waste Generator Overview

Waste Documentation Forms

Waste Management Coordinator Requirements

The following RCRA self-study courses were developed in 1999:

Environmental Issues for Managers

Waste Management Overview

Waste Characterization Overview

Waste Storage and Disposal Overview

Environmental Regulation Overview

l. Hazardous and Solid Waste Amendments Compliance Activities. In 1999, the ER Project remained in compliance with Module VIII of the RCRA permit. The Laboratory's ER Project originally involved approximately 2,100 potential release sites (PRSs), consisting of solid waste management units and areas of concern. The ER Project has recommended designating approximately 1,400 PRSs as no further action (NFA) because they meet one or more of the following criteria.

Criterion 1. The site does not exist, is a duplicate of another site, cannot be located, or is located within another site and has been or will be investigated as part of that site.

Criterion 2. The site,was never used for the management (i.e., generation, treatment, storage, or disposal) of RCRA solid or hazardous wastes and/or constituents.

Criterion 3. The site is not known to have released nor is it suspected of releasing or having released RCRA solid or hazardous wastes and/or constituents to the environment. The term "release" means any spilling, leaking, pouring, emitting, emptying, discharging, injecting, pumping, escaping, leaching, dumping, or disposing of hazardous wastes (including hazardous constituents) into the environment.

Criterion 4. The site is regulated under another state and/or federal authority. If the site is known to have released or is suspected of releasing or having released RCRA solid or hazardous wastes and/or constituents to the environment, it has been or will be investigated and/or remediated in accordance with applicable state and/or federal regulations.

Criterion 5. The site was characterized or remediated in accordance with current applicable state and/or federal regulations, and the available data indicate that contaminants pose an acceptable level of risk, assuming current and projected future land use.

The ER Project continues to reevaluate many of these sites for ecological and other relevant and appropriate concerns. At the end of FY99, approximately 280 PRSs had been evaluated and found to comply with the criteria needed to justify the NFA classification, and 102 PRSs had been removed from the RCRA permit.

In 1999, the LANL ER Project HSWA compliance activities included remedial site assessments and site cleanups. The assessment portion of the ER Project included submission of eight RCRA facility investigation (RFI) reports to NMED and RFI fieldwork on numerous sites. Remedial activities cleaned seven sites including an inactive firing site, septic tanks, and areas with contaminated soil.

The ER Project anticipates that the corrective action process for all PRSs will be complete by 2013. Based on the new watershed approach (as described in Section 2.E.1), future work will focus on PRSs in the Los Alamos townsite at the head of Los Alamos, Pueblo, Guaje, Rendija, Barranca, Bayo, and DP Canyons and work down each canyon to the Rio Grande. Work will then continue southward, watershed by watershed, until work on PRSs in all eight watersheds is completed.

2. Comprehensive Environmental Response, Compensation, and Liability Act

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, as amended by the Superfund Amendments and Reauthorization Act (SARA) of 1986, mandates actions for certain releases of hazardous substances into the environment. The Laboratory is not listed on the EPA's National Priority List, but the ER Project follows some CERCLA guidelines for remediating Laboratory sites that contain certain hazardous substances not covered by RCRA and/or that may not be included in Module VIII of the Laboratory's Hazardous Waste Facility Permit.

DOE fulfills its responsibilities as both a natural resource trustee and lead response agency for Project activities at the Laboratory. DOE's policy is to consider CERCLA Natural Resource Damage Assessment (NRDA) issues and, when appropriate, resolve them with other natural resource trustees as part of the ER Project remedy selection process. ER Project cleanup considers integrated resource management activities (e.g., biological resource management, watershed management, and groundwater protection) at the Laboratory. As ER Project cleanup activities progress, natural resource trustees (i.e., Department of Interior, Department of Agriculture Forest Service, Cochiti Pueblo, Jemez Pueblo, San Ildefonso Pueblo, Santa Clara Pueblo, and the State of New Mexico) are invited to participate in the process. DOE initiated its dialogue with the natural resource trustees on ER Project activities in 1997. In 1999, the natural resource trustees conducted a preliminary assessment of potential natural resource impact indicators and service losses and conducted a field survey of best management practices for surface water protection at ER Project PRSs. Additionally, ER Project-related issues are discussed in the Pajarito Plateau Watershed Partnership and the East Jemez Resources Council meetings.

3. Emergency Planning and Community Right-to-Know Act

a. Introduction. The Laboratory is required to comply with the Emergency Planning and Community Right-to-Know Act (EPCRA) of 1986 and EO 12856.

b. Compliance Activities. In 1999, the Laboratory submitted three annual reports to fulfill its requirements under EPCRA, as shown on Table 2-3 and described below.

Emergency Planning Notification. Title III, Sections 302-303, of EPCRA requires the preparation of emergency plans for more than 360 extremely hazardous substances if stored in amounts above threshold limits. The Laboratory is required to notify state and local emergency planning committees of any changes at the Laboratory that might affect the local emergency plan or if the Laboratory's emergency planning coordinator changes. In July 1999, LANL sent notification to the state and local planning committees regarding the presence of nickel carbonyl, hydrogen fluoride, chlorine, sulfuric acid, and nitric acid at the facility. Officials were informed of the presence of these materials in excess of chemical specific threshold quantities.

Emergency Release Notification. Title III, Section 304 of EPCRA requires facilities to provide emergency release notification of leaks, spills, and other releases of specified chemicals over specified reporting quantities into the environment. Releases must be reported immediately to the state and local emergency planning committees and to the National Response Center. No leaks, spills, or other releases of specific chemicals into the environment that required EPCRA reporting occurred during 1999.

Material Safety Data Sheet/Chemical Inventory Reporting. Title III, Sections 311-312, of EPCRA requires facilities to provide an annual inventory of the quantity and location of hazardous chemicals present at the facility above specified thresholds; the inventory includes the material safety data sheet for each chemical. The Laboratory submitted a report to the state emergency response commission, the local emergency planning committee, and the Los Alamos County Fire Department listing 58 chemicals and explosives at the Laboratory during 1999 in quantities exceeding threshold limits.

Table 2-3. Compliance with Emergency Planning and Community Right-to-Know Act during 1999

Statute	Brief Description	Compliance
EPCRA Sections 302-303 Planning Notification	Requires emergency planning notification to state and local emergency planning committees.	LANL sent notification to appropriate agencies (July 30, 1999) informing officials of the presence of hazardous materials in excess of specific threshold planning quantities and of the current facility emergency coordinator.
EPCRA Section 304 Release Notification	Requires reporting of releases of certain hazardous substances over specified thresholds to state and local emergency planning committees and to the National Response Center.	There were no leaks, spills, or other releases of chemicals into the environment that required EPCRA Section 304 reporting during 1999.
EPCRA Sections 311-312 MSDSs and Chemical Inventories	Requires facilities to provide appropriate emergency response personnel with an annual inventory and other specific information for any hazardous materials present at the facility over specified thresholds.	The presence of 58 hazardous materials over specified quantities in 1999 required submittal of a hazardous chemical inventory to the state emergency response commission, the local emergency planning committee, and the Los Alamos County Fire Department.
EPCRA Section 313 Annual Releases	Requires all federal facilities to report total annual releases of listed toxic chemicals used in quantities above reportable thresholds.	Threshold quantities for nitric acid were exceeded in 1999 requiring submittal of a Toxic Chemical Release Inventory Reporting Form to the EPA.

Toxic Release Inventory Reporting. Title III, Section 313, of EPCRA, as modified by EO 12856, requires all federal facilities to report total annual releases of listed toxic chemicals. Nitric acid was the only Section 313-listed toxic chemical that was used in quantities above reportable thresholds in 1999. Approximately 13,000 lb of nitric acid were used for plutonium processing and an additional 2,518 lb were used in glassware cleaning and ion exchange. The 1999 Toxic Release Inventory reported air emissions between 10–100 lb of nitric acid resulting from these activities.

4. Emergency Planning under DOE Order 151.1

The Laboratory's Emergency Management Plan is a document that describes the entire process of planning, responding to, and mitigating the potential consequences of an emergency. The most recent revision of the plan, incorporating DOE Order 151.1, will be published in early 2000. In accordance with DOE Order 151.1, it is the Laboratory's policy to develop and maintain an emergency management system that includes emergency planning, emergency preparedness, and effective response capabilities for responding to and mitigating the consequences of an emergency. In FY99, 1,162 employees received training as a result of Emergency Management Plan requirements and the Emergency Management and Response organization's internal training program.

5. Toxic Substances Control Act

Because the Laboratory's activities are research and development and do not involve making chemicals to sell, the polychlorinated biphenyls (PCB) regulations (40 CFR 761) have been the Laboratory's main concern under the TSCA. The PCB regulations govern substances including but not limited to dielectric fluids, contaminated solvents, oils, waste oils, heat transfer fluids, hydraulic fluids, slurries, soils, sanitary treatment solids from the Sanitary Wastewater Systems (SWS) Facility, and materials contaminated by spills.

In 1999, the Laboratory's Operations Working Group adopted a goal of having the Laboratory PCB-free, and efforts are continuing to reduce the Laboratory's inventory of PCB items. ESH-19 personnel are preparing an inventory of items containing PCB and looking for funding sources to replace existing serviceable items that contain PCB with new items that are PCB-free.

During 1999, the Laboratory had 15 off-site shipments of PCB waste. The quantities of waste disposed include 910 kg of capacitors; 550 kg of cleanup waste, 208 kg of laboratory waste; 500 kg of PCB-contaminated liquids; 282 kg of PCB oil; 101,420 kg of sludge, grit, and screening with PCB; 6,530 kg of fluorescent light ballasts; and 764 kg of PCB-contaminated soil.

The Laboratory manages all wastes in accordance with 40 CFR 761 manifesting, record keeping, and disposal requirements. PCB wastes are sent to EPA-permitted disposal and treatment facilities. Light ballasts are shipped off-site for recycling.

The Laboratory generated 0.46 m^3 of radioactively contaminated PCB solids in 1999. Nonliquid wastes containing PCB contaminated with radioactive constituents are disposed of at the Laboratory's EPA-authorized TSCA landfill located at TA-54, Area G. Radioactively contaminated PCB liquid wastes are stored at the TA-54, Area L, TSCA-authorized storage facility. Many of these items have exceeded TSCA's one-year storage limitation and are covered under the Final Rule for the Disposal of PCB, dated August 28, 1998. No liquid radioactively contaminated PCB were disposed of on-site in 1999.

The primary compliance document related to 40 CFR 761.180 is the annual PCB report submitted to EPA, Region 6. EPA did not conduct an audit of the Laboratory's PCB management program during 1999.

6. Federal Insecticide, Fungicide, and Rodenticide Act

The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) regulates the manufacturing of pesticides, with requirements for registration, labeling, packaging, record keeping, distribution, worker protection, certification, experimental use, and tolerances in foods and feeds. Sections of this act that are applicable to the Laboratory include requirements for certification of workers who apply pesticides. The New Mexico Department of Agriculture (NMDA) has been granted the primary responsibility for pesticide enforcement under the FIFRA. The New Mexico Pesticide Control Act regulates private and public applicators, commercial and noncommercial applicators, pest management consultants, pesticide dealers, pesticide manufacturers, and all activities relating to the distribution and use of pesticides.

For the Laboratory, these regulations apply to the licensing and certification of pesticide applicators, record keeping, pesticide application, equipment inspection, pesticide storage, and disposal of pesticides.

NMDA did not conduct an inspection of the Laboratory's pesticide application program in 1999.

Amount of Pesticides Used during 1999.

TEMPO (insecticide)	1,600 grams
MAX FORCE (ant granules)	62 oz
FLOREL (growth retardant)	5 gal.
STINGER (wasp freeze)	50 oz
A2,4-D (herbicide)	4 gal.
TELAR (herbicide)	17 g
VELPAR L (herbicide)	11 gal.
MAKI (rodenticide)	46 oz
DICOT (fertilizer)	20 lb

7. Clean Air Act

NMED or the EPA regulates Laboratory operations and its air emissions. A complete description of air quality requirements applicable to the Laboratory is presented in the Air Quality Group's QA Project Plan for the Operating Permit Project, available at *http://www.esh.lanl.gov/~AirQuality/qa_airqual.htm*. A summary of the major aspects of the Laboratory's air quality compliance program is presented below.

a. New Mexico Air Quality Control Act. In December 1995, LANL submitted to NMED the Operating Permit application that Title V of the Clean Air Act (CAA) and Title 20 of the New Mexico Administrative Code, Chapter 2, Part 70–Operating Permits (20 NMAC 2.70) requires. NMED has not yet issued a permit. Meanwhile, LANL operates under the terms of its application. When issued, the permit will specify the operational terms and limitations imposed on LANL to continue to ensure that all federal and state air quality standards are being met. Because NMED is not scheduled to issue a permit for a couple of years, LANL began updating the application so that a current application will be available if NMED requests it. LANL updates the application as it adds new emission units and as the regulations change.

LANL is a major source under the Operating Permit program based on the potential to emit regulated air pollutants. Specifically, LANL is a major source of nitrogen oxides (NO_x), emitted primarily from the TA-3 steam plant boilers. However, LANL initiated a project to install flue gas recirculation equipment on the boilers to reduce the NO_x emissions by approximately 70%. Project implementation begins in 2000.

LANL reviews plans for new and modified projects, activities, and operations to identify all applicable air quality requirements including the need to revise the Operating Permit application, to apply for construction permits, or to submit notifications to NMED (20 NMAC 2.72). During 1999, over 300 air quality reviews were performed. One of these projects required a construction permit. However, six sources/activities (a new storage tank, relocation of generators, and new generators) were exempt from permitting but required written notification to NMED.

As part of the Operating Permit program, NMED collects fees (20 NMAC 2.71) from sources that are required to obtain an Operating Permit. For LANL, the fees are based on the allowable emissions from activities and operations as reported in the Operating Permit application. LANL's fees for 1999 were $13,017.50.

LANL reports regulated air pollutant emissions to NMED annually as required by 20 NMAC 2.73. Table 2-4 shows LANL's 1999 calculated air pollutant emissions reported to NMED for the annual emissions inventory based on actual production rates or fuel consumption rates. LANL reports for the following industrial-type sources: boilers, water pumps, and asphalt production. These industrial-type sources operated primarily on natural gas. However, the steam plant boilers at TA-3 and TA-21 use diesel as a backup. In addition, LANL reports emissions from a paper shredder, a degreaser, and a rock crusher and from beryllium-permitted activities. LANL calculates air emissions using emission factors from source tests, manufacturer data, and EPA documentation. Detailed analysis of chemical tracking and procurement records indicates that LANL procured approximately 20 tons of VOCs. For a conservative estimate of air emissions from R&D activities, we assumed that the total VOC quantity was emitted.

Combustion units were the primary source of criteria pollutants (NO_x, sulfur oxides [SO_x], particulate matter [PM], and carbon monoxide [CO] emissions) emitted at LANL. Of all combustion units, the TA-3 steam plant was the primary source of criteria pollutants. R&D activities were the primary source of VOC emissions. Additional information can be found in LA-13728-SR.

Table 2-4. Calculated Actual Emissions for Regulated Pollutants (Tons) Reported to NMED

	Pollutants				
Emission Units	**PM**	**CO**	**NO_x**	**SO_x**	**VOC**
Asphalt Plant	0.103	0.498	0.037	0.007	0.025
TA-3 Steam Plant	3.05	16.0	65.3	0.412	2.20
TA-16 Boilers	0.126	0.616	0.616	0.010	0.091
TA-21 Steam Plant	0.141	1.55	1.85	0.044	0.101
Water Pump	0.003	1.65	5.17	0.002	0.103
TA-48 Boilers	0.255	2.81	3.35	0.020	0.184
TA-53 Boilers	0.205	2.27	2.70	0.016	0.149
TA-55 Boilers	0.443	4.89	6.58	0.023	0.218
TA-59 Boilers	0.152	1.68	2.00	0.012	0.110
Degreaser	NA	NA	NA	NA	0.032
Paper Shredder	0.001	NA	NA	NA	NA
Rock Crusher	0	0	0	0	0
Total	4.48	32.0	87.6	0.546	3.21

NA = not applicable.

An assessment of the ambient impacts of air pollutant emissions, presented in the Site-Wide Environmental Impact Statement (SWEIS) for Los Alamos (DOE 1999), indicates that no adverse air quality impacts result from LANL's combustion and industrial-type sources. The actual amounts of air pollutant emissions generated in 1999 are less than the amounts for which the SWEIS analyzed impacts.

Figure 2-1 provides a comparison among recent emissions inventories reported to NMED with some noteworthy differences in the emissions from 1998 to 1999. Overall, LANL used more fuel in 1999. For example, the steam plant at TA-3 used 21% more natural gas and the steam plant at TA-21 used 27% more natural gas than in the previous year. In addition, emissions from diesel combustion at the two steam plants were reported for 1999 and not for 1998, because LANL used diesel as a Y2K preventative measure. Emission estimates, where appropriate, have been updated to reflect significant changes in EPA emission factors for natural gas combustion. The rock crusher was not operated in 1999. Therefore, there were no PM emissions from the crushing activities and no combustion products from the rock crusher diesel-fired engine.

The VOC emissions from R&D activities are 60% higher than in 1998. This evaluation does not necessarily indicate an increase in the amount of chemicals used. Other factors affecting this evaluation are the improved tools for chemical management and the availability of electronic data for the physical properties and chemical formulas. Air quality reports on the nonradionuclide air emissions are available at *http://www.esh.lanl.gov/~AirQuality/aqreports.htm* on the World Wide Web.

Smaller sources of air pollutant emissions, such as nonregulated boilers, emergency generators, space heaters, etc., are located throughout LANL. NMED considers them insignificant sources. These sources are not required to be and were not included in the annual emissions inventory.

An advantage of the Operating Permit will be the consolidation of all air quality requirements into one document for LANL. The following existing air quality programs/projects will be incorporated into the Operating Permit when it is issued.

Construction Permits. LANL currently operates under the air permits listed in Table 2-1. Table 2-5 summarizes allowable emissions from 20 NMAC 2.72 Construction Permits**.** In June, the Laboratory was issued a Construction Permit to operate an impact rock crusher to crush potentially radioactively contaminated concrete removed from buildings as part of the Laboratory's D&D efforts. However, the equipment was not operated in 1999.

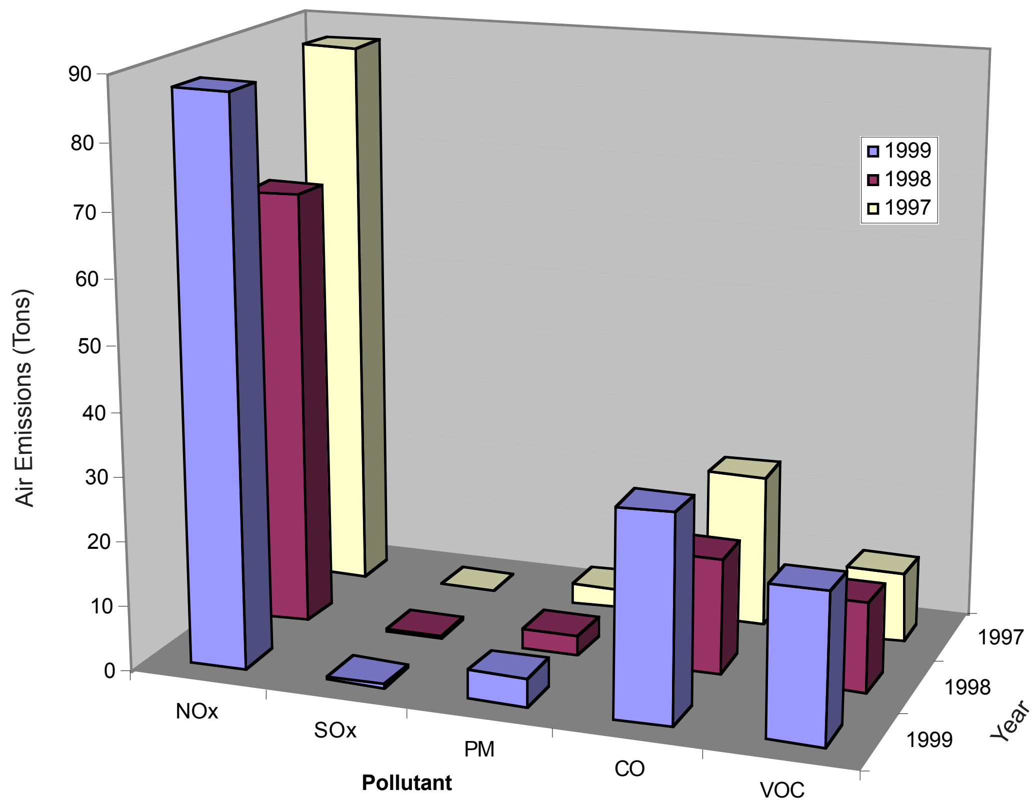

Figure 2-1. Emissions generated in 1997, 1998, and 1999.

Open Burning. LANL has an Open Burning permit (20 NMAC 2.60) for operational burns conducted for research projects. LANL also acquired two burn permits for prescribed burns as a preventive measure against wildfires. However, LANL conducted only one burn, which occurred in November 1999. Measured levels of suspended particulate matter in the size range of 10 microns or less (PM_{10}) met state and federal standards during the November burn.

Asbestos. The National Emission Standard for Hazardous Air Pollutants for Asbestos (Asbestos NESHAP) requires that LANL provide advance notice to NMED for large renovation jobs involving asbestos and of all demolition projects. The Asbestos NESHAP further requires that all activities involving asbestos be conducted in a manner that mitigates visible airborne emissions and that all asbestos-containing wastes be packaged and disposed of properly.

LANL continued to perform renovation and demolition projects in accordance with the requirements of the Asbestos NESHAP. These activities included four large renovation jobs and demolition projects for which NMED received advance notice. These larger projects and numerous smaller projects generated 76.6 m^3 of asbestos waste, which was not radioactively contaminated. All asbestos wastes were properly packaged and disposed at approved landfills.

To ensure compliance, the Laboratory conducted internal inspections of job sites and asbestos packaging approximately monthly. In addition, two inspections by NMED during the year identified no violations. The Air Quality Group's QA Project Plan for the Asbestos Report Project is available at *http://www.esh.lanl.gov/~AirQuality/qa_airqual.htm* on the World Wide Web.

b. Federal Clean Air Act. All of the federal air quality requirements, with a couple of exceptions, have been adopted by the State of New Mexico as part of its State Implementation Plan and have been summarized in the previous section. The exceptions are the Stratospheric Ozone Protection, the NESHAP for Radionuclides, and one newly mandated program under the CAA.

Ozone-Depleting Substances. Title VI of the CAA contains specific sections establishing regulations and requirements for ozone-depleting substances (ODS) such as halons and refrigerants. The sections

Table 2-5. Allowable Air Emissions (20 NMAC 2.72)

Source	Regulated Pollutant	Allowable Emissions
Beryllium Machining at TA-3-39	Beryllium	0.008 lb/yr
	Beryllium	4.0E-06 lb/hr
Beryllium Machining at TA-3-102	Beryllium	0.00014 lb/yr
	Beryllium	4.0E-07 lb/hr
Beryllium Machining at TA-3-141	Beryllium	0.0004 lb/yr
	Beryllium	3.0E-06 lb/hr
Beryllium Machining at TA-35-213	Beryllium	0.0008 lb/yr
	Beryllium	4.0E-07 lb/hr
Beryllium Cutting and Bead Dressing at TA-55-4	Beryllium	0.0041 lb/yr
	Beryllium	1.0E-05 lb/hr
	Aluminum	0.0042 lb/yr
	Aluminum	1.0E-05 lb/hr
Beryllium Metallography at TA-55-4	Beryllium	0.0030 lb/yr
	Beryllium	2.0E-06 lb/hr
Rock Crusher	Particulate Matter	Limited[a]
	Nitrogen Dioxide	6.4 tons/yr
	Nitrogen Dioxide	6.2 lb/hr
	Carbon Monoxide	1.4 tons/yr
	Carbon Monoxide	1.3 lb/hr
	Volatile Organic Compounds	0.5 tons/yr
	Volatile Organic Compounds	0.5 lb/hr
	Sulfur Dioxide	0.4 tons/yr
	Sulfur Dioxide	0.4 lb/hr

[a] Fugitive particulate matter emissions from transfer points, belt conveyors, screens, feed bins, and from stockpiles shall not exhibit greater than 10% opacity. Fugitive particulate matter emissions from the rock crusher shall not exhibit greater than 15% opacity. Opacity is the degree to which emissions reduce the transmission of light and obscure the view of a background object.

applicable to LANL include Section 608, National Recycling and Emission Reduction Program, and Section 609, Servicing of Motor Vehicle Air Conditioners. Section 608 prohibits individuals from knowingly venting ODS into the atmosphere during maintenance, repair, service, or disposal of halon fire-suppression systems and air conditioning or refrigeration equipment. It also requires technician certification and the use of certified recovery equipment. Section 609 includes standards and requirements for recycling equipment that services motor vehicle air conditioners and for training and certifying maintenance and repair technicians. LANL contracts with Johnson Controls Northern New Mexico (JCNNM) and other vendors to maintain, service, repair, and dispose of halon fire-suppression systems and air conditioning and refrigeration equipment. LANL contracts automotive repair work, including motor vehicle air-conditioning work, to qualified local automotive repair shops.

Radionuclides. Under the National Emission Standard for Hazardous Air Pollutants for Radionuclides (Rad NESHAP), EPA limits the effective dose equivalent (EDE) to any member of the public from radioactive airborne releases from a DOE facility, such as LANL, to 10 mrem/yr. The 1999 EDE (as calculated using EPA-approved methods) was 0.32 mrem. Because the Los Alamos Neutron Science Center did not operate in 1999, the dose was from a number of smaller sources. The Air Quality Group's QA Project Plan for the Rad/NESHAP Compliance Project is available at *http://www.esh.lanl.gov/~AirQuality/qa_airqual.htm* on the World Wide Web. In addition, air quality reports on the radionuclide air emissions are available at *http://www.esh.lanl.gov/~AirQuality/aqreports.htm* on the World Wide Web.

LANL reviews plans for new and modified projects, activities, and operations to identify the need for emissions monitoring or prior approval from EPA. During 1999, approximately 150 reviews involved the evaluation of air quality requirements associated with the use of radioactive materials. None of these projects required EPA prior approval.

In 1999, independent auditors completed a report of LANL's 1996 compliance status. The independent audit, which was initiated in 1997, found that the Laboratory was not in compliance with certain regulatory and technical requirements of the CAA in 1996. It is important to note, however, that the audit report recognized that it is very unlikely that LANL exceeded the 10 mrem/yr dose standard. Section 2.D., Consent Decree, provides more information.

Risk Management Program. In 1990, Congress amended the CAA by adding Section 112(r), Prevention of Accidental Releases. Section 112(r) required EPA to establish a risk management program (RMP) to prevent accidental releases of flammable and toxic substances to the environment and to minimize the consequences of a release. EPA established the requirements for the RMP in 40 CFR 68. Facilities that are subject to the RMP were required to register with EPA and submit a facility-specific risk management plan by June 21, 1999. The 112(r) program provides lists of toxic and flammable substances with their associated Threshold Quantities (TQs). Any process or storage facility that uses any listed substance in quantities exceeding its TQ is subject to EPA's RMP. Under the 112(r) program, the threshold determinations are based on the quantity of substance present at a particular location or in a particular process at any point in time (i.e., what is the potential for release during an accident) and not on cumulative usage.

LANL did not exceed any TQ between the effective date (June 21, 1999) and the end of the year and, therefore, was not subject to the RMP and was not required to register with EPA. LANL will continue to evaluate chemical procurements and new sources and to track known processes containing regulated substances to determine any change in the applicability status of the RMP.

8. Clean Water Act

a. National Pollutant Discharge Elimination System Outfall Program. The primary goal of the Clean Water Act (CWA) (33 U.S.C. 1251 *et seq.*) is to restore and maintain the chemical, physical, and biological integrity of the nation's waters. The act established the requirements for National Pollutant Discharge Elimination System (NPDES) permits for point-source effluent discharges to the nation's waters. The NPDES outfall permit establishes specific chemical, physical, and biological criteria that an effluent must meet before it is discharged. Although most of the Laboratory's effluent is discharged to normally dry arroyos, the Laboratory is required to meet effluent limitations under the NPDES permit program.

UC and DOE are co-permittees of the NPDES permit covering Laboratory operations. EPA Region 6 in Dallas, Texas, issues and enforces the permit. However, NMED certifies the EPA-issued permit and performs some compliance evaluation inspections and monitoring for EPA through a Section 106 water quality grant.

The current Laboratory NPDES Permit, No. NM0028355, expired October 31, 1998, but EPA has administratively continued it until a new permit is issued. As required by the NPDES regulations, on May 4, 1998, 180 days before permit expiration, the Laboratory submitted an application to EPA for renewal of the NPDES permit. Each year, the number of permitted outfalls at the Laboratory is decreasing in response to the success of the Waste Stream Characterization Program and Corrections Project and the NPDES Outfall Reduction Program. As of January 1, 1999, the Laboratory's NPDES permit had 36 outfalls, which included one sanitary outfall and 35 industrial outfalls. By December 31, 1999, 16 industrial outfalls had been eliminated, bringing the total number of NPDES-permitted outfalls to 20. The Laboratory achieved this reduction in outfalls by removing process flows for seven industrial outfalls and completing the lease transfer of the drinking water system, including nine associated outfalls, to Los Alamos County. Future activities are planned to further reduce the number of permitted outfalls at the Laboratory. Ten additional outfalls are currently targeted for elimination. These include NPDES Outfalls 051, 02A129, 03A024, 03A027, 03A047, 03A048, 03A130, 03A158, 031028, and 05A097. Completing equipment upgrades to treatment facilities, decontamination and decommissioning of nonessential facilities, combining of process flows, installation of closed loop cooling systems, containerization of wastewater, and removal of experimental processes will eliminate these outfalls. Additionally, long-term objectives of the NPDES Outfall Reduction Program will require that outfall owners evaluate outfalls for continued operation and that new construction designs and modifications to existing facilities provide for reduced or no-flow effluent discharge systems.

Under the Laboratory's NPDES outfall permit, samples for effluent quality limits are collected for analysis weekly, monthly, and quarterly depending on the outfall category. Water quality samples are collected for analysis annually at all outfalls. The Laboratory reports results to EPA and NMED at the end of the monitoring period for each respective outfall category. During 1999, 16 of the 1,250 samples collected from the industrial outfalls exceeded effluent limits (see Table 2-6). No effluent limit exceedances occurred in the 175 samples collected from the SWS Facility Outfall 13S. See Table A-4 for a summary of these outfalls and a listing of the permit's monitoring limits.

Table 2-6 presents the exceedances of the water quality parameters for sanitary and industrial outfalls during 1999. The following is a summary of the corrective actions the Laboratory took during 1999 to address the effluent-limit exceedances.

TA-53, Low-Energy Demonstration Accelerator (LEDA) Cooling Tower (NPDES Outfall 03A113). On January 22, 1999, the chlorine (Cl_2) concentrations exceeded the NPDES average and

Table 2-6. National Pollutant Discharge Elimination System Permit Monitoring of Effluent Quality and Water Quality Parameters at Industrial Outfalls: Exceedances during 1999[a]

EPA ID	Technical Area	Date	Parameter		Results/Limits	
January						
03A113	TA-53-952 (LEDA)	01/22/99	Cl_2[b]	(daily max.)	6.1/0.5	mg/l
03A113	TA-53-952 (LEDA)	11/01/98–11/31/99	Cl_2	(daily avg.)	3.1/0.2	mg/l
March						
051	TA-50-1	03/15/99	TSS[c]	(daily max.)	78.3/62.6	lbs/day
051	TA-50-1	03/29/99	TSS	(daily max.)	81.2/62.6	lbs/day
051	TA-50-1	03/1/99–03/31/99	TSS	(daily avg.)	33.0/18.8	lbs/day
May						
129	TA-21-357	05/14/99	P	(daily max.)	45/40	mg/l
129	TA-21-357	05/1/99–07/31/99	P	(daily avg.)	21/20	mg/l
June						
051	TA-50-1	06/01/99–06/30/99	Zn	(daily avg.)	0.66/0.62	lbs/day
173	Guaje Well #2	06/03/99	Al	(daily avg.) - *WQP	5.2/5.0	mg/l
173	Guaje Well #2	06/03/99	Al	(daily max.) - *WQP	5.2/5.0	mg/l
July						
051	TA-50-1	07/06/99	Zn	(daily max.)	3.43/1.83	lbs/day
051	TA-50-1	07/01/99–07/31/99	Zn	(daily avg.)	1.10/0.62	lbs/day
August						
051	TA-50-1	08/02/99	Zn	(daily max.)	2.10/1.83	lbs/day
051	TA-50-1	08/01/99–08/31/99	Zn	(daily avg.)	0.66/0.62	lbs/day
October						
051	TA-50-1	10/14/99	Zn	(daily max.)	2.28/1.83	lbs/day
051	TA-50-1	10/01/99–10/31/99	Zn	(daily avg.)	0.86/0.62	lbs/day

*Water Quality Parameter

Note: During February, April, September, November, and December, there were no NPDES exceedances.

[a] Effluent quality limits are presented in Table A-5; water quality parameters are presented in Table A-6.
[b] Chlorine.
[c] Total Suspended Solids.

maximum permit limits at NPDES Outfall 03A113 at the TA-53-LEDA cooling tower. On the day of the exceedance, craft workers were scheduled to perform work inside the new LEDA cooling tower at TA-53. A leaking solenoid valve deposited treated water into the empty basin where the work was to be performed. To avoid delays in the scheduled work, a TA-53 employee drained the water in the basin, which discharged directly through the outfall. Because the wastewater was discharged without going through the neutralization process, a chlorine exceedance occurred. The cooling tower maintenance crew was notified of the condition as soon as the elevated Cl_2 concentrations were discovered. The leaking solenoid was valved off, and site operators worked with the manufacturer to repair it. A repeat compliance sample collected on January 25, 1999, documented the Cl_2 level of 0.0 mg/l. As a result of this incident, and other site-wide safety concerns, operations at TA-53 were shut down. Operations restart procedures included a review of the Operation and Maintenance (O&M) Procedures and equipment for cooling towers. The review revealed that the equipment and O&M procedures were not consistent. Facility Management personnel updated the O&M procedures and along with craft workers, received training in the new procedure. Additionally, personnel at TA-53 now conduct routine inspections to detect mechanical deficiencies, and corrective actions are implemented when they discover any defects.

TA-50, Building 1 (NPDES Outfall 051). On March 15, 1999, and March 29, 1999, the total suspended solids (TSS) concentrations exceeded the NPDES average and maximum permit limits at the NPDES Outfall 051 at the TA-50 Radioactive Liquid Waste Treatment Facility (RLWTF). Radioactive Liquid Waste Group (FWO-RLW) personnel conducted an investigation into the occurrence. FWO-RLW reviewed the TA-50 RLWTF's operational sampling data and records for March 15, 1999, and March 29, 1999, but did not find any off-normal conditions. On April 6, 1999, the Occurrence Investigation Group (ESH-7), ESH-18, EM-FWO, and DOE/LAAO personnel discussed the findings of the investigations and corrective actions at an occurrence investigation meeting. The collection of operational samples for TSS and other NPDES analytes occurs after the gravity filters and before discharge into one of two effluent holding tanks. The pH adjustment that occurs in the effluent holding tank(s) may have caused calcium carbonate to precipitate out of solution. The calcium carbonate may have caused the TSS to exceed NPDES effluent limits. FWO-RLW personnel conducted additional bench studies to evaluate pH adjustment effects on TSS levels in the effluent tank(s). Operational samples collected at the facility were below effluent limits before discharge. Additionally, facility operators relocated the operational sampling point to the effluent tank.

TA-21-357 (NPDES Outfall 02A129). On May 14, 1999, the total phosphorus (P) concentration exceeded the average and maximum NPDES permit limits at Outfall 02A129 at TA-21-357. However, reanalysis of the sample resulted in a lower phosphorus concentration that was within permit limits. An investigation indicated that the original high analytical reading was most likely a result of spot contamination in the digestion tube during analyses. Because the first sample was the only one that met all NPDES quality assurance/quality control requirements, the first analytical result exceeding the average and maximum permit limit was reported.

Guaje Well #2 (NPDES Outfall 04A173). On June 3, 1999, the aluminum concentrations exceeded the NPDES average and maximum permit limits at NPDES Outfall 04A173, associated with Guaje Well #2. As of September 1998, the water supply system is operated by the County of Los Alamos and owned by DOE, under a lease agreement. The Laboratory deleted this outfall from its NPDES Permit on September 21, 1999. In addition, the County of Los Alamos demolished this outfall on August 6, 1999.

TA-50, Building 1 (NPDES Outfall 051). On June 21, 1999, July 6, 1999, August 2, 1999, and October 14, 1999, the TA-50 RLWTF exceeded the average and/or maximum permit loading limits at NPDES Outfall 051 for total zinc (Zn). These zinc exceedances were a result of the new chemical denitrification treatment process that TA-50 RLWTF implemented to make the treatment plant effluent meet DOE Derived Concentration Guidelines and New Mexico groundwater standards for nitrate. This treatment process uses zinc. The TA-50 RLWTF also uses tubular ultrafiltration (TUF) and reverse osmosis (R/O) treatment units to meet NPDES permit limits. The reject wastewater from the R/O units currently is blended back into the headworks of the TA-50 RLWTF. As a result, zinc is continually recirculated through the TA-50 RLWTF and concentrated in the R/O wastewater.

After the zinc exceedances on June 21, 1999, July 6, 1999, and August 2, 1999, the clarifiers at TA-50 RLWTF were put back online on August 10, 1999, to precipitate out the residual zinc. These clarifiers were taken offline when the membrane treatment train (TUF/centrifugal ultrafilter/reverse osmosis) went into service. This measure was not sufficient; therefore, the last discharge of chemical denitrification unit effluent to the headworks occurred during the first week of November 1999. No further zinc-laden wastes from this treatment unit will be introduced into the TA-50 RLWTF headworks until another corrective measure has been identified to handle the zinc. Additionally, on November 16, 1999, facility operators implemented operational sampling to test for zinc before discharge from the effluent tanks. In the future, routine treatment of radioactive liquid wastewater will include the membrane treatment train and the clariflocculator treatment process.

In addition to the corrective actions noted, additional measures implemented to prevent noncompliances include performing operational sampling before discharge at outfalls, developing wastewater disposal policy with Waste Acceptance Criteria for treatment facilities, refining waste characterization and profiling processes, and using alternative wastewater disposal practices such as land application for dust suppression or re-use in cooling tower systems.

b. National Pollutant Discharge Elimination System Sanitary Sewage Sludge Management Program. In July 1997, the Laboratory requested approval from the EPA Region 6 to make a formal change in its sewage sludge disposal practices from land application under 40 CFR Part 503 regulations to landfill disposal as a 50–499 ppm PCB-contaminated waste. This change was necessary because of the repeated detection of low-level PCB (less than 5 ppm) in the SWS Facility’s sewage sludge. The EPA approved the Laboratory’s request in September 1997. In November 1997, the Laboratory formally adopted the following interim management practice: all sewage sludge generated at the SWS Facility will, until further notice, be handled, sampled, and disposed of in accordance with TSCA regulations for 50–499 ppm PCB-contaminated waste.

During 1999, the SWS Facility generated approximately 31.6 dry tons (63,200 dry lb) of sewage sludge. All of this sludge was, or will be, disposed of as 50–499 ppm PCB-contaminated waste at a TSCA-permitted landfill.

c. National Pollutant Discharge Elimination System Permit Compliance Evaluation Inspection. The NMED did not conduct a NPDES Outfall Compliance Evaluation Inspection during 1999.

d. National Pollutant Discharge Elimination System Storm Water Program. The NPDES permit program also regulates storm water discharges from certain activities. During 1999, the Laboratory had seven NPDES permits for its storm water discharges (see Table 2-1). Under the EPA Region 6 NPDES Storm Water Construction permit six projects were permitted: DARHT, Guaje Well Improvements Project, the Fire Protection Improvements Project, the Strategic Computing Complex (SCC), the Norton Power Line Project, and the TA-9-15 Gas Pipeline Replacement Project.

UC and DOE are co-permittees under the NPDES Multi-Sector General Permit for the Laboratory. The Multi-Sector General Permit regulates storm water discharges from the following industrial activities: hazardous waste treatment, storage, and disposal facilities operating under interim status or a permit under Subtitle C of RCRA (this category includes SWMUs); landfills, land application sites, and open dumps including those that are subject to regulation under Subtitle D of RCRA; steam and electric power generating facilities; asphalt batch plant operations and metal fabrication activities; vehicle maintenance activities; primary metal activities; and chemical manufacturing activities.

The Multi-Sector General Permit is the second general permit published by EPA that regulates storm water discharges from industrial activities. This permit expires in September of 2000, and EPA has proposed a third general permit for these activities.

As with the Baseline General Permit, the Multi-Sector General Permit requires the development and implementation of a Storm Water Pollution Prevention Plan. During 1999, the Laboratory developed and implemented 22 Storm Water Pollution Prevention Plans for its industrial activities.

The Multi-Sector General Permit requires monitoring of the storm water discharges from all industrial activities. The Laboratory collected approximately 74 samples for the three monitoring quarters during 1999 and will submit this monitoring data to EPA in the form of a Discharge Monitoring Report (DMR) before March 31, 2000.

To meet the monitoring requirements of the Multi-Sector General Permit, the Laboratory is operating 54 stream monitoring and partial record storm water monitoring stations on the canyons entering and leaving the Laboratory, at the confluence of these major canyons, and in certain segments of these canyons and at a number of facilities. The discharge information for 1999 is reported in “Surface Water Data at Los Alamos National Laboratory: 1999 Water Year” (Shaull et al., 2000).

e. National Pollutant Discharge Elimination System Storm Water Program Inspection. On July 12, 1999, EPA Region 6 and NMED conducted a compliance inspection of the Laboratory's Storm Water Program. Deficiencies noted during the inspection are being corrected.

f. Spill Prevention Control and Countermeasures Program. The Laboratory's Spill Prevention Control and Countermeasures (SPCC) Plans, as required by the CWA in accordance with 40 CFR 112, are comprehensive plans developed to meet the EPA requirements that regulate water pollution from oil spills. The Laboratory has SPCC Plans for the 28 aboveground oil storage tanks that operated during 1999.

g. Dredge and Fill Permit Program. Section 404 of the CWA requires the Laboratory to obtain permits from the Army Corps of Engineers (the Corps) to perform work within perennial, intermittent, or ephemeral watercourses. Projects involving excavation or fill below the normal high-water mark must be conducted with attention to water quality and riparian habitat preservation requirements of the Act. The Corps has issued a number of nationwide permits that cover specific activities. Each nationwide permit contains conditions to protect water quality. Section 401 of the CWA requires states to certify that 404 permits the Corps issued will not prevent attainment of state-mandated stream standards. NMED reviews Section 404/401 joint permit applications and issues separate Section 401 certification letters, which include additional permit requirements to meet state stream standards for individual projects at the Laboratory.

As shown on Table 2-1, the Laboratory had 19 nationwide permits under the Sections 404/401 program during 1999. Projects permitted include utility lines, road crossings, headwaters and isolated waters, and wetland/riparian areas.

9. Safe Drinking Water Act

a. Introduction. On September 8, 1998, DOE transferred operation of the Los Alamos Water Supply System from the Laboratory to Los Alamos County under a lease agreement. Under this agreement, the Laboratory retained responsibility for operating the distribution system within the Laboratory's boundaries, whereas the county assumed full responsibility for operating the water system including ensuring compliance with the requirements of the Safe Drinking Water Act (SDWA) (40 CFR 141) and the New Mexico Drinking Water Regulations (NMEIB 1995). Under the SDWA, Los Alamos County is required to collect samples from various points in the Laboratory's, Los Alamos County's, and Bandelier National Monument's water distribution systems and from the water supply wellheads to demonstrate compliance with SDWA maximum contaminant levels (MCLs). The EPA has established MCLs for microbiological organisms, organic and inorganic constituents, and radioactivity in drinking water. The state has adopted these standards and has included them in the NMEIB. The EPA has authorized NMED to administer and enforce federal drinking water regulations and standards in New Mexico.

During 1999, the Laboratory sampled all of the water supply wells in operation at the time of sampling for quality assurance purposes. The Laboratory's monitoring results are not for SDWA compliance purposes; Los Alamos County's SDWA sampling program determines SDWA compliance. This report presents the results from both the quality assurance monitoring the Laboratory conducted and the SDWA compliance monitoring Los Alamos County conducted.

In 1999, the monitoring network for Los Alamos County's SDWA compliance sampling program consisted of the following four location groups:

(1) wellhead sampling from the water supply wells in operation at the time of sampling (Guaje wells G1A, G2A, G3A, G4A, and G5A; Pajarito Mesa wells PM1, PM2, PM5; and Otowi well O4);

(2) the 6 total trihalomethane (TTHM) sampling locations within the distribution system;

(3) the 41 microbiological sampling sites located throughout the Laboratory, Los Alamos County, and Bandelier National Monument; and

(4) the 29 residential lead and copper sampling sites located in White Rock and the Los Alamos townsite.

Staff from NMED's Drinking Water Bureau performed all chemical and radiological sampling for Los Alamos County with the exception of TTHM and lead/copper sample collection, which JCNNM and Los Alamos County staff conducted. The New Mexico Health Department's Scientific Laboratory Division in Albuquerque and the Soil and Water Testing Laboratory in Las Cruces received samples for analysis. The JCNNM Health and Environmental (HENV) laboratory performs microbiological sampling and analysis. NMED has certified the HENV laboratory for microbiological compliance analysis. Certification requirements include proficiency samples, maintenance of an approved quality assurance/quality control program, and periodic NMED audits.

In 1999, the Laboratory's monitoring network for quality assurance sampling consisted of the following location group: wellhead sampling from the eight water supply wells in operation at the time of sampling (Guaje wells G1A, G2A, G3A, G4A; Pajarito Mesa wells PM1, PM2, PM5; and Otowi well O4). The Laboratory's quality assurance drinking water program provides additional assurance during the transition period following transfer of the water system to Los Alamos County. Sampling locations, frequencies, preservation, handling, and analyses follow the requirements specified in federal and state regulations. Laboratory staff performed chemical and radiological sampling and submitted the samples for analysis to the New Mexico Health Department's Scientific Laboratory Division in Albuquerque. NMED has certified laboratory staff to perform drinking water sampling. ESH-18 maintains both electronic and hard copy files of all data collected from quality assurance testing.

b. Radiochemical Analytical Results. In 1999, Los Alamos County collected drinking water samples from four water supply wells to determine the radiological quality of the drinking water. As shown in Table 2-7, the concentrations of gross alpha and gross beta activity were less than the EPA screening levels. When gross alpha and beta activity measurements are below the screening levels, Los Alamos County does not need to perform further isotopic analyses or perform dose calculations under the SDWA program. However, it should be noted that ESH-18 also conducts comprehensive monitoring of the water supply wells for radiochemical constituents (see Table 5-16).

Radon is a naturally occurring radionuclide produced during the decay of geological sources of uranium. In 1999, Los Alamos County conducted radon sampling at the five water supply wells in the Guaje well field. As shown in Table 2-8, the concentrations ranged from 224 to 576 pCi of radon per liter of water. On August 6, 1996, EPA withdrew the proposed MCL of 300 pCi of radon per liter of water. In August 1999, the EPA issued a new proposed rule for radon that sets the following regulatory standards for radon: an MCL of 300 pCi/L and an Alternative Maximum Contaminant Level (AMCL) of 4,000 pCi/L. The AMCL applies to those states that implement an EPA-approved Multi-Media Mitigation

Table 2-7. Radioactivity in Drinking Water (pCi/L) during 1999 by LANL

	Gross Alpha			Gross Beta		
Sample Location	**Calibration Std.**	**Value**	**(Uncertainty)**	**Calibration Std.**	**Value**	**(Uncertainty)**
Wellheads:						
Pajarito Well-PM1	^{241}Am	1.0	(0.4)	^{137}Cs	3.6	(0.9)
	Natural U	1.3	(0.5)	^{90}Sr, ^{90}Y	3.4	(0.8)
Pajarito Well-PM2	^{241}Am	0.5	(0.3)	^{137}Cs	1.7	(0.8)
	Natural U	0.6	(0.4)	^{90}Sr, ^{90}Y	1.7	(0.8)
Pajarito Well-PM5	^{241}Am	0.8	(0.4)	^{137}Cs	2.7	(0.9)
	Natural U	1.0	(0.5)	^{90}Sr, ^{90}Y	2.6	(0.9)
Guaje Well-G1A	^{241}Am	0.2	(0.3)	^{137}Cs	3.3	(0.9)
	Natural U	0.3	(0.4)	^{90}Sr, ^{90}Y	3.2	(0.8)
Guaje Well-G2A	^{241}Am	0.2	(0.3)	^{137}Cs	2.5	(0.8)
	Natural U	0.3	(0.4)	^{90}Sr, ^{90}Y	2.4	(0.8)
Guaje Well-G3A	^{241}Am	0.7	(0.3)	^{137}Cs	1.0	(0.8)
	Natural U	0.9	(0.4)	^{90}Sr, ^{90}Y	0.9	(0.8)
Guaje Well-G4A	^{241}Am	1.0	(0.3)	^{137}Cs	1.2	(0.8)
	Natural U	1.2	(0.4)	^{90}Sr, ^{90}Y	1.1	(0.8)
Otowi Well-O4	^{241}Am	1.2	(0.5)	^{137}Cs	3.1	(1.0)
	Natural U	1.4	(0.7)	^{90}Sr, ^{90}Y	3.0	(1.0)
EPA Maximum Contaminant Level		15			NA	
EPA Screening Level		5			50	

Table 2-8. Compliance Radon in Drinking Water (pCi/L) during 1999 by LA County

Sample Location	Value	(Uncertainty)[a]
Wellheads:		
Guaje Well Field-G1A	301	(20)
Guaje Well Field-G2A	345	(22)
Guaje Well Field-G3A	224	(17)
Guaje Well Field-G4A	576	(33)
Guaje Well Field-G5A	352	(23)
Proposed EPA Maximum Contaminant Level	300	

[a] Uncertainties are expressed as one standard deviation.

(MMM) program for reducing radon levels in indoor air. The State of New Mexico has announced that it intends to develop an MMM program. The EPA plans to publish the final rule by August 2000.

In 1999, the Laboratory collected quality assurance drinking water samples at eight water supply wells to determine the radiological quality of the drinking water. As shown in Table 2-9, the concentrations of gross alpha and gross beta activity were less than the EPA screening levels.

c. Nonradiological Analytical Results. In 1999, Los Alamos County collected TTHM samples during each quarter from six locations in the Laboratory and Los Alamos County water distribution systems. As shown in Table 2-10, the annual average for samples in 1999 was 5.2 µg of TTHM per liter of water, less than the SDWA MCL of 100 µg of TTHM per liter of water. In 1999, Los Alamos County collected samples for inorganic constituents in drinking water at the nine water supply wells in operation at the time of sampling. As shown in Table 2-11, all inorganic constituents at all locations were less than the SDWA MCLs.

In 1999, Los Alamos County collected VOC samples from the nine water supply wells in operation at the time of sampling. As shown Table 2-12, no VOCs were detected at any of the sampling locations with the exception of chloroform in the following wells: G2A (0.20 µg/L), G3A (1.20 µg/L), and G5A (0.20 µg/L). The SDWA MCL for chloroform is 80 µg of chloroform per liter of water. Chloroform is a byproduct of chlorine disinfection. It is believed that the source of the chloroform found in the samples was the chlorine used in disinfecting the wells. LANL's quality assurance sampling of wells G2A and G3A in November 1999 did not detect chloroform in the samples at concentrations greater than the analytical laboratory's sample detection limit.

In 1999, Los Alamos County collected lead and copper samples at residential drinking water taps. Under the SDWA, if more than 10% of the samples collected from selected residential sites exceed the action levels for lead or copper, then the water supplier must take prescribed actions to monitor and control the corrosivity of the water supplied to customers. Additionally, if 90% of the sample sites are below the action levels for lead and copper, then the water system is in compliance without the need to implement corrosion controls. As shown in Table 2-13, all 29 samples collected during 1999 were below EPA action levels for lead and copper. The Los Alamos Water Supply System was in compliance with the SDWA regulations for lead and copper in drinking water during 1999.

In 1999, Los Alamos County collected synthetic organic compound (SOC) samples from the following seven water supply wells in operation at the time of sampling: PM1, PM2, PM5, O4, G2A, G4A, and G5A. No SOCs were detected at any of the sampling locations at concentrations greater than the analytical laboratory's sample detection limit.

In 1999, LANL collected quality assurance samples for inorganic constituents in drinking water at the eight water supply wells in operation at the time of sampling. As shown in Table 2-14, all inorganic constituents at all locations were less than the SDWA MCLs.

In 1999, LANL collected quality assurance VOC samples from the eight water supply wells in opera-

Table 2-9. Compliance Radioactivity in Drinking Water (pCi/L) during 1999 by LA County

	Gross Alpha			Gross Beta		
Sample Location	**Calibration Std.**	**Value**	**(Uncertainty)[a]**	**Calibration Std.**	**Value**	**(Uncertainty)[a]**
Entry Points:						
Pajarito Well Field-PM2	^{241}Am	–0.20	(0.20)	^{137}Cs	2.50	(0.80)
	Natural U	–0.20	(0.30)	^{90}Sr, ^{90}Y	2.40	(0.80)
Pajarito Well Field-PM5	^{241}Am	–0.20	(0.30)	^{137}Cs	2.60	(0.80)
	Natural U	–0.20	(0.30)	^{90}Sr, ^{90}Y	2.50	(0.70)
Otowi Well Field-O4	^{241}Am	0.50	(0.40)	^{137}Cs	5.10	(0.80)
	Natural U	0.60	(0.50)	^{90}Sr, ^{90}Y	5.00	(0.80)
Guaje Well Field-G4A	^{241}Am	1.00	(0.60)	^{137}Cs	3.90	(0.80)
	Natural U	1.20	(0.80)	^{90}Sr, ^{90}Y	3.80	(0.80)
EPA Maximum Contaminant Level		15			NA	
EPA Screening Level		5			50	

[a]Uncertainties are expressed as one standard deviation.

Table 2-10. Compliance Total Trihalomethanes in Drinking Water (µg/L) during 1999 by LA County

	1999 Quarters			
Sample Location	**First**	**Second**	**Third**	**Fourth**
Distribution Sites:				
Los Alamos Airport	5.2	7.9	8.8	4.4
White Rock Fire Station	<0.5	1.3	<0.5	<0.5
North Community Fire Station	1.7	2.1	9.5	2.8
S-Site Fire Station	2.1	3.5	5.2	2.9
Barranca Mesa School	1.5	1.5	0.6	1.3
TA-39, Bldg. 02	13.2	13.5	19.5	15.2
1999 Average of 5.2 µg/L				
EPA Maximum Contaminant Level			100.0	
Sample Detection Limit			0.5	

Table 2-11. Compliance Inorganic Constituents in Drinking Water (mg/L) during 1999 by LA County

Sample Location	As	Ba	Be	Cd	Cr	F	CN	Hg	Ni	NO_3 (as N)	Se	Sb	Tl	SO_4
Wellheads:														
Pajarito Well Field-PM1	0.001	<0.1	<0.001	<0.001	0.003			<0.0002	<0.01	0.48	<0.005	<0.001	<0.001	
Pajarito Well Field-PM2	<0.001	<0.1	<0.001	<0.001	0.003			<0.0002	<0.01	0.33	<0.005	<0.001	<0.001	
Pajarito Well Field-PM5	0.001	<0.1	<0.001	<0.001	0.004			<0.0002	<0.01	0.30	<0.005	<0.001	<0.001	
Otowi Well Field-O4	0.002	<0.1	<0.001	<0.001	0.003			<0.0002	<0.01	0.38	<0.005	<0.001	<0.001	
Guaje Well Field-G1A	0.004	<0.1	<0.001	<0.001	<0.001	0.42	<0.1	<0.0002	<0.01	0.41	<0.005	<0.001	<0.001	<10
Guaje Well Field-G2A	0.010	<0.1	<0.001	<0.001	0.004	0.36	<0.1	<0.0002	<0.01	0.40	<0.005	<0.001	<0.001	<10
Guaje Well Field-G3A	0.005	<0.1	<0.001	<0.001	<0.001	0.32	<0.1	<0.0002	<0.01	0.52	<0.005	<0.001	<0.001	<10
Guaje Well Field-G4A	0.002	<0.1	<0.001	<0.001	0.002			<0.0002	<0.01		<0.005	<0.001	<0.001	
Guaje Well Field-G5A	0.003	<0.1	<0.001	<0.001	0.003	0.29	<0.1	<0.0002	<0.01	0.40	<0.005	<0.001	<0.001	<10
EPA MCLs	0.05	2.0	0.004	0.005	0.10	4.0	0.20	0.002	0.1	10.0	0.05	0.006	0.002	

Table 2-12. Compliance Volatile Organic Constituents in Drinking Water (µg/L) during 1999 by LA County

Sample Location	VOC Group I 62 Compounds
Entry Points:	
Pajarito Well Field-PM1	U
Pajarito Well Field-PM2	U
Pajarito Well Field-PM5	U
Otowi Well Field-O4	U
Guaje Well Field-G1A	U
Guaje Well Field-G2A	0.20 µg/L Chloroform
Guaje Well Field-G3A	1.20 µg/L Chloroform
Guaje Well Field-G4A	U
Guaje Well Field-G5A	0.20 µg/L Chloroform

U = None detected above the Sample Detection Limit (SDL).

tion at the time of sampling. No VOCs were detected at any of the sampling locations at concentrations greater than the analytical laboratory's sample detection limit.

d. Microbiological Analyses of Drinking Water. Each month during 1999, Los Alamos County collected an average of 46 samples from the Laboratory's, Los Alamos County's, and Bandelier National Monument's water distribution systems to determine the free chlorine residual available for disinfection and the microbiological quality of the drinking water. Of the 555 samples analyzed during 1999, none indicated the presence of total or fecal coliforms. Noncoliform bacteria were present in 38 of the microbiological samples. Noncoliform bacteria are not regulated, but their repeated presence in samples may serve as an indicator of stagnation and biofilm growth in water pipes. Table 2-15 presents a summary of the monthly analytical data.

e. Long-Term Trends. The Los Alamos water system has never incurred a violation for an SDWA-regulated chemical or radiological contaminant. The water supply wells have, on occasion, exceeded the proposed SDWA MCL for radon because of its natural occurrence in the main aquifer.

f. Drinking Water Inspection. The NMED did not conduct an inspection of the drinking water system during 1999.

10. Groundwater

a. Groundwater Protection Compliance Issues. Groundwater monitoring and protection efforts at the Laboratory have evolved from programs initiated by the US Geological Survey in the 1940s to present efforts. The major regulations, orders, and policies pertaining to groundwater are as follows.

DOE Order 5400.1 requires the Laboratory to prepare a Groundwater Protection Management Program Plan that focuses on protection of groundwater resources in and around the Los Alamos area and ensures that all groundwater-related activities comply with the applicable federal and state regulations.

Task III of Module VIII of the RCRA Hazardous Waste Facility Permit, the HSWA Module, requires the Laboratory to collect information regarding the environmental setting at the facility and to collect data on groundwater contamination. Task III, Section A.1, requires the Laboratory to conduct a program to evaluate hydrogeologic conditions. Task III, Section C.1, requires the Laboratory to conduct a groundwater investigation to characterize any contamination at the facility.

Table 2-13. Compliance Lead and Copper in Drinking Water at Residential Taps during 1999 by LA County

Values	Lead	Copper
Values less than or equal to Detection Limit	29 samples	29 samples
Values Detectable but less than Action Level	0 samples	0 samples
Values greater than Action Level	0 samples	0 samples
Total	29 samples	29 samples
Sample Detection Limit (SDL)	5 µg/L	50 µg/L
90th Percentile Value	<5 µg/L	<50 µg/L
EPA Action Level	15 µg/L	1300 µg/L

Table 2-14. Inorganic Constituents in Drinking Water (µg/L) during 1999 by LANL

Sample Location	As	Ba	Be	Cd	Cr	F	CN	Hg	Ni	NO_3 (as N)	Se	Sb	Tl
Wellheads:													
Pajarito Well-PM1	0.003	<0.1	<0.001	<0.001	0.006	0.26	<0.005	<0.0002	<0.01	0.47	<0.005	<0.001	<0.001
Pajarito Well-PM2	0.001	<0.1	<0.001	<0.001	0.006	0.27	<0.005	<0.0002	<0.01	0.32	<0.005	<0.001	<0.001
Pajarito Well-PM5	0.001	<0.1	<0.001	<0.001	0.003	0.27	<0.005	<0.0002	<0.01	0.29	<0.005	<0.001	<0.001
Guaje Well-G1A	0.014	<0.1	<0.001	<0.001	0.008	0.53	<0.005	<0.0002	<0.01	0.43	<0.005	<0.001	<0.001
Guaje Well-G2A	0.009	<0.1	<0.001	<0.001	0.003	0.38	<0.005	<0.0002	<0.01	0.4	<0.005	<0.001	<0.001
Guaje Well-G3A	0.002	<0.1	<0.001	<0.001	0.006	0.30	<0.005	<0.0002	<0.01	0.60	<0.005	<0.001	<0.001
Guaje Well-G4A	0.002	<0.1	<0.001	<0.001	0.002	0.28	<0.005	<0.0002	<0.01	0.50	<0.005	<0.001	<0.001
Otowi Well-O4	0.002	<0.1	<0.001	<0.001	0.002	0.30	<0.005	<0.0002	<0.01	0.38	<0.005	<0.001	<0.001
EPA Maximum Contaminant Levels	0.05[a]	2.0	0.004	0.005	0.1	4.0	0.2	0.002	0.1	10.0	0.05	0.006	0.002

[a] Proposed SDWA Primary Drinking Water Standard.

Table 2-15. Compliance Bacteria in Drinking Water at Distribution System Taps during 1999 by LA County

Month	No. of Samples Collected	No. of Positive Tests		
		Coliform	Fecal Coliform	Noncoliform
January	47	0	0	3
February	48	0	0	4
March	47	0	0	3
April	45	0	0	3
May	46	0	0	2
June	45	0	0	3
July	46	0	0	6
August	47	0	0	4
September	47	0	0	4
October	45	0	0	1
November	47	0	0	1
December	45	0	0	4
Total 1999	555	0	0	38
Maximum Contaminant Level (MCL)		[a]	[b]	[c]

[a] The MCL for coliforms is positive samples not to exceed 5% of the monthly total.
[b] The MCL for fecal coliforms is no coliform-positive repeat samples following a fecal coliform positive sample.
[c] There is no MCL for noncoliforms.

In March 1998, NMED approved a comprehensive hydrogeologic characterization work plan for the Laboratory. The Hydrogeologic Workplan (LANL 1998) was developed partially in response to NMED's denial of the Laboratory's RCRA groundwater monitoring waiver demonstrations. The plan proposes a multiyear drilling and hydrogeologic analysis program to characterize the Pajarito Plateau and to assess the potential for groundwater contamination from waste disposal operations. The goal of the project is to develop greater understanding of the geology, groundwater flow, and geochemistry beneath the 43-square-mile Laboratory area and to assess any impacts that Laboratory activities may have had on groundwater quality. The Hydrogeologic Workplan will result in an enhanced understanding of the Laboratory's groundwater setting and an improved ability to ensure adequate groundwater monitoring. Completion of the Hydrogeologic Workplan is anticipated in 2005.

New Mexico Water Quality Control Commission (NMWQCC) regulations control liquid discharges onto or below the ground surface to protect all groundwater in the State of New Mexico. Under the regulations, when required by NMED, a facility must submit a groundwater discharge plan and have NMED (or the Oil Conservation Division for energy/mineral extraction activities) approval. Subsequent discharges must be consistent with the terms and conditions of the discharge plan.

The Laboratory has three approved groundwater discharge plans to meet NMWQCC regulations (Table 2-1): one for TA-57 (Fenton Hill); one for the SWS Facility; and one for the land application of dried sanitary sewage sludge from the SWS Facility. On August 20, 1996, the Laboratory submitted a ground-water discharge plan application for the RLWTF at TA-50. As of December 31, 1999, NMED approval of the plan was still pending.

b. Compliance Activities. The Laboratory continued an ongoing study of the hydrogeology and stratigraphy of the region, as required by the HSWA Module of the RCRA Hazardous Waste Facility Permit, DOE Order 5400.1, and the Hydrogeologic Workplan (LANL 1998). The Groundwater Protection Management Program Plan that ESH-18 administers integrates studies by several Laboratory programs. The Laboratory's Groundwater Annual Status Summary Report (Nylander et al., 2000) provides more detailed information on newly collected groundwater data. Drilling progress for the Hydrogeologic Workplan (LANL 1998) during 1999 included work on the following wells. Some key findings for 1999 are noted.

- R-9 is located at the Laboratory's eastern boundary in Los Alamos Canyon. A temporary casing was removed, and well construction was completed in October.
- R-12 is located at the Laboratory's eastern boundary in Sandia Canyon. Well construction was in progress at the end of 1999.
- R-15 is located on the floor of Mortandad Canyon, approximately one mile upstream of the eastern Laboratory boundary. The well is downstream of the TA-50 RLWTF effluent discharge point. During drilling, we found tritium levels of approximately 4,000 pCi/L in a perched groundwater zone at 646 feet, indicating Laboratory impacts. However, tritium levels of < 3 pCi/L in the regional aquifer at 964 ft indicated no contamination. R-15 has been cased and developed.
- R-25 is located near the Laboratory's western boundary, south of Cañon de Valle within TA-16. During drilling in 1998, groundwater samples from a perched zone below 750 ft and from the regional aquifer showed high explosives and chemicals associated with their breakdown. In 1999, drilling was completed, and the well was partially constructed before complications with screen #3 delayed completion.
- R-31 is located in Ancho Canyon west of State Road 4. The first phase of drilling was completed in 1999.

The EPA issued findings from a 1998 groundwater sampling inspection of the Laboratory (EPA 1999). During the inspection, approximately 40 water samples were collected from wells, effluent sources, and springs located on DOE and San Ildefonso Pueblo lands. The findings are consistent with previous Laboratory studies and refer to water in the alluvium just below the canyon floor: "…three of the canyons sampled (DP, Mortandad, and Los Alamos) had groundwater exceeding EPA's Drinking Water MCLs for radionuclides and/or nitrate. All contamination detected within these canyons were within the LANL boundary, and no off-site contamination was detected. None of the contaminated aquifers (sic) are currently being used as a drinking water source." The EPA recommended additional characterization and groundwater monitoring of intermediate and deep groundwater underlying these canyons. In December 1999, the EPA returned to the Laboratory to conduct additional groundwater sampling of the water supply production wells and in Mortandad Canyon.

During the 1998 sampling inspection, the Laboratory and the NMED collected split samples at many of the sampling sites for comparison with the EPA results. A statistical analysis showed good overall agreement between EPA, NMED, and LANL results (Gallaher et al., 2000). In some 95% of the laboratory measurements, the three organizations agreed on whether contaminant levels exceeded regulatory limits.

11. National Environmental Policy Act

a. Introduction. The National Environmental Policy Act (NEPA) of 1969 (42 U.S.C. 4331 *et seq.*) requires federal agencies to consider the environmental impacts of proposed actions before making decisions. NEPA also requires a decision-making process open to public scrutiny. All activities DOE or the Laboratory proposes are subject to NEPA review. DOE is the sponsoring agency for most LANL activities. DOE must comply with the regulations for implementing NEPA published by the Council on Environmental Quality at 40 CFR Parts 1500–1508 and its own NEPA Implementing Procedures as published at 10 CFR Part 1021. Under these regulations and DOE Order 451.A, DOE reviews proposed LANL activities and determines whether the activity is categorically excluded from the need to prepare further NEPA documentation based on previous agency experience and analysis or whether to prepare one of the following:

- An Environmental Assessment (EA), which should briefly provide sufficient evidence and analysis for determining whether to prepare an Environmental Impact Statement (EIS) or a Finding of No Significant Impact (FONSI) for the proposed action, or
- An EIS, which is a detailed written statement of impacts with a subsequent Record of Decision (ROD).

If an EA or an EIS is required, DOE is responsible for its preparation. In some situations, a LANL project may require an EA or EIS; but, because the project is connected to another larger action that requires an EIS, the LANL Site-Wide EIS, or a programmatic EIS done at the nationwide level, the LANL project may be included in the larger EIS. The LANL project is then analyzed in the larger action or may later tier off the final programmatic EIS after a ROD is issued.

LANL project personnel initiate NEPA reviews by completing environment, safety, and health identification documents. These documents create the basis of a DOE NEPA Environmental Review Form, formerly known as a DOE Environmental Checklist. The LANL Ecology Group (ESH-20) prepares these documents using the streamlined format as specified by DOE/LAAO.

b. Compliance Activities. In 1999, LANL sent 159 NEPA Environmental Review Forms to DOE for review. DOE categorically excluded 70 actions and amended the categorical exclusion for 75 actions. DOE made other determinations on six actions. Two EA determinations resulted in FONSIs. Six actions were unresolved in 1999. LANL applied DOE "umbrella" categorical exclusion determinations for 161 actions.

c. Environmental Impact Statements.

Site-Wide Environmental Impact Statement. Under DOE's compliance strategy for NEPA, a SWEIS is prepared to examine the environmental impacts of operations at a multiprogram site. An earlier SWEIS for LANL operations was prepared in 1979; that document and subsequent NEPA reviews for specific project or program activities have served as the NEPA basis for operations at LANL until now. DOE completed a new SWEIS (DOE 1999) in January 1999; the associated ROD was signed on September 13, 1999. NEPA documents at LANL will be tiered from or reference this SWEIS until the DOE determines that a new SWEIS is needed. An annual report that identifies how LANL's operations track against the projections made in the SWEIS, the *SWEIS 1998 Yearbook,* is available at *http://lib-www.lanl.gov/la-pubs/00460172.pdf*, and an overview of the Yearbook is available at *http://lib-www.lanl.gov/la-pubs/00460173.pdf* on the World Wide Web. The yearbook will be published annually.

Conveyance and Transfer of Certain Land Tracts Located within Los Alamos and Santa Fe Counties and Los Alamos National Laboratory. DOE completed this EIS (DOE/EIS-0293) to assess the environmental impacts of conveying or transferring certain land tracts under the administrative control of DOE within Los Alamos and Santa Fe Counties in October 1999. Its ROD is anticipated in early 2000. The EIS evaluates the congressionally mandated action required under PL 105-119 to convey or transfer certain land tracts to the County of Los Alamos and to the Secretary of the Interior in trust for San Ildefonso Pueblo.

d. Environmental Assessments Completed during 1999. The status of the Laboratory's EA-level NEPA documentation and project descriptions follows.

Decontamination and Volume Reduction System for Transuranic Waste at Los Alamos National Laboratory (DOE-EA-1269). This EA addressed a decontamination and compaction process for reducing the volume of oversized metallic TRU wastes at LANL that require disposal at the Waste Isolation Pilot Plant (WIPP). The process, called the decontamination and volume reduction system (DVRS), will be implemented at TA-55 Dome 226. The DVRS will have the capability to produce and dispose of approximately 3,120 yd^{3}of oversized metallic TRU waste that is currently in storage at TA-55, within a substantially reduced operating period. The majority of this oversized TRU waste will be sorted, segregated, and decontaminated to meet low-level waste (LLW) criteria and then compacted and disposed of on-site as LLW. The remainder of oversized metallic TRU waste that cannot be decontaminated to meet LLW criteria will be cut up and compacted to fit into WIPP-approved waste containers, packaged, and shipped as TRU waste to WIPP. The DVRS is expected to process an estimated 7,020 yd^3 of oversized metallic TRU waste in about six years. DOE determined that the proposed action would not significantly affect the quality of the human environment, completed the EA, and issued a FONSI on June 25, 1999. This EA is available at *http://lib-www.lanl.gov/la-pubs/00326873.pdf* on the World Wide Web.

Nonproliferation and International Security Center (DOE-EA-1238). This EA analyzed construction and operation of a Nonproliferation and International Security Center at TA-3. The facility will increase the efficiency and effectiveness of support to DOE's Office of Nonproliferation and National Security through consolidation of personnel at a central location at LANL. The approximate 164,000-ft^2 building will contain offices and an instrumentation and calibration laboratory and will house approximately 465 employees relocated from other LANL facilities. LANL was the only site under consideration for the facility. The analysis indicated that potential adverse affects are only associated with severe and extremely unlikely accident conditions involving LANL's Chemistry and Metallurgy Research building. DOE determined that the proposed action would not significantly affect the quality of the human environment, completed the EA, and issued a FONSI on July 22, 1999. This EA is available at *http://nepa.eh.doe.gov/ea/ea1238/ea1238.html* on the World Wide Web.

Parallex Project Fuel Manufacture and Shipment (DOE-EA-1216). Activities necessary to analyze and manufacture 59.2 lb of mixed oxide (MOX) fuel at TA-55 and ship it to the US-Canada border were analyzed in this EA. The EA discusses a limited-scale test to provide DOE information necessary to assess and demonstrate the feasibility of using MOX fuel in Canadian Deuterium Uranium (CANDU) reactors as a potential disposition option for surplus weapons-usable plutonium. The ROD for *The Storage and Disposition of Weapons-Usable Fissile Materials Programmatic EIS* (DOE/EIS-0229) requires that DOE retain the option of dispositioning some weapons-usable plutonium as MOX fuel in heavy water reactors, such as CANDU reactors, if Russia, Canada, and the U.S. sign a multilateral agreement. DOE determined that the proposed action would not significantly affect the quality of the human environment, completed the EA, and issued a FONSI on August 13, 1999. This EA is available at *http://nepa.eh.doe.gov/ea/ea1216/ea1216.pdf* on the World Wide Web.

e. Environmental Assessments in Progress during 1999.

Electric Power System Upgrade. The proposed action consists of constructing and operating a 19.5-mi electric power transmission line from the Norton Station west across the Rio Grande to locations within TA-3 and TA-5. The project includes the construction of associated electric substations at the Laboratory, as well as the construction of two short line segments that would uncross a portion of two existing power lines. Additionally, a fiber optics communications line is included as part of the required grounding conductor for the power line. Work on the EA continued through 1999.

Leasing Land to a Commercial AM Radio Station. The proposed action is to lease approximately three acres of land at TA-54 to construct and operate a commercial (KRSN) radio broadcasting antenna. Work on this EA began in late December 1999.

f. Mitigation Action Plans. As part of the implementation requirements under NEPA, DOE prepares and is responsible for implementing Mitigation Action Plans (MAPs) (10 CFR 1021, Section 331 [a] July 9, 1996). MAPs are generally project specific and are designed to (1) document potentially adverse environmental impacts of a proposed action, (2) identify impact mitigation commitments made in the final NEPA documents (FONSIs or RODs), and (3) establish action plans to carry out each commitment. The MAP Annual Report (MAPAR) reports the implementation status of each MAP to the public. ESH-20 coordinates the implementation of the following DOE MAPs at the Laboratory.

Site-Wide Environmental Impact Statement. DOE issued this MAP in September 1999. The MAP provides details about the mitigation actions found in the ROD and tasks LANL with preparation of a project plan to implement them. Mitigations include specific measures to further minimize the impacts identified in the SWEIS as a result of operations (e.g. electrical power and water supply, waste management, and wildfire) and measures to enhance existing programs to improve operational efficiency and minimize future potential impacts from LANL operations (e.g., cultural resources, traditional cultural properties, and natural resources management). Specific measures should be completed by FY2006, and the enhancement of existing programs should be implemented by FY2003. A MAPAR will be prepared in 2000.

Dual Axis Radiographic Hydrodynamic Test Facility Mitigation Action Plan. DOE issued this MAP in 1995. On January 14, 1999, the DARHT MAPAR for 1998 was released to the public for review and comment.

During 1999, all DARHT construction-related mitigation measures were completed. ESH-20 issued a memorandum through DOE/LAAO providing a status and closure on all DARHT construction-related mitigation commitments and action plans on June 24, 1999. The memorandum was required as part of attaining authorization to begin operations for the DARHT project and provides documentation of DOE concurrence with ESH-20 that all applicable DARHT MAP construction mitigation measures have been appropriately addressed and are now complete. All operational mitigation action commitments for protecting workers, soils, water, biotic resources, and cultural resources in and around the DARHT facility are being implemented and are on schedule.

Low-Energy Demonstration Accelerator Mitigation Action Plan. DOE issued this MAP in 1996. On January 14, 1999, the LEDA MAPAR for

1998 was released to the public for review and comment. All MAP commitments for preventing soil erosion and monitoring industrial NPDES outfalls and potential wetlands formation in and around the LEDA facility are being implemented and are on schedule.

Lease of Land for the Development of a Research Park at LANL Mitigation Action Plan. DOE issued this MAP in October 1997. Implementation of the MAP was contingent on the completion and approval of the formal lease agreement between DOE and the lessee. The lease agreement is complete, and Congress approved it in February 1999. A MAPAR will be prepared in 2000.

12. Integrated Resources Management

DOE and LANL began planning and developing an Integrated Resources Management Plan (IRMP) in 1999. The Record of Decision for the LANL SWEIS includes a DOE commitment to prepare a site-wide IRMP over the next three years under the implementation of the SWEIS MAP.

The IRMP involves DOE and multiple LANL organizations and is being developed as a mission-oriented tool for integrating facility and land use planning activities with the management of natural and cultural resources. In 1999, DOE and LANL established an IRMP Project Management Team (PMT) to direct the preparation of the plan. The PMT completed a work plan to prepare the IRMP in November 1999. In addition, the Site-Wide Issues Project Office established a LANL steering committee to facilitate the development of the IRMP. The plan will integrate existing resource management plans and the development of other management plans with LANL site planning and mission activities.

As part of the IRMP effort in 1999, LANL began developing a Cultural Resources Management Plan (CRMP) and Biological Resources Management Plan (BRMP).

Cultural Resources Management Plan. As part of the MAP in the ROD for the Laboratory SWEIS, the Cultural Resources Team is assisting DOE/LAAO in developing a CRMP to provide an institutional approach for managing prehistoric and historic properties. Work on the CRMP began in 1999 and will continue through 2002. The CRMP will include an archaeological research design; historic contexts for evaluating buildings and structures of the Manhattan Project and the Cold War; the process the Laboratory uses for reviewing undertakings and determining effects; and the standards, procedures, and professional qualifications for managing cultural resources. In association with the CRMP, we will develop a policy-based approach to managing traditional cultural properties that are sacred to traditional Native American cultures. Additionally, the CRMP will contain a set of management goals and a five-year plan for attaining them that includes inventory and assessment targets for prehistoric and historic properties. Implementation of the CRMP will begin in 2003.

Biological Resources Management Plan. The BRMP is being developed to respond to an institutional need for an integrated and comprehensive approach to site-wide management of the following biological resources: threatened and endangered and other sensitive species; sensitive habitats (floodplains, wetlands, and Native American resource collection areas); large game and other wildlife species; and forests. The BRMP will address such issues as wildfire risk, vehicle accidents with elk and deer, and water quality issues like soil erosion and the movement of contaminants.

13. Cultural Resources

a. Introduction. The ESH-20 Cultural Resources Team is responsible for developing the CRMP (see Section 12), building and maintaining a database of all cultural resources found on DOE land, supporting DOE's compliance with the requirements applicable to cultural resource legislation as listed below, and providing appropriate information to the public on cultural resource management issues. Cultural resources are defined as archaeological materials and sites dating to the prehistoric, historic, or European contact period that are currently located on or beneath the ground; standing structures that are over 50 years old or are important because they represent a major historical theme or era; cultural and natural places, select natural resources, sacred objects and sites that have importance to American Indians; and American folklife traditions and arts.

b. Compliance Overview. Section 106 of the National Historic Preservation Act, Public Law 89-665, implemented by 36 CFR 800, requires federal agencies to evaluate the impact of all proposed actions on cultural resources. Federal agencies must also consult with the State Historic Preservation Officer (SHPO) and/or National Advisory Council on Historic Preservation about possible effects on identified resources.

During 1999, Laboratory archaeologists evaluated 749 Laboratory proposed actions and conducted 18 new field surveys to identify cultural resources. DOE sent 18 survey results to the SHPO for concurrence in findings of effects and determinations of eligibility for National Register inclusion of cultural resources located during the survey. The Governors of San Ildefonso, Santa Clara, Cochiti, and Jemez Pueblos and the President of the Mescalero Apache Tribe received copies for comment and identification of any traditional cultural properties that may be affected by a proposed action. ESH-20 identified no adverse effects to prehistoric cultural resources in 1999.

The American Indian Religious Freedom Act of 1978 (Public Law 95-341) stipulates that it is federal policy to protect and preserve the right of American Indians to practice their traditional religions. Tribal groups must receive notification of possible alteration of traditional and sacred places. The Native American Grave Protection and Repatriation Act of 1990 (Public Law 101-601) states that if burials or cultural objects are inadvertently disturbed by federal activities, work must stop in that location for 30 days, and the closest lineal descendant must be consulted for disposition of the remains. No discoveries of burials or cultural objects occurred in 1999.

The Archaeological Resources Protection Act (ARPA) of 1979 (Public Law 96-95) provides protection of cultural resources and sets penalties for their damage or removal from federal land without a permit. No ARPA violations were recorded on DOE land in 1999.

c. Compliance Activities.

Nake'muu. As part of the DARHT MAP, the Cultural Resource Team is conducting a long-term monitoring program at the ancestral pueblo of Nake'muu. The team is implementing the program to assess the impact of LANL mission projects on cultural resources. Nake'muu is the only pueblo at the Laboratory that still contains its original standing walls. It dates from circa 1200–1325 AD and contains 55 rooms with walls standing up to 6 feet high. As such, it represents one of the best-preserved ruins on the Pajarito Plateau. In 1999, the site was mapped and photographed and detailed drawings were made of all the standing masonry architecture. The team will update this baseline database on an annual basis and make continual assessments of site condition, deterioration rate, and possible sources of impact. The site is ancestral to the people from San Ildefonso Pueblo who refer to it in their oral histories and songs. They are invited for annual visits to Nake'muu to personally view the ruins and consult on the long-term status of the site.

Traditional Cultural Properties Consultation Comprehensive Plan. In 1999, the Cultural Resources Team assisted DOE/LAAO in developing a Traditional Cultural Properties Consultation Comprehensive Plan. This plan will provide the framework to open government-to-government consultations between DOE/LAAO and interested Native American tribal organizations on identifying, protecting, and gaining access to traditional cultural properties and sacred places. The development of the comprehensive plan is part of the mitigation actions described in the ROD for the SWEIS for the Continued Operation of the Los Alamos National Laboratory. The plan provides the legislative basis for traditional cultural properties protection and access agreements with participating tribal organizations. It also describes methods and procedures for maintaining confidentiality of sensitive information. The comprehensive plan will be available for tribal comment in the summer of 2000.

Land Conveyance and Transfer. Public Law 105-119, November 1997, directs the Department of Energy to convey and transfer parcels of DOE land in the vicinity of the Laboratory to the County of Los Alamos, New Mexico, and to the Secretary of the Interior, in trust for the San Ildefonso Pueblo. In support of this effort, the Cultural Resources Team conducted historic property inventories and evaluations as required under Section 106 of the National Historic Preservation Act, in preparation for the eventual transfer of lands out of federal ownership. This effort has included the archaeological survey of 4,700 acres of Laboratory lands and the inventory and evaluation of 47 buildings and structures located on the transfer parcels. Final cultural resources reports are scheduled to go to the New Mexico SHPO in the spring of 2000.

14. Biological Resources including Floodplain and Wetland Protection

a. Introduction. The DOE and the Laboratory comply with the Endangered Species Act; the Migratory Bird Treaty Act; the Bald Eagle Protection Act; Presidential Executive Order 11988, Floodplain Management; Presidential Executive Order 11990, Protection of Wetlands (Corps 1989); and Section 404 of the Clean Water Act. The Laboratory also protects plant and animal species listed by the New Mexico Conservation Act and the New Mexico Endangered Species Act.

b. Compliance Activities. During 1999, the ESH-20 Biology Team reviewed 409 proposed Laboratory activities and projects for potential impact on biological resources, including federally listed threatened and endangered species. These reviews evaluate the amount of previous development or disturbance at the site, determine the presence of wetlands or floodplains in the project area, and determine whether habitat evaluations or species-specific surveys are needed. Of the 409 reviews, the Biology Team identified 52 projects that required habitat evaluation surveys to assess whether the appropriate habitat types and parameters were present to support any threatened or endangered species. As part of the standard surveys associated with the Threatened and Endangered Species Habitat Management Plan, the Biology Team conducted approximately 30 species-specific surveys to determine the presence or absence of a threatened or endangered species at LANL. The Laboratory adhered to protocols set by the US Fish and Wildlife Service and to permit requirements of the New Mexico State Game and Fish Department.

c. Biological Resource Compliance Documents. In 1999, the Biology Team prepared several biological resource documents, such as biological assessments, biological evaluations, and other compliance documents. These documents included, among others, a biological assessment of the electrical power systems upgrade (Balice and Haarmann 1999) and the Isotope Production Facility (Loftin and Haarmann 1999). DOE determined that these projects may affect but are not likely to adversely affect individuals of threatened and endangered species or their critical habitat; the US Fish and Wildlife Service concurred with these determinations.

The Biology Team contributed to the continued implementation of the Threatened And Endangered Species Habitat Management Plan (HMP) (LANL 1998b). Site plans were successfully used to further evaluate and manage the threatened and endangered species occupying DOE/Laboratory property (see Sections 2.E.4 and 6.C.20). Members of both the Biology and Natural Resources Management Teams began developing the BRMP as described in Section 12.

C. Current Issues and Actions

1. Compliance Agreements

a. New Mexico Hazardous Waste Management Regulations Compliance Orders. The Laboratory received Compliance Order (CO) 98-01 on June 8, 1998, which alleged noncompliance with the NM Hazardous Waste Management Regulations at the DP Tank Farm, PRS 21-029. As part of the ordered actions, the Laboratory submitted a Sampling and Analysis Plan to NMED to address the alleged deficiencies in October 1998. NMED accepted the plan in 1999, and the CO has been resolved.

On June 25, 1998, the Laboratory received CO-98-02 that alleged two violations of the NM Hazardous Waste Management Regulations at TA-21 concerning the storage of gas cylinders. NMED proposed civil penalties of over $950,000. The Laboratory filed its answer to the CO on August 10, 1998, meeting the compliance schedule by demonstrating that all gas cylinders had been disposed of properly. Efforts to resolve this CO continued during 1999.

On December 21, 1999, the Laboratory received CO-99-03. It covered the alleged deficiencies the NMED Hazardous and Radioactive Materials Bureau discovered during a five-month inspection that took place in 1997. The inspection was called “wall-to-wall” because NMED personnel walked every space at the Laboratory—storage areas, laboratories, hallways, stairwells, and the areas around buildings—looking for improperly stored hazardous chemicals. In past inspections, only designated storage areas were included. A large number of violations were alleged with over $1 million in proposed penalties.

Twenty-nine deficiencies were alleged, including the following:

- inoperable eyewash decontamination unit (1),
- no accumulation start date on a container label (1),
- an open container (1),
- illegal storage past 90 days (1),
- no hazardous waste code on Land Disposal Restriction (LDR) notices (2),
- no annual RCRA refresher training (2),
- improperly labeled wastes (3),
- inadequately controlling hazardous wastes (6), and
- no hazardous waste determination (12).

The Laboratory will prepare its response to the CO during 2000. Because of the long time between the inspection and the issuance of the CO, the Laboratory has corrected most of the alleged violations.

The Laboratory received CO-99-01 on December 28, 1999, in response to the NMED inspection conducted between August 10 and September 18,

1998. The inspection team visited approximately 544 sites at the Laboratory. Total penalties proposed were almost $850,000.

The following 30 violations were alleged in the Compliance Order:

illegal storage past 90 days (4),

no hazardous waste determination (5),

no weekly inspections of storage areas (2),

no accumulation state date on a container label (1),

improperly labeling hazardous waste (4),

no hazardous waste code on the LDR notice (1),

not certifying an LDR notice (1),

no decontamination equipment (2),

no emergency communication devices (2),

no emergency fire equipment (1),

no annual RCRA review training (2),

inadequate operating records (4), and

inadequately controlling hazardous waste (1).

The Laboratory is in the process of preparing its answer to the Compliance Order. The full text of the COs received during 1999, as well as status updates, is available at *www.drambuie.lanl.gov/~esh19/* on the World Wide Web.

2. Environmental Oversight and Monitoring Agreement

The Agreement-in-Principle between the Department of Energy and the State of New Mexico for Environmental Oversight and Monitoring provides technical and financial support for state activities in environmental oversight and monitoring. The requirements of the agreement are carried out by the DOE Oversight Bureau of the New Mexico Environment Department. The bureau holds public meetings and publishes reports on its assessments of Laboratory activities. Highlights of the Oversight Bureau's activities are presented below.

Gamma radiation and air particulate monitoring. The bureau monitored gamma radiation at 11 stations near the Laboratory's perimeter and one station in Santa Fe. Airborne radionuclides were measured at four air monitoring stations surrounding the Laboratory. The levels of gamma radiation and airborne radionuclides were consistent with the levels LANL measured and were in the range of background.

Soil, sediment, and biota. Soil and sediment samples were collected at 21 locations. Except at a few locations known to be influenced by historical Laboratory releases, the levels of radionuclides and metals were consistent with regional background. A technical report, *NMED/LANL 1996 Soil Results: Data Evaluation and Statistical Comparison*, was issued. The report compares the bureau's results to LANL's for samples collected at 16 soil sampling stations. The results were similar to LANL's.

The bureau collected 11 fish samples from Cochiti and Abiquiu Reservoirs. Results for mercury were consistent with LANL's and within the range of historical data. Because the standard method for analyzing biological material for PCB compounds gave results at or below the method quantitation limit, the bureau analyzed some of its samples using a high-resolution method that quantifies low levels of PCB. Data resulting from the low-level measurements may be useful in evaluating potential toxicity of the compounds.

In 1999 NMED issued, *Flora and Fauna Sampling Results at Los Alamos National Laboratory, New Mexico during 1995 and 1996* (NMED 1999). In this report, results for all constituents, with the exception of lead, were similar to the results obtained by the Laboratory. For lead, the bureau measured concentrations lower than those LANL reported. The report also described results from Cochiti Reservoir fish samples that were analyzed for mercury and PCB compounds. The mercury concentrations were similar to those found in fish from other reservoirs in the state and were similar to those LANL reported. PCB were either not detected or were found at or below the method quantitation limit.

Surface Water and Groundwater. Bureau staff collected 60 samples from on-site and off-site wells, springs, and surface water stations. Storm water was collected from five of the Laboratory's eight major drainages. The bureau followed the hydrogeologic investigations, particularly the drilling of deep aquifer wells in Mortandad Canyon and at TA-16, and collected samples from some of the wells.

Environmental Restoration. The Oversight Bureau continued to participate in the work of the LANL Environmental Restoration Project. The bureau reviewed investigation and cleanup work associated with townsites, material disposal areas, and canyons. The bureau collected samples at two sites near Acid Canyon: below the former radioactive liquid waste treatment plant and in a drainage channel below the Old Catholic church.

The bureau helped to develop guidance for the assessment of ecological risk, reviewed and participated in the development of the Watershed Management Plan, and participated in the development of the watershed approach. Issues relating to surface water quality and contaminant transport were identified. Staff participated in developing and implementing a process to evaluate sites for the potential for erosion caused by surface water.

D. Consent Decree

1. Clean Air Act Consent Decree/Settlement Agreement

During 1997, DOE and the Laboratory Director entered into a Consent Decree and a Settlement Agreement to resolve a lawsuit that the Concerned Citizens for Nuclear Safety filed. The lawsuit, filed in 1994, alleged that LANL was not in full compliance with the CAA Radionuclide NESHAP, 40 CFR 61, Subpart H. The decree and agreement require actions that will continue through 2002 and, depending upon the results of the independent audits, may continue through 2004. All of the provisions of the decree and the agreement were met during 1999 and are described in detail at *http://drambuie.LANL.gov/~AirQuality/CD_Agreement.htm* on the World Wide Web.

Risk Assessment Corporation (RAC) completed the first independent technical audit of the Laboratory's Radionuclide NESHAP program during 1999. The final report indicates that the Laboratory did not meet certain regulatory and technical requirements and was not in compliance with 40 CFR 61, Subpart H for 1996. The audit also concluded that the Laboratory did not exceed the 10-mrem-per-year dose standard prescribed in the regulation. Although the Laboratory agreed that technical recommendations the RAC final report made would enhance the quality of the radionuclide NESHAP program, LANL did not agree that these findings demonstrate noncompliance with the NESHAP regulation during 1996 and did not modify its certification of compliance sent to EPA for that year. The Laboratory implemented most of the technical recommendations contained in the final audit report. The Laboratory submitted RAC's final audit report to DOE, and DOE has provided copies to EPA Region 6, NMED, and to the Laboratory's Community Reading Room. The second audit of the radionuclide NESHAP will begin in June 2000.

An independent contractor completed monitoring of thermoluminescent dosimeters during 1999. The Laboratory made the final payment to the University of New Mexico School of Medicine to fund development of a curriculum in the Masters of Public Health degree program on environmental health issues, called for by the 1997 Consent Decree, during 1999.

E. Significant Accomplishments

1. Environmental Restoration Project—The Watershed Approach

The ER Project reorganized its activities during 1999 according to the natural watersheds across the Laboratory in which the various PRSs are located. Each watershed consists of one or more components called aggregates; each aggregate contains several PRSs that will be investigated, assessed, and remediated (if necessary) as a group. The ER Project reevaluated over 2,100 individual PRSs to determine which were related by contaminant source, geographic location, and potential cumulative risk to group sites into eight watersheds.

A single watershed comprises one or more mesas and a common canyon drainage. The mesas draining into a common canyon may contain multiple contaminated sites. Each major canyon in the Los Alamos area was identified as an aggregate; eight canyon aggregates drain into the Rio Grande. Six of the eight watersheds contain multiple canyons and drainage systems with several hundred PRSs. As noted, these watersheds are subdivided into aggregates; additionally, potentially contaminated sites located on mesa tops and slopes were grouped into 27 site aggregates. Table 2-16 presents, by watershed, the canyon and site aggregates. The specific location of each canyon is shown on Figure 1-3.

The objective of the ER Project is to complete corrective actions at every site under its purview. Corrective actions are considered complete at a site when

- the ER Project has demonstrated and documented that the site either poses no risk to humans and ecological receptors or that the risk is acceptable—or a final remedy is evaluated, selected, and implemented to reduce or eliminate risk—and

- the administrative authority has concurred.

The ER Project Installation Work Plan fully documents the watershed approach; the plan is updated annually as part of the requirements of the RCRA Hazardous Waste Facility Permit, (LANL 2000).

In addition to a reengineered approach, the ER Project also revised its risk assessment methodology to add ecological risk assessments to the human health risk assessment if warranted by the risk-screening assessment. The current and future land use of the site determines human health exposure scenarios. Those scenarios include residential, industrial, recreational, and resource user categories (Mirenda and Soholt 1999). The ER Project has defined general risk endpoints for the Laboratory and has developed screening methods for assessing potential ecological risks (Ryti et al., 1999). The Installation Work Plan explains this process in more detail.

Readers can view the DOE's Paths to Closure for a review of the project schedule. Readers can keep current on the ER Project by reviewing *http://erproject.lanl.gov* on the World Wide Web.

2. TA-21 Nontraditional In Situ Vitrification Cold Demonstration

In April 1999, members of the ER Project, in conjunction with the DOE/LAAO; the DOE's Environmental Management Office of Science and Technology; MSE Technology Applications, Inc.; and Geosafe Corporation executed a demonstration of a nontraditional *in situ* vitrification (NTISV) technology on an area north of Area V in TA-21. The NTISV technology uses heat from electricity to convert earth into an inert, glass-like monolith. The conversion occurs below the ground surface. It is called a "cold" demonstration because it involves no radioactive constituents; the simulated bed contained low levels of petroleum hydrocarbons and nonhazardous chemicals chosen because they would behave like actual contaminants during the process. Analysis of the resultant materials is still in progress.

3. Pollution Prevention

In 1999, the Laboratory applied for nine NMED-sponsored Green Zia Pollution Prevention Environmental Excellence awards. The Laboratory has also encouraged subcontractors to apply and utilize these tools, resulting in two contractor applications.

The following are specific Laboratory projects completed in 1999:

- In September, the Laboratory opened a Materials Recovery Facility to capture recyclable materials and hazardous waste before they are shipped to the county landfill.
- The Laboratory initiated a procurement to have industry present technologies to increase the efficiency of the cooling towers, the largest source of water consumption at LANL. The cooling towers are currently only about 50% efficient, measured by the ratio of evaporated water to make-up water, and this project is expected to increase that efficiency to at least 75%.
- The Laboratory purchased a mobile unit to treat photochemicals, chiller cleaner, rinsewater, and other hazardous liquid wastes to meet the waste acceptance criteria for the sanitary waste plant.
- Replacing mercury thermometers with digital or alcohol-based thermometers has minimized the amount of mercury in Radiological Controlled Areas.

The Laboratory is currently using the Green Zia tools on the Transition Manufacturing & Safety Equipment (TMSE) Project. The TMSE Project is the primary project to ready LANL for nuclear pit production. This $72 million construction project includes significant facility upgrades in the TA-55 area. The Environmental Stewardship Office is working with the Nuclear Materials Technology Division to utilize the Green Zia tools to evaluate, avoid, reduce, and/or recycle TMSE radioactive and nonradioactive waste.

4. New Mexico Water Quality Control Commission 1998 Triennial Review

The Laboratory provided testimony as an interested party in a hearing NMWQCC conducted as part of the 1998 Triennial Review of water quality standards for the State of New Mexico. The amendments that resulted from this hearing may affect the effluent limitations that apply to Laboratory discharges regulated by the NPDES industrial outfall permit. Representatives from ESH-18, Laboratory Counsel, an independent law firm, water resource experts, and an aquatic biologist prepared and presented the Laboratory's testimony.

Table 2-16. Canyon Aggregates and Site Aggregates within Watersheds

Watershed	Canyon Aggregate	Site Aggregate
Los Alamos/Pueblo	Los Alamos/Pueblo	Middle Los Alamos/DP
		Pueblo
		Upper Los Alamos
		Bayo
		Rendija/Barranca/Guaje
		Lower Los Alamos
Sandia	Sandia	Upper Sandia
		Lower Sandia
Mortandad	Mortandad	Middle Mortandad/Ten-site
		Upper Mortandad
		Middle Cañada del Buey
		Upper Cañada del Buey
		Lower Mortandad/Cañada del Buey
		Lower Mortandad/Cedro
Pajarito	Pajarito	Lower Pajarito
		Threemile
		Starmer/Upper Pajarito
		Twomile
Water/Cañon de Valle	Water/Cañon de Valle	Cañon de Valle
		S-Site
		Potrillo/Fence
		Upper Water
		Lower Water/Indio
Ancho	Ancho	North Ancho
		South Ancho
Chaquehui	Chaquehui	Chaquehui
Frijoles	Frijoles	Frijoles

On December 7 and 8, 1999, the NMWQCC approved the final *State of New Mexico Standards for Interstate and Intrastate Surface Waters.* The new water quality standards were filed with the New Mexico State Records Center on January 24, 2000, and were effective February 23, 2000. EPA may consider the new water quality standards in establishing effluent discharge limits in the Laboratory's new NPDES industrial outfall permit.

5. SWEIS Yearbook

During production of the SWEIS, the SWEIS Project Office recognized the opportunity to make the SWEIS a "living" document that would provide both LANL and DOE with a tool to minimize additional NEPA analysis for ongoing projects. The idea was formulated for producing an annual "yearbook" for the SWEIS, which would minimize the need to update the SWEIS itself and would thereby result in substantial cost savings to DOE and the Laboratory. This yearbook provides comparisons of actual operations data to projections made in the SWEIS based on DOE's ROD for continued operation of the Laboratory. Not only does the yearbook enable DOE to make a decision on when and if a new SWEIS is needed, but it also serves as a guide to facilities and managers at LANL in determining whether activities are within the SWEIS operating envelope. Having this information available can streamline the NEPA process for new activities and avoid project delays. The first annual yearbook was published in December 1999.

6. Wildlife Reserve

SWIPO was the point-of-contact for LANL in the creation of the White Rock Canyon Wildlife Reserve that Secretary of Energy Bill Richardson dedicated on

October 30, 1999. This reserve of approximately 1,000 acres on the southeast perimeter of the Laboratory will be managed for its significant biological attributes, ecological and cultural resources, and research potential. The DOE and the Department of the Interior, National Park Service will co-manage the reserve with programmatic and technical assistance from UC/LANL.

7. V Site

In May 1998, DOE/LAAO received a Save America's Treasures matching grant to restore the V Site Manhattan Project buildings at Los Alamos National Laboratory. The Save America's Treasures grant was part of the Millennium Grant program sponsored by the White House and administered by the Department of Interior. The grant requires the Department of Energy to raise nonfederal matching funds to implement the award. In 1999, to facilitate the fund-raising activities, DOE has entered into a Memorandum of Understanding with the National Trust for Historic Preservation, a nonprofit historic preservation organization located in Washington, D.C., to assist the department in raising the necessary matching funds. The grant will help restore the V Site, which contains the most important remaining Manhattan Project buildings at Los Alamos. The high-explosive components of the "plutonium gadget" were assembled at V Site and detonated at Trinity Site in southern New Mexico on July 16, 1945. The restored buildings will house a Manhattan Project museum that will present interpretive displays and artifacts from the Manhattan Project at Los Alamos. The museum will be an annex of the Bradbury Science Museum in Los Alamos. This federal grant of $700,000 is contingent on obtaining matching funds.

8. Clean Water Act

During 1999, the Laboratory installed and/or instrumented an additional 22 stream monitoring stations, with eight additional stations proposed for FY00. The stations are located on the major canyons entering and leaving the Laboratory. In addition, stations were installed at the confluence of the major canyons within the Laboratory boundary and within certain segments of the larger canyons. The Laboratory is currently operating 54 monitoring stations.

F. Significant Events

1. Plutonium-239, -240 in Acid Canyon

Acid Canyon is a tributary to upper Pueblo Canyon, part of the Los Alamos/Pueblo watershed. Former TA-45 was located at the top of Acid Canyon; a wastewater treatment plant for radioactive liquid wastes and a vehicle decontamination facility were located there during the 1950s and early 60s. Decontamination and decommissioning of the main structures, associated waste lines, and wastewater outfalls began in October 1966.

In 1967, Los Alamos County assumed title to the property and used the site for storing and staging equipment and supplies for the Utility Department. After the Utility Department moved to its current site on Trinity Drive, the county built a skate park on the site in 1997. Investigation and cleanup activities have continued at former TA-45 and in Acid Canyon since 1945. The cleanups met the cleanup standards in place at the time.

In 1999, environmental personnel took sediment samples to confirm the results of previous studies. The sampling used a geomorphic approach (based on land forms) to identify and locate potentially contaminated sediment deposits. The sampling was designed to find the areas that might contain the highest contamination levels and involved detailed mapping of sediment deposits and intensive radiation surveys with field instruments.

Results of the investigation showed plutonium-239, -240 levels from 2 to 1,880 piC/g in sediment. The 1,880 piC/g value is three times higher than any previous sample analyzed from Acid Canyon. The Laboratory performed additional field studies, collecting 35 new sediment samples in November 1999 to further characterize plutonium concentrations and evaluate risks associated with these concentrations. The risk assessment will take place in 2000 when the sampling results are received and a more complete characterization of contaminants in Acid Canyon is available.

2. Detonable High Explosives at Material Disposal Area P

The Laboratory's ER Project has been working at Area P at TA-16 for several years implementing the cleanup of this site under a closure plan approved by NMED (see Section 2.B.1.c). Area P received burn pad debris and other wastes from the early 1950s until

1984. By December 1997, the Laboratory had excavated test pits, and workers began removing surface debris in October 1998. In February 1999, workers began excavating the landfill itself. In addition to removing equipment contaminated with HE from the World War II-era buildings, workers expected to remove HE residues, barium, and empty drums, bottles, and debris. They also found detonable pieces of HE. After revising the safety plan for the site, Laboratory workers began using a remote-handled machine to excavate the landfill. Explosives ordnance disposal experts sorted through the excavated materials. By the end of 1999, over 120 pounds of HE had been removed from the site and burned. ER Project managers expect cleanup work at the site to be completed during 2001.

3. Contamination in Wells in 1999

Data from the Hydrogeologic Workplan has shown that Laboratory operations have affected the deepest groundwater zone in some areas. Low levels of nitrate, tritium, and high explosives have been found in the deepest zone but have not impacted the present municipal drinking water supply wells. Well R-25 in TA-16 is located in an area where operations include high-explosives research, development, testing, and manufacturing. Discharges from past manufacturing activities appear to be the source of high-explosives constituents discovered in groundwater samples from this well.

G. Awards

1. Water Quality

Members of the ESH-18 NPDES Outfall and Storm Water/SPCC Teams received awards during 1999: the 1999 Pollution Prevention Success Award from the LANL Environmental Stewardship Office for NPDES Permit Reapplication Project, R-25 Monitoring Well Land Application, and the Surface Water Site Assessment Process. A member of the ESH-18 Storm Water/SPCC Team also received the LANL Achievement Award for his support of the TA-54 Storm Water Pollution Prevention Program.

2. Air Quality

A member of ESH-17 received a Los Alamos Achievement Award for outstanding research and development and was recognized by the ESH Division Review Committee for improved protection of the public. This research and development lead to improvements in atmospheric tritium measurements that provide for more accurate estimates of public health impacts from Laboratory operations.

3. Solid and Hazardous Waste

Three members of ESH-19 received Los Alamos Distinguished Performance Awards in 1999. One award was made for work on the Legacy Materials Cleanup project that resulted in significant time and dollar savings to the Laboratory. Members of teams that played essential roles in getting the first shipment of waste sent to the WIPP also received Distinguished Performance Awards.

ESH-19 staff participated on two Ship-to-WIPP projects and received several Laboratory division awards and letters of commendation from DOE Headquarters and the Albuquerque Area Office Manager’s Performance Excellence Award. Many years of effort went into getting the WIPP site open to receive waste and then demonstrating to the NMED that the Laboratory was ready to ship its waste.

A member of ESH-19 received two Pollution Prevention Awards during 1999. The first was for efforts to recycle 5,500 pounds of mercury rather than disposing of it. The second was for establishing recycling areas for solid wastes such as circuit boards, scrap metal, and cardboard that JCNNM maintenance and construction generated.

4. Ecology

Several ESH-20 employees received Los Alamos Achievement Awards for their work on the Threatened and Endangered Species Habitat Management Plan.

The DOE Los Alamos Area Office presented ESH-20 with Personal Peer Awards for work on specific projects. These included recognition for

- continued support of regulatory compliance programs and various interagency teams, including the Interagency Wildfire Management Team;
- continued support to the National Historic Preservation Act Compliance Program;
- continued support to the National Environmental Policy Act Compliance Program; and
- continued support to the Endangered Species Act Compliance Program.

ESH-20 received a Performance Excellence Award for the Land Conveyance and Transfer Project in recognition of significant contribution to the achievement of DOE Albuquerque Area Office's vision, mission, goals, and objectives.

One member of the ESH-20 technical staff was a distinguished nominee at the national conference for the Society of Mexican American Engineers and Scientists. He received an award from that Society in recognition of his professional contributions in the field of environmental research. The Spring/Summer 1999 magazine *Mexican American Engineers and Scientists* profiled his biography.

An ESH-20 graduate student received outstanding recognition and was presented with the Best Student Presentation Award at the annual meeting of the Society of Environmental Toxicology and Chemistry.

One member of the ESH-20 technical staff received a Performance Excellence Award from the DOE Albuquerque Operations Office for the Stockpile Stewardship Management Programmatic Environmental Impact Statement.

5. Environmental Restoration Project

The ER Project Program Manager and other project leaders and personnel received Los Alamos Achievement Awards for their efforts in directing and supporting the project reengineering. Members of the Communication and Outreach Team of the ER Project received Los Alamos Achievement Awards and DOE Environmental Excellence Awards for their work on preparing and presenting the *Land Conveyance and Transfer at Los Alamos National Laboratory under Public Law 105-119* document. ER Project personnel participated in the Team Award for Pollution Prevention Success with members of ESH-18 for their work on the R-25 Monitoring Well Land Application Project.

6. Waste Management Program

The Laboratory received three Green Zia awards in 1999. The Transuranic Waste Inspectable Storage Project received an achievement level award, and the Environmental Science and Waste Technology Division and Hydrodynamic Operations Group (DX-3) received commitment level Green Zia awards.

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3. Environmental Radiological Dose Assessment

3. Environmental Radiological Dose Assessment

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Abstract

We calculate potential radiological doses to members of the public who may be exposed to Los Alamos National Laboratory (LANL or the Laboratory) operations. To fully understand potential radiological impacts, we calculate the doses to the population nearby, to potentially maximally exposed individuals on- and off-site, and to "average" residents of Los Alamos and White Rock. The population and individual doses include consideration of all potential exposure pathways (primarily inhalation, ingestion, and direct exposure). Our calculations indicate the population within 80 km of LANL received a dose of 0.3 person-rem, smaller than last year's 0.8 person-rem (person-rem is the quantity used to describe population dose). The calculated maximum off-site radiation dose to a member of the public from Laboratory sources is near the Shell Station on Trinity Drive and was 0.7 mrem, which is less than 1% of the Department of Energy (DOE) dose limit of 100 mrem and also well below the level at which health affects would occur. This dose is calculated using all exposure pathways to satisfy DOE requirements and is different from the dose presented in Chapter 2, which is calculated for compliance with National Emission Standards for Hazardous Air Pollutants and considers only the dose from the air pathway. The calculated maximum on-site individual exposure to a member of the public is 3 mrem, which compares with 6 mrem in 1998. This member of the public is a hypothetical individual who passes along Pajarito Road near the Technical Area 18 Criticality Facility. Most of this dose would be from direct radiation for which the applicable dose limit is 100 mrem, the allowed dose from all pathways. No health effects would be expected from an exposure of this magnitude. Ingestion doses were calculated for produce, fish, eggs, deer, elk, and other locally grown or gathered foods. Among these, we saw net doses where the number is larger than its uncertainty for ingestion of deer collected in Los Alamos and cattle at San Ildefonso.

Health effects from radiation exposure have been observed in humans only at doses in excess of 10 rem. We conclude that the doses calculated here, which are in the mrem (one one-thousandth of a rem) range, would cause no human health effects. They are also much smaller than typical variations in the background radiation dose. The total dose from background radiation, greater than 99% of which is from natural sources, is about 360 mrem in this area and can vary by 10 mrem from year to year.

To Read About . . . **Turn to Page . . .**

A. Overview of Radiological Dose Equivalents

Radiological dose equivalents presented here are calculated doses received by individuals exposed to radioactivity. Radiation can damage living cells because of its ability to deposit energy as it passes through living matter. Energy deposited in the cell can result in cell damage, cell death, and, rarely, cell mutations that survive and can cause cancer. Because energy deposition is how radiation causes cell damage, radiation doses are measured in the quantity of radiation energy deposited per unit mass in the body. Different types of radiation carry different amounts of energy and are multiplied by adjustment factors for the type of radiation absorbed. Radiation affects different parts of the body with different degrees of effectiveness, but we need to report the "effective" dose the whole body has received. The term "effective dose equivalent" (EDE), referred to here as dose, is the "effective" dose calculated to have been received by the whole body, generally from an external radiation source. To calculate this dose we sum the doses to individual organs or tissues.

Long-lived radionuclides that a body inhales or ingests continue to deposit energy in the body and give doses for a long time after their intake. To account for this extended dose period, we also calculated a "committed effective dose equivalent" (CEDE), also referred to in this report as "dose." The CEDE gives the total dose, integrated over 50 years, that would result from radionuclides taken into the body from short-term exposures. In this report, we calculate CEDEs for radionuclides taken into the body during 1999. The doses we report below include the contributions from internally deposited radionuclides (CEDE) and from radiation exposures received from sources outside the body (EDE) all under the general term "dose."

Federal government standards limit the dose that the public may receive from Laboratory operations. The Department of Energy (DOE 1990) public dose limit to any individual is 100 mrem per year received from all pathways (i.e., all ways in which people can be exposed to radiation, such as inhalation, ingestion, and direct exposure). The dose received from airborne emissions of radionuclides is further restricted by the dose standard of the Environmental Protection Agency (EPA) of 10 mrem per year, which is codified in the Code of Federal Regulations (40 CFR 61); see Appendix A. These doses are in addition to exposures from normal background, consumer products, and medical sources. Chapter 2 presents dose calculations performed to comply with 40 CFR 61 (EPA 1986) that are based on different pathways and use different modeling programs than those performed for DOE requirements, which are presented here in Chapter 3.

This chapter reports calculations of potential radiological doses to members of the public. Therefore, we don't present worker doses in this report. Information on LANL worker radiation doses is published quarterly in the report "Los Alamos National Laboratory, Radiological Protection Program, Performance Indicators for Radiation Protection," which can be found in the Community Reading Room (505-665-4400).

B. Public Dose Calculations

1. Scope

Annual radiation doses to the public are evaluated for three principal exposure pathways: inhalation, ingestion, and external (also referred to as direct) exposure. We calculate doses that the population as a whole within 80 km may have received and also doses to specific hypothetical individuals within that population as shown below.

(1) *The entire population within 80 km of the Laboratory.* We base this modeled dose on all significant sources of radioactive air emissions at LANL. The modeling includes direct exposure to the radioactive material as it passes, inhalation of radioactive material, and ingestion of material that is deposited on or incorporated into vegetation and animal products such as poultry, eggs, and beef.

(2) *The maximally exposed individual (MEI) who is not on LANL/DOE property (referred to as the off-site MEI).* For this calculation, we use the definition of location in 40 CFR 61, which defines the receptor as someone who lives or works at the off-site location. Any school, residence, place of worship, or non-LANL workplace would be considered a potential location for the off-site MEI. Please note that although the definition for the location of this hypothetical individual is taken from 40 CFR 61, the dose calculation we perform here is more comprehensive than the one required for compliance with 40 CFR 61 (as presented in Chapter 2). The calculated dose to the off-site MEI we present here is an "all-pathway" assessment, which includes contributions from air emissions from stack and diffuse sources at LANL, ingestion of food gathered locally, drinking water from local supply wells, exposure to soils in the Los Alamos/White Rock area, and any other significant exposure route.

(3) *The on-site MEI is defined as someone who is in transit through LANL/DOE property but not necessarily employed by LANL.* DOE-owned roads are generally open to public travel. We calculate this dose for a hypothetical member of the public who is exposed while on LANL/DOE property.

(4) *An "average" resident of Los Alamos and White Rock.* We used average air concentrations from LANL's Air Monitoring Network (AIRNET) in Los Alamos and White Rock to calculate these doses. To these calculated doses, we add the contributions from other potentially significant sources, which may include the Los Alamos Neutron Science Center (LANSCE) and Technical Area (TA) 18 (LANSCE and TA-18

emissions are not measurable by AIRNET), from ingestion of local food products and water, and from exposure to radionuclides in local soils.

(5) *Ingestion doses for various population locations in northern New Mexico from ingestion of food grown (fruits and vegetables) or harvested (deer, elk, beef, and fish) locally.* Because not all food products are available everywhere within the 80-km radius, we do not have a uniform set of ingestion data on which to calculate doses. We report doses for all locations from which food was gathered.

(6) *Special Scenarios*

Each year, we look at a number of special situations that could result in the exposure of a member of the public. This year, we report doses calculated for

- drinking radioactive effluent from the TA-50 Outfall and
- exposure of a member of the public in Acid Canyon.

Other scenarios, which we analyzed and reported in previous reports (ESP 1996, 1997, and 1998), have not changed since that time, and, therefore, we did not reanalyze them. For example, in previous reports (ESP 1996, 1997), we modeled potential doses from contaminated sediments in Mortandad Canyon. Sediment sampling from 1999 indicates no significant changes from past years, so we did not perform new dose calculations for this exposure pathway. For the best estimate of potential doses from exposure to contaminated sediments in Mortandad or Los Alamos Canyon, see last year's report (ESP 1998). Finally, because wild fruits and vegetables were collected in Mortandad Canyon during 1997 but not 1998 or 1999, the best assessment of the dose from ingestion of fruits and vegetables is in Chapter 3 of the 1998 report (ESP 1998).

2. General Methodology

Our radiological dose calculations follow methodologies recommended by federal agencies to determine radiation doses (DOE 1991, NRC 1977) where possible. However, where our calculations do not lend themselves easily to standard methodologies, we have developed appropriate methods described below. The general process for calculating doses from ingestion or inhalation is to multiply the concentration of each radionuclide in the food product, water, or air by the amount of food or water ingested or air inhaled to calculate the amount of radioactivity taken into the body. Then, we multiply this amount by factors specific to each radionuclide (DOE 1988b) to calculate the dose from each radionuclide. We sum these amounts to give the total dose from each pathway, such as ingestion and inhalation, throughout the year. Where local concentrations are not known but source amounts (amounts released from stacks or from diffuse emission sources) are known, we can calculate the doses at receptor locations using a model. The model combines source-term information with meteorological data to estimate where the radioactive material went. By determining air concentrations in all directions around the source, the model can then calculate doses at any location. The models are also capable of calculating how much of the airborne radioactive material finds its way into nearby vegetation and animal material. Direct doses from radiation sources external to the body are calculated by multiplying the concentration of the radionuclide by the appropriate exposure factors (DOE 1988a). We use the Generation II (GENII) model for all dispersion evaluations (Napier et al., 1988) because this is the model DOE has accepted for dose calculation. The following sections provide some of the specifics of the modeling.

C. Dose Calculations and Results

Explanation of Reported Negative Doses: Because the concentrations of radionuclides are extremely low in most environmental samples, it is common that some of these concentrations will be reported as negative values by the analytical laboratory that performs the analyses. This result should be expected when very small concentrations are being analyzed. In fact, if all of our samples truly contained zero radioactivity, about half of our analyses would show positive numbers, about half would show negative results, and a few would actually show zero.

In Environmental Surveillance at Los Alamos reports before 1997, we carried these negative concentrations through all calculations, but then, if the calculated dose was less than zero, we reported it as zero. Starting in 1997, and continuing with this report, we report doses exactly as calculated based on analytical results. Therefore, you will see that some of the reported doses are less than zero. Obviously, a person could not receive a negative dose, and it may seem incorrect to report these numbers. However, many of the positive numbers we report are also not meaningfully positive. By reporting all of the calculated doses here, whether negative or positive, and using all these data over a period of years, it is possible to evaluate doses to individuals more accurately.

Many of the doses reported also include a number in parentheses. This number is one standard deviation of the dose. It means that approximately 67% of the dose values lie within the dose plus or minus one standard deviation. A large standard deviation means there is much uncertainty in the reported dose.

1. Dose to the Population within 80 km

We used the local population distribution to calculate the dose from 1999 Laboratory operations to the population within 80 km (50 miles) of LANL (Figure 3-1). Approximately 264,000 persons live within an 80-km radius of the Laboratory. We used county population estimates for 1999 provided by the University of New Mexico Bureau of Business and Economic Research (BBER). These statistics are available at *http://www.unm.edu/~bber/*.

The collective EDE (or dose) from Laboratory operations is the sum of the estimated dose each member of the population within an 80-km radius of LANL received. The 80-km ring is assumed to center on TA-3, the main technical area for Los Alamos National Laboratory. The dose calculation does not include those working on-site. It is intended to calculate doses to residents at their homes. Because this dose results from airborne radioactive emissions, we estimated the collective dose by modeling the transport of radioactive air emissions.

We calculated the collective dose with the GENII collection of computer programs (Napier et al., 1988). The analysis included airborne radioactive emissions from all types of releases. Stack emissions were modeled from all monitored stack sources. We also included diffuse emissions from LANSCE and Area G in the modeling. We used air concentration data from the nine AIRNET stations at Area G to calculate the diffuse emission source term from Area G. The exposure pathways included inhalation of radioactive materials; external radiation from materials present in the atmosphere and deposited on the ground; and ingestion of radionuclides in meat, produce, and dairy products.

We calculated the 1999 collective population dose attributable to Laboratory operations to persons living within 80 km of the Laboratory to be 0.3 person-rem (person-rem is the quantity used to describe population dose), which compares with the population dose of 0.8 person-rem reported for 1998 (ESP 1999). Figure 3-2 shows the different contributors to the population dose. Short-lived air activation products such as carbon-11, nitrogen-13, and oxygen-15 that the accelerator at LANSCE creates contribute about 6% to the calculated population dose. This amount was much less than previous years because LANSCE operated very little during 1999. Diffuse emissions of uranium, plutonium, and tritium from Area G are about 9% of the dose, and tritium from stack sources is about 83% of the dose. Plutonium, uranium, and americium from stack sources contribute about 3% of the dose.

2. Dose to Maximally Exposed Individual Not on Los Alamos National Laboratory Property (Off-Site MEI)

The location of the off-site MEI, the hypothetical highest exposure to a member of the public for the off-site MEI, has traditionally been at East Gate along State Road 502 entering the east side of Los Alamos County. East Gate is normally the location of greatest exposure because of its proximity to LANSCE. During experimentation at LANSCE, short-lived positron emitters are released from the stacks and diffuse from the buildings. These emitters release photon radiation as they decay, producing a potential external radiation dose. During 1999, however, LANSCE operated much less than in previous years, and the dose from LANSCE was very small.

To determine the location of the off-site MEI for 1999 (in the absence of a significant dose contribution from LANSCE), we used AIRNET results to find where the highest concentrations of radionuclides of potential LANL origin coincided with a residential area. To the dose calculated from AIRNET results, we added modeled doses from LANSCE and TA-18, whose emissions cannot be measured by AIRNET. We also added the contribution from ingesting food grown or gathered locally, from drinking water from local supply wells, and from living on contaminated soils in the vicinity (even though nobody actually lives at the location of these soils).

We found that the highest calculated dose from ambient air concentration of plutonium, americium, and tritium was at the apartments just south of the

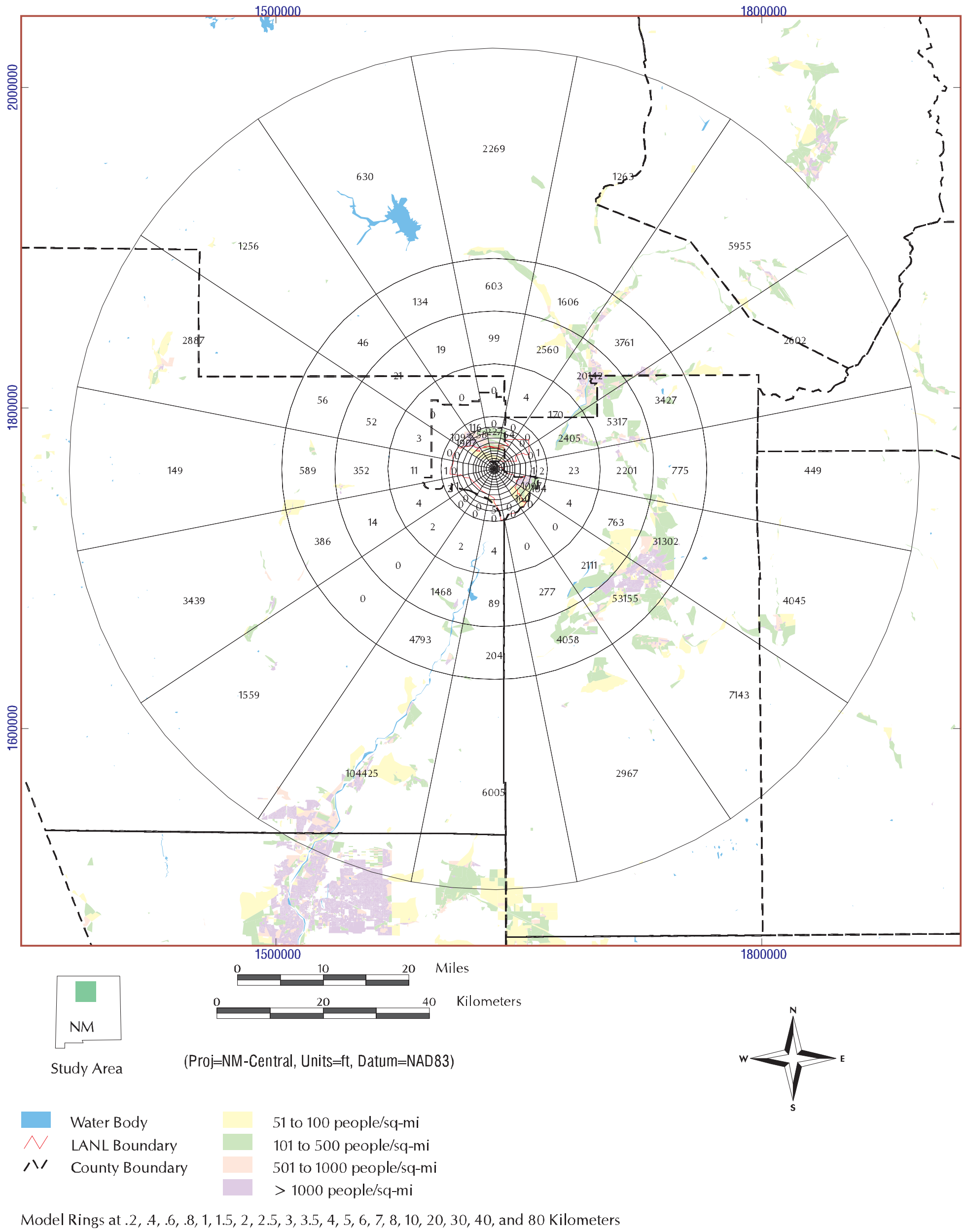

Figure 3-1. Estimated population around Los Alamos National Laboratory.

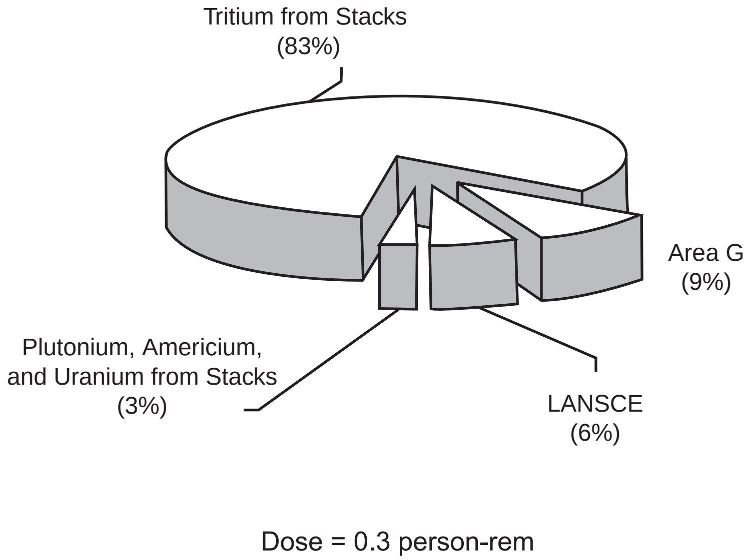

Figure 3-2. LANL contributions to population air pathway dose.

Shell Station on Trinity Drive in Los Alamos. The calculated net inhalation dose there was 0.04 mrem. To this inhalation dose, we added modeled doses from releases from LANSCE and TA-18 using the GENII computer code, which DOE developed for use in modeling doses from its facilities. The LANSCE contribution to the dose near the Shell Station was 0.0006 mrem, and the TA-18 contribution was 0.000003 mrem (Table 3-1). This calculated dose does not include the contribution from tritium from LANSCE because that tritium is included in the 0.04 mrem inhalation dose reported above.

Where references providing ingestion quantities were not available for locally grown or gathered food products, we attempted to quantify how much each food type contributed to the average person's ingestion dose. We interviewed residents of Los Alamos and White Rock to evaluate their ingestion habits. Based on these interviews, we concluded that average residents of Los Alamos/White Rock don't consume some of the food products gathered and analyzed this year. However, individuals who do consume products such as goat's milk and Navajo tea can calculate their individual doses by multiplying the amount they consume (in appropriate units) by the unit dose amounts provided in Table 3-2. We also concluded that the amounts of deer, elk, honey, and steer were less than the rates assumed in past environmental surveillance reports (ESP 1992–1999) and scaled these amounts to reflect local habits. The individual doses by food type for Los Alamos, White Rock, and San Ildefonso residents are discussed below. Table 3-2 shows these doses from consumption of various food types. However, the "average" doses shown in that table are based on national or regional averages (where these are known) and are not, in some cases, reflective of local consumption rates and habits. The total calculated food ingestion dose for an average resident of Los Alamos based on these calculations is 0.037 mrem.

LANL samples water supply wells each year, and the dose from drinking water from these wells is usually reported in these annual reports. Because of complications following the Cerro Grande fire, the subject matter experts determined that the sampling results for water supply wells for Los Alamos and White Rock were unreliable this year; please see more the detailed discussion in Chapter 5. The only two radionuclides (besides uranium, which is naturally occurring) that had concentrations above their detection limits were strontium-90 and americium-241. However, because of analytical problems, the strontium data were considered unreliable. The reported americium concentration was approximately the same as the concentration reported for a "blank." Blanks are sent to the lab and analyzed even though they are known to contain no radioactive material. They allow an assessment of the radioanalytical

Table 3-1. Summary of Doses to Various Receptors in the Los Alamos Area for 1999

	Receptors			
Sources	**Off-Site MEI Shell Station (mrem)**	**On-Site MEI Pajarito Road (mrem)**	**LA Average Resident (mrem)**	**WR Average Resident (mrem)**
LANSCE[a]	0.00060	0.00045	0.00045	0.00097
TA-18	0.0000025	2.6	0.0000053	0.000042
Ambient Air[b]	0.035	–0.039	–0.039	–0.043
Food Stuffs Ingestion[c]	0.037	0.037	0.037	0.038
Well Water Ingestion[d]	0.25	0.25	0.25	0.25
Soils Exposure[e]	0.33	0.33	0.33	0.33
Total	0.7	3	0.6	0.6

[a] These doses are modeled using GENII.
[b] These doses are calculated based on data from AIRNET stations in these areas. The calculations include background subtraction. The dose at Pajarito Road assumes the receptor is an average Los Alamos resident.
[c] Calculated from ingestion of foods grown or gathered locally.
[d] Calculated based on average of doses from 1995–1998.
[e] These doses are modeled with the RESRAD Code 5.70 using radionuclide data from local soil concentrations.

process. In this case, because the blank showed about the same amount of americium-241 as the sample from one of the wells, the subject matter experts concluded that we should not report americium-241 as present in that well. Instead of using the current year samples, we used an average of the past four years' data. Because concentrations within large aquifers are unlikely to change rapidly, averaging results from recent years should give a reasonable estimate of current concentrations. Uranium, which was detected in the samples, is presumably natural in origin and is not included in the dose assessment, which is intended to calculate potential LANL impacts. The dose calculated based on the average of four years' data is 0.3 (0.3) mrem.

We also calculated the net dose received from soils in the Los Alamos/White Rock area. Analyses from all soil samples from the entire area in or near Los Alamos and White Rock were combined to estimate average soil concentrations in this area. These average soil concentrations (Table 6-1) were the RESRAD input concentrations used to calculate the dose from gross (no background subtraction) soil concentrations. We calculated the net dose by subtracting the dose from background soil concentrations from the dose from gross concentrations. We used a simplified version of the residential scenario originally developed by Fresquez and others (1996) in a computer model, RESRAD Version 5.82, to estimate the EDE from external radiation and the CEDE from internally deposited radiation (Yu et al., 1993). The primary simplification was that the modeling performed here did not consider horizons other than the surface zone from which the soil samples were taken (Table 3-3). The rationale behind the decision to not include the plant or drinking water ingestion or soil inhalation pathways here is that they are evaluated through direct measurement of these media. We have included direct exposure to, and ingestion of, contaminated soil in this assessment.

Our intent with these calculations is to evaluate the potential exposure contribution from past or present LANL operations. Because uranium-238 is the source for atmospheric radon-222, uranium from LANL could be a source for atmospheric radon gas. However, uranium-238 has a half-life of several billion years and must decay through several, long-lived radionuclides before radon is produced. Therefore, any Laboratory-produced uranium that was deposited in the soil will be producing negligible amounts of radon. For this reason, we do not include the radon pathway. We compared the doses calculated with those

Table 3-2. Ingestion Doses from Foods Gathered or Grown in the Area during 1999

	Dose per Unit Consumed in 1999 (mrem)	Average Consumption[a] Dose[b] (mrem)		Maximum Consumption[a] Dose[b] (mrem)	
Produce					
Regional Background (see text)	1.2×10^{-6}/lb	**0.00036**	**(0.00028)**	**0.0013**	**(0.0010)**
LANL On-Site Stations	-8.6×10^{-7}/lb[c]	–0.00025	(0.00028)	–0.00093	(0.0010)
Los Alamos Townsite	-1.0×10^{-6}/lb	–0.00029	(0.00029)	–0.0011	(0.0011)
White Rock & Pajarito Acres	-3.4×10^{-7}/lb	–0.00010	(0.00032)	–0.00037	(0.0012)
San Ildefonso Pueblo	-8.7×10^{-7}/lb	–0.00026	(0.00029)	–0.00094	(0.0011)
Cochiti Pueblo	-7.9×10^{-7}/lb	–0.00023	(0.00028)	–0.00085	(0.0010)
Piñon					
Regional Background (see text)	1.3×10^{-2}/lb	**0.038**	**(0.0043)**	**0.13**	**(0.014)**
Los Alamos	–0.0021/lb	–0.0063	(0.0087)	–0.021	(0.029)
White Rock	–0.0013/lb	–0.0038	(0.0057)	–0.013	(0.019)
San Ildefonso Pueblo	–0.0045/lb	–0.014	(0.0053)	–0.045	(0.018)
Goat's Milk					
Regional Background (Albuquerque)	0.0001/gal				
Los Alamos	–0.0009/gal				
White Rock	0.0083/gal				
Honey					
Regional Background	0.00012/lb	0.0004	0.0051	0.0013	0.017
Los Alamos	–2.5 E-10/lb	–9.2 E-10	8.70 E-09	–2.70 E-09	2.90 E-08
White Rock	–0.00011/lb	–0.00037	0.0052	0.0012	0.017
Navajo Tea (Cota)					
Regional Background (Española)	0.00012/L				
Los Alamos	0.00036/L				
White Rock	–0.00052/L				
San Ildefonso Pueblo	0.00075/L				
Egg					
Regional Background (Española)	0.00022/2 eggs	**0.040**	**(0.017)**	**0.060**	**(0.025)**
Los Alamos	–0.000063/2 eggs	–0.012	(0.021)	–0.017	(0.032)
White Rock/Pajarito Acres	0.000021/2 eggs	0.0039	(0.018)	0.0058	(0.027)
San Ildefonso Pueblo	–0.000074/2 eggs	–0.014	(0.024)	–0.020	(0.036)
Spinach					
Regional Background	0.0048/lb	**0.0013**	**0.00021**		
Los Alamos	–0.0025/lb	–0.00067	0.00036		
White Rock	–0.0015/lb	–0.00041	0.00029		
San Ildefonso Pueblo	–0.0037/lb	–0.001	0.0005		
Steer					
Regional Background	2.7×10^{-5}/lb muscle 0.14/lb bone	**7.3**	**1.1**	**8.5**	**1.2**
San Ildefonso Pueblo	0.0013/lb muscle 0.0032/lb bone	0.44	1.3	0.51	1.5

Table 3-2. Ingestion Doses from Foods Gathered or Grown in the Area during 1999 (Cont.)

	Dose per Unit Consumed in 1999 (mrem)	Average Consumption[a] Dose[b] (mrem)	Maximum Consumption[a] Dose[b] (mrem)
Deer			
Regional Background (Dulce, NM)	0.00015/lb muscle		
	0.038/lb bone		
Los Alamos Area Roads	0.00015/lb muscle		
	0.040/lb bone		
Elk			
Regional Background (Coyote, NM)	0.00060/lb muscle		
	0.062/lb bone		
Los Alamos Area Roads	–0.00035/lb muscle		
	0.039/lb bone		
Game Fish			
Regional Background (upstream)	0.00052/lb		
Cochiti (downstream)	0.00040/lb		
Nongame Fish			
Regional Background (upstream)	0.0012/lb		
Cochiti (downstream)	0.00023/lb		

[a] Average and maximum consumption values used in calculations are reported in text for specific food product.
[b] The mean dose is reported with two standard deviations (2s) given in parentheses. Because most of the means are very close to zero, the 2s range usually includes zero, small positive, and small negative values. If the mean is greater than 2s, it is more likely that the mean is significant. **Numbers where the mean is greater than or equal to the 2s value are bolded in the table.**
[c] See Section 3.C for an explanation of negative numbers.
Note—doses presented in this table are based on foodstuffs and biota data included in Chapter 6.
Note—Background doses (indicated in the table as “Regional Background”) are calculated based on food products from areas distant from LANL. Net doses are calculated by subtracting background doses from those at a sampled location near LANL.

Table 3-3. RESRAD Input Parameters for Soils Exposure Evaluation for 1999

Parameter	Value	Comments
Area of contaminated zone	10,000 m^2	RESRAD default value; a large area maximizes exposure via external gamma, inhalation, and ingestion pathways
Thickness of contaminated zone	3 m	Based on mesa top conditions (Fresquez et al., 1996)
Time since placement of material	0 yr	Assumes current year (i.e., no radioactive decay) and minimal weathering
Cover depth	0 m	Assumption of no cover maximizes dose
Density of contaminated zone	1.6 g/cm^3	Based on previous models (Buhl 1989) and mesa top conditions (Fresquez et al., 1996)
Contaminated zone erosion rate	0.001 m/yr	RESRAD default value
Contaminated zone total porosity	0.5	Average from several samples in Mortandad Canyon (Stoker et al., 1991)
Contaminated zone effective porosity	0.3	Table 3.2 in data handbook (Yu et al., 1993)
Contaminated zone hydraulic conductivity	440 m/yr	An average value for soil (not tuff) (Nyhan et al., 1978)
Contaminated zone b parameter	4.05	Mortandad Canyon consists of two units, the topmost unit being sand (Purtyman et al., 1983) and Table 13.1 in the data handbook (Yu et al., 1993)
Humidity in air	4.8 g/m^3	Average value from Los Alamos Climatology (Bowen 1990)
Evapotranspirations coefficient	0.85	Based on tritium oxide tracers in Mortandad Canyon (Penrose et al., 1990)
Wind Speed	2 m/s	RESRAD default value
Precipitation	0.48 m/yr	Average value from Los Alamos Climatology (Bowen 1990)
Irrigation rate	0 m/yr	Water in Mortandad Canyon is not used
Runoff coefficient	0.52	Based on mesa top conditions (Fresquez et al., 1996)
Inhalation rate	8,400 m^3/yr	RESRAD default value
Mass loading for inhalation	9×10^{-5} g/m^3	Phermex (OU 1086) Risk Assessment for respirable particles
Exposure duration	1 year	Assumes current year exposure only
Dilution length for airborne dust	3 m	RESRAD default value
Shielding factor, inhalation	0.4	RESRAD default value
Shielding factor, external gamma	0.7	RESRAD default value
Fraction of time spent indoors in study area each year	0.5	RESRAD default value
Fraction of time spent outdoors in study area	0.25	RESRAD default value
Shape factor	1	Corresponds to a contaminated area larger than a circular area of 1,200 m^2
Depth of soil mixing layer	0.15 m	RESRAD default value
Soil ingestion rate	44 g/yr	Calculated based on 100 mg/d for 24 yr (adult) and 200 mg/d for 6 yr (child) (Fresquez et al., 1996)

from exposure to background soils from the Embudo, Cochiti, and Jemez areas.

The net dose and one standard deviation for Los Alamos/White Rock area were found to be 0.3 (0.6) mrem. The background dose was 0.6 (0.2) mrem. The dose summary table (Table 3-1) includes the Los Alamos/White Rock doses. They are also added to the dose to an average member of Los Alamos or White Rock from other pathways or sources as described below. These doses are similar to the doses reported last year (within the range of uncertainty), as would be expected in the absence of any large-scale ground-contaminating event.

Figure 3-3 shows that the combination of the AIRNET calculated dose of 0.04 mrem, the GENII modeled doses of 0.0006 and 0.000003 mrem (from LANSCE and TA-18, respectively), the food ingestion dose of 0.037 mrem (Table 3-4), the water ingestion dose of 0.3 mrem, and the soils dose of 0.3 mrem gives a total off-site MEI dose of 0.7 mrem (Table 3-1). This level is far below the applicable 100 mrem standard, and we conclude these doses would cause no human health effects.

This dose is not comparable directly with the doses reported in Chapter 2, which are calculated for compliance with 40 CFR 61. The Chapter 2 dose includes only the air pathway and is modeled using a different computer model, CAP88, as required by 40 CFR 61. The dose presented here is for all pathways and uses the DOE GENII computer code.

3. Dose to Maximally Exposed Individual on Los Alamos National Laboratory/Department of Energy Property (On-Site MEI)

The Laboratory's largest contributor to the on-site MEI is the Criticality Facility at TA-18. Criticality experiments produce neutrons and photons, both of which contribute to the external penetrating radiation dose. During experiments, neutrons and photons from the experiments reach Pajarito Road, a LANL/DOE-owned local road that is open to the public most of the time. During experiments that have the potential to produce a dose of several mrem per operation, public access is restricted by closing Pajarito Road between White Rock and TA-51. Exposure to a member of the public would be negligible during road closures. However, we evaluated doses to an individual who passed by the facility frequently and received very small exposures from operations that took place while the road remained open. The exposure scenario likely to give the largest cumulative dose to a member of the public is a slow jogger who passes the facility frequently. Experimentation at TA-18 did not result in any road closures during 1999, so the total measured exposure was used in the dose calculation. We divided the total measured dose by 16 to account for the amount of time a member of the public might realistically have been in the area.

The dose we calculated by this method for 1999 operations of TA-18 is 2.6 mrem. Assuming that the

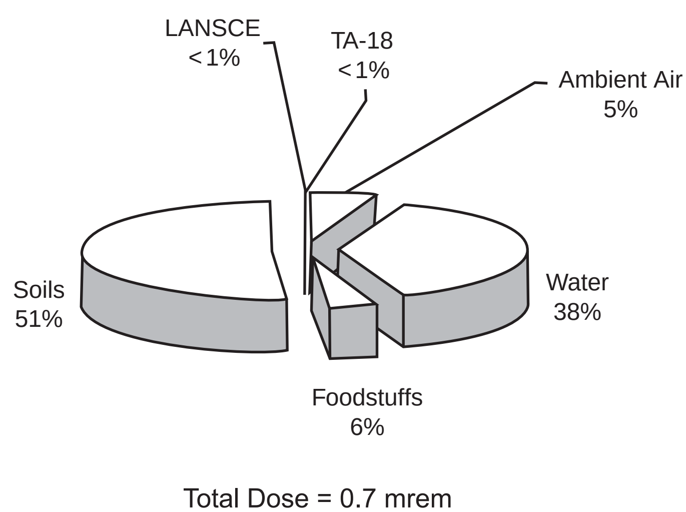

Figure 3-3. LANL contributions to maximally exposed off-site hypothetical individual during 1999.

Table 3-4. Compilation of Calculated Ingestion Doses for Los Alamos and White Rock

	Los Alamos (mrem)	1s (mrem)	White Rock (mrem)	1s (mrem)
Deer	**0.018**	**0.0044**	**0.018**	**0.0044**
Eggs	NC[a]	0	NC	0
Elk	0.021	0.025	0.021	0.025
Game Fish	NC	0	NC	0
Goat's Milk	NC	0	NC	0
Honey	NC	0	NC	0
Nongame Fish	NC	0	NC	0
Navajo Tea	NC	0	NC	0
Pinon	NC	NC	NC	NC
Produce	–0.000292	0.000289	–0.000101	0.000321
Spinach	–0.0007	0.0004	–0.0004	0.0003
Steer	NC	NC	NC	0
Total	0.037	0.025	0.038	0.025

[a] NC—not calculated. We did not calculate values for these foods because we determined that they were not a significant part of the average resident's diet.
Note—Bold indicates where value is larger than its uncertainty.

jogger was a resident of Los Alamos during 1999, the dose from food and water ingestion, from LANSCE operation, and from exposure to contaminated soils and air would add to the dose from TA-18. These additional doses appear in Table 3-1 and in Figure 3-4. The total calculated dose to this hypothetical resident of Los Alamos would be 3.2 mrem. This dose is about 3% of the DOE public dose limit of 100 mrem.

4. Doses to Average Residents of Los Alamos and White Rock

We calculated doses to the average residents of Los Alamos and White Rock based on average air concentrations (as determined from AIRNET data) in these areas. To these calculated doses, we added the contributions from LANSCE and TA-18 (some radionuclides emitted from LANSCE and TA-18 are not measurable by AIRNET), from ingestion of local food products and water, and from exposure to radionuclides in soil. In years before 1997, the Laboratory's annual environmental surveillance report did not include doses other than those from LANSCE and those calculated from AIRNET data in estimating average doses to Los Alamos and White Rock residents. Therefore, the doses reported here are not directly comparable with those earlier estimates of average doses in Los Alamos and White Rock.

a. Los Alamos Dose. The total LANL contribution to the dose to an average resident of Los Alamos during 1999 was 0.6 mrem from all pathways (Table 3-1). Figure 3-5 shows the various Laboratory contributions to this dose. The remainder of this section explains what contributed to this calculated 0.6 mrem dose.

We compiled air concentration data for uranium, plutonium, americium, and tritium from stations #4 (Barranca School), #5 (Urban Park), #6 (48th Street), #7 (Shell Station), #8 (McDonalds), #9 (Los Alamos Airport), #10 (East Gate), #12 (Royal Crest Trailer Court), #60 (Los Alamos Canyon), #61 (Los Alamos Hospital), and #62 (Trinity Bible Church). The inhalation dose calculated from the Los Alamos AIRNET data is –0.04 mrem and includes a subtraction for background air concentrations. The dose does not include a contribution from uranium isotopes because, based on evaluation of the ratio of uranium isotopes 234 and 238, only natural uranium was measured in the ambient air. Because no significant LANL-derived uranium was measured, we saw no reason to add uranium into the dose. Discussion of negative doses appears earlier in this chapter.

Because most of the radioactive emissions from LANSCE and TA-18 are not measurable by AIRNET, we modeled the dose from these emissions to a central

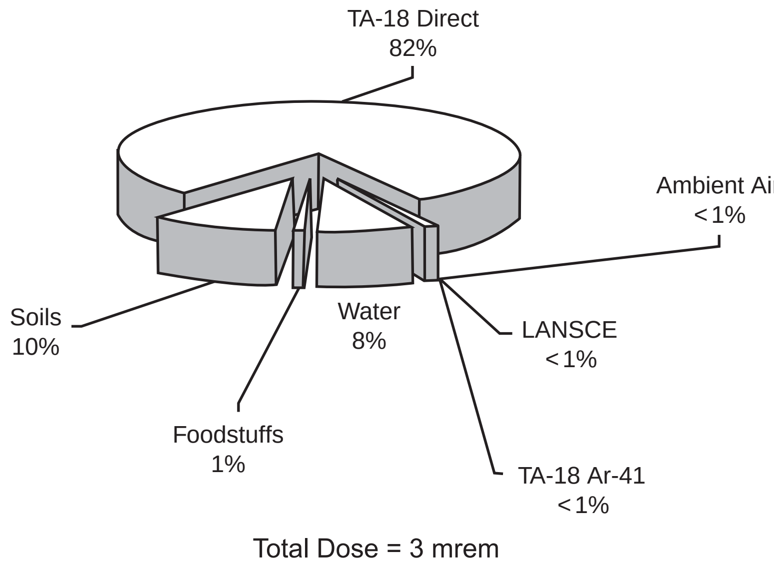

Figure 3-4. LANL contributions to maximally exposed on-site hypothetical individual during 1999.

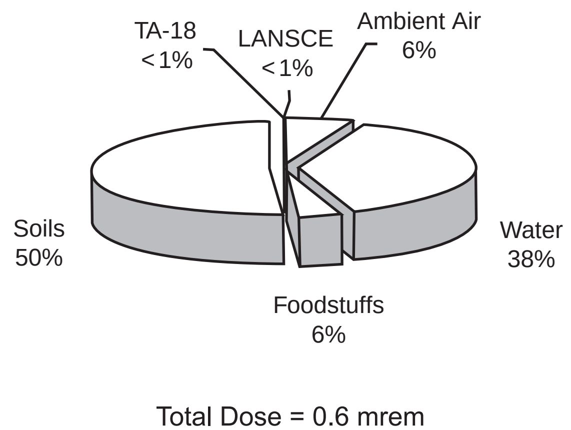

Figure 3-5. LANL contributions to an average Los Alamos resident's radiological dose in 1999.

point in Los Alamos using the GENII computer code. Exposure to the radioactive plume as it passes was the only significant pathway. We calculated the dose to a typical Los Alamos resident to be 0.0005 mrem from LANSCE and 0.000005 mrem from TA-18 (Table 3-1).

As discussed earlier, the dose calculated from exposure to contaminated soil in Los Alamos is 0.3 mrem. Because the one-standard-deviation value associated with this dose is 0.6 mrem, the net dose most likely lies within a range that includes zero.

Ingestion of locally grown or gathered food could provide additional dose. We calculated the dose from ingestion of food gathered or grown in the Los Alamos area and consumed by locals to be 0.037 mrem (Table 3-1).

As described above, we calculated the water ingestion dose from the Los Alamos/White Rock water supply by averaging the previous four years' data. The calculated dose is 0.3 (0.3) mrem with the uncertainty of one standard deviation in parentheses.

Summing all the possible contributors results in a total dose to an average Los Alamos resident of 0.6 mrem. This calculated dose derives mainly from water consumption and soil exposure. The uncertainties in these numbers indicate that this calculated dose is statistically indistinguishable from zero.

b. White Rock Dose. The total dose from all pathways to an average resident of White Rock from Laboratory operations was 0.6 mrem in 1999. The methodology for calculating the White Rock dose was identical to that used for Los Alamos. We used the following AIRNET stations to calculate average White Rock air concentrations: #13 (Rocket Park Tennis Courts), #14 (Pajarito Acres), #15 (White Rock Fire Station), #16 (White Rock Church of the Nazarene), and #63 (Monte Rey South). The net air inhalation dose calculated from these data is –0.04 mrem. The dose contribution from LANSCE operations in 1999 was 0.001 mrem, and the contribution from TA-18 was 0.00004 mrem (Table 3-1).

The potential dose from the water supply is the same as calculated for Los Alamos and was 0.3 (0.3) mrem based on an average of water sampling results for 1995–1998. Living on local soils provides the same dose potential as to a member of Los Alamos (because all sites in the Los Alamos/White Rock area were grouped together for the soil exposure evaluation); the dose would be 0.3 mrem (0.6 mrem) from exposure to soils. Ingestion of locally grown or gathered food products would provide a dose of 0.037 mrem (Table 3-1).

Summing all the possible contributors results in a total dose to an average White Rock resident of 0.6 mrem. This calculated dose derives mainly from water consumption and soil exposure. The uncertainties in these numbers indicate that the actual dose most likely lies within a range that includes zero.

5. Ingestion Doses for Various Locations in Northern New Mexico

We collected and analyzed many different types of food products for their radionuclide content. The following section presents the details of calculating food ingestion doses for various locations and food types in northern New Mexico. The food ingestion doses described here are included in the total doses reported above for average and maximally exposed residents of Los Alamos and White Rock if the foods were gathered from those areas and are part of the "average" diet. These doses are tabulated in Table 3-2.

The following sections describe the doses calculated for each type of food. Doses are calculated (Table 3-2) for regional background concentrations (foods that were grown or gathered distant from LANL and that are presumed to reflect concentrations not affected by LANL operations) and for net concentrations at all other locations. We calculated net concentrations by subtracting background concentrations from those at the location of interest. The general process for calculating ingestion doses is to multiply the amount of each radionuclide ingested in a food product by a dose conversion factor for that radionuclide (DOE 1988b) to obtain the dose contribution for each radionuclide. We sum these contributions to calculate the total dose from each food type.

We performed three calculations for foodstuffs whose average and maximum consumption values are documented: one assuming average consumption rates, one assuming maximum hypothetical consumption rates, and one for dose-per-unit of food consumed. We have been reviewing the consumption rates used in our ingestion calculations and have begun updating these rates to be consistent with more recent studies compiled in the Environmental Protection Agency's Exposure Factors Handbook (EPA 1989), where appropriate. Therefore, the average and maximum doses calculated here may not be comparable with earlier reports. Unit doses are, however, directly comparable. From the Exposure Factors

Handbook, we use the mean and 95% values for average and maximum intake, respectively, for households that garden in the western United States. The consumption rates we used in these calculations are reported in the subsections below. We report the dose-per-unit of food consumed so that individuals may calculate their own hypothetical doses based on their knowledge of their actual consumption rates. Consumption doses are calculated for all foodstuffs for which we had acceptable data. The uncertainty of one standard deviation is reported in parentheses.

a. Ingestion of Produce (Fruits and Vegetables). We collected fruits and vegetables at a number of locations throughout northern New Mexico. Because the plant types collected differed according to site, it was not possible to compare produce ingestion doses from location to location. Although the specific food types differed at various locations, Table 6-3 shows the values for the category of fruits and vegetables collected. For this report, we assume an average consumption rate of 294 lb per year and a maximum rate of 1,071 lb per year of homegrown fruits and vegetables (EPA 1997). These calculated ingestion amounts are based on Tables 13-12 and 13-17 (EPA 1989), which apply to intake of homegrown fruits and vegetables among western households that garden. This calculation assumes a body weight of 78.1 kg (Table 7-2, EPA 1989), which is the average body weight for adult males aged 18 to 75. The highest doses calculated occurred from ingestion of food products in regional background locations. The average consumption net annual dose at LANL on-site locations was –0.0003 (0.0003) mrem.

b. Ingestion of Piñon. Doses for ingestion of piñon tree nuts or tree shoot tips are calculated because of the importance of piñon in the local diet. The piñon trees produce piñon nuts irregularly in non-annual cycles about every seven to 10 years. Nuts were only available in 1998 at regional locations and sites on LANL property. The analytical results from the nuts are included in Chapter 6, but we did not perform dose calculations because nuts were not collected from local, non-LANL areas. Because results from piñon nuts were not available, we collected and analyzed piñon tree shoot tips, and Table 6-14 reports those results. Most literature suggests that the inedible portions of plants tend to have higher concentrations of radionuclides than the edible portions of plants (Fresquez et al., 1998a). Therefore, using piñon tree foliage to estimate doses for the ingestion of pine nuts probably overestimates risk. We included all radionuclides shown in Table 6-14 in the dose calculation. The highest (and only positive) unit dose of 0.013 (0.0014) mrem per pound of piñon shoots was calculated for the background station average. We assumed that the average annual consumption was about 3 lb and that the maximum annual consumption was 10 lb. We calculated the dose from average consumption of piñon shoots at San Ildefonso Pueblo for 1999 to be –0.014 (0.005) mrem.

c. Ingestion of Goat's Milk. Goat's milk was collected from Los Alamos, White Rock/Pajarito Acres, and Albuquerque (the background location) and analyzed (Table 6-7). "Average" consumption doses are not reported because few people drink goat's milk (Table 3-2). We report dose per gallon consumed so that those people who do drink goat's milk may calculate their dose. Some doses for White Rock/ Pajarito Acres and for the Albuquerque (background) milk were positive. The net dose in Los Alamos was negative but smaller than its associated uncertainty. The positive doses were also smaller than their uncertainties.

d. Ingestion of Navajo Tea. We collected Navajo tea (Cota) stems from Los Alamos, White Rock/Pajarito Acres, San Ildefonso Pueblo, and background locations. All calculated doses were smaller than their associated uncertainties. We calculated positive, very small doses for Los Alamos, San Ildefonso, and Española (background) area. The largest dose we calculated was for San Ildefonso and was 0.0008 (0.006) mrem per liter of tea consumed (Table 3-2).

e. Ingestion of Chicken Eggs. We collected and analyzed chicken eggs from Los Alamos, White Rock/ Pajarito Acres, San Ildefonso Pueblo, and from Española (the background location). All of the doses we calculated from egg consumption were extremely small; only the background dose was statistically different from zero. We calculated positive doses for the background location in Española and for White Rock (Table 3-2). An annual dose from an average consumption of one egg per day from the background location would be 0.04 (0.02) mrem.

f. Ingestion of Steer Meat and Bone. We collected free-range cattle from San Ildefonso Pueblo lands, and we compared the results of the analyses with regional background averages (Table 6-12). Table 3-2 presents the doses for consumption of meat and bone from the average background steer and for consumption of the steer from San Ildefonso Pueblo.

(Note: Pieces of bone sometimes end up in food-stuffs.) Consuming muscle and bone from San Ildefonso Pueblo would give doses of 0.001 and 0.003 mrem per pound, respectively.

g. Ingestion of Deer Meat and Bone. We collected deer killed along roadways within and around Los Alamos, analyzed their meat and bone tissue, and compared the results with regional background samples. We calculated the dose from the background deer to be 0.0002 mrem per pound of muscle consumed and 0.04 mrem per pound of bone consumed. The deer killed in the Los Alamos area would give net doses of 0.0002 and 0.04 mrem per pound consumed of muscle and bone, respectively.

h. Ingestion of Elk Meat and Bone. We collected elk around Los Alamos, analyzed their meat and bone tissues, and compared the results to regional background elk samples. We calculated the dose from the background elk to be 0.0006 mrem per pound of muscle consumed and 0.06 mrem per pound of bone consumed. Calculated net dose for consumption of the Los Alamos elk was –0.0004 mrem per pound of muscle and 0.04 mrem per pound of bone consumed (Table 3-2).

Note on Deer and Elk Analyses:

A two-year elk tracking study concluded that elk that spent an average of 50% of their time on LANL lands contained radionuclide concentrations in muscle and bone similar to those in elk collected as roadkill for the Laboratory's environmental surveillance program (Fresquez et al., 1998b). Therefore, it is our conclusion that these roadkill deer and elk provide a reasonable representation of the contamination levels in deer and elk populations that frequent LANL properties.

i. Ingestion of Fish. We compared surface- and non-bottom-feeding fish (referred to as game fish), including trout, walleye, and bass, collected from reservoirs upstream of LANL (Abiquiu, Heron, and El Vado) with game fish collected from Cochiti Reservoir, downstream of LANL. The calculated dose per pound from ingesting downstream game fish [0.0004 (0.0006) mrem] was slightly lower than the 0.0005 (0.0004) mrem per pound dose for upstream fish although the uncertainties indicate the doses are not statistically different from each other (Table 3-2).

We collected bottom-feeding fish (referred to as nongame fish), including carp, catfish, and sucker, from the same reservoirs as game fish. For nongame fish, the background dose was slightly higher than the net downstream dose although, as for the game fish, the differences were not statistically meaningful (Table 3-2). The assumed average and maximum consumption rates were the same for nongame fish as for game fish.

j. Ingestion Doses for San Ildefonso Pueblo. Residents of San Ildefonso Pueblo may receive doses from ingestion of food products grown or gathered locally and from drinking water from local supply wells.

Food products were analyzed for radionuclide content (see Chapter 6), and we used these analyses to calculate doses from ingestion. Table 3-2 contains the doses from ingestion of all foods grown or gathered locally. Samples from wells in and around San Ildefonso Pueblo were not available for this report.

k. Summary of Food Product Ingestion Doses. Statistically significant doses were seen for consumption of several food types from background locations. However, the only statistically significant *net* dose we calculated was for consumption of deer from areas around Los Alamos. By significant, we mean that the uncertainty in the measurements (which is shown in parentheses) is smaller than the measured number and that the measured number is positive. When the uncertainty range includes zero (i.e., when the reported number minus the uncertainty is less than zero), then the number itself is not different from zero in a statistically significant sense.

6. Special Scenarios

a. Potential Radiological Dose to a Member of the Public Visiting Acid Canyon, Los Alamos. Acid Canyon is a tributary of upper Pueblo Canyon and received discharges of radioactive waste during the 1940s, 1950s, and 1960s from former TA-1 and TA-45. Since that time, the upper reaches of Acid Canyon have undergone a series of investigations. During 1999, detailed sampling by ER, NMED, and EPA was based on geomorphic assessment of where contaminants are most likely to be found (Reneau et al., 2000). The sampling revealed that some sediments along the several hundred meters of the South Fork of Acid Canyon contain relatively high concentrations of radionuclides. This area is open to the public. In fact, a maintained trail crosses this part of Acid Canyon in two places, and sections of the trail parallel the canyon for much of its length. Residential areas nearby make this a popular area for walking, running, biking, and general recreation.

We calculated the radiological dose that a frequent adult visitor to this area could receive. To develop this dose calculation, we evaluated all the sediment sampling results to determine how much radioactive material could be contributed to ambient air. We summed the contributions to calculate the total amount of radioactive material we would conservatively expect to be suspended in the local air. We assumed that this air was not mixing with air outside the immediate area. In other words, all the air was derived from suspension of the soils along the stream sides and within about 25 meters of the stream on both sides of the canyon.

An individual was assumed to breathe the local air for an hour per day, every day of the year. This individual was assumed to be breathing very heavily for 10 minutes and breathing lightly for the rest of the time. A possible scenario is as follows:

Someone has been running hard for a few minutes and runs up the trail into the upper Acid Canyon area. When the individual reaches the area (the area is too small for someone to jog in for any length of time), he or she sits down on the banks of the stream to relax and recover and remains there for 50 minutes. We also assume that the individual ingests 100 mg of dust derived locally per visit (EPA 1989).

The dose calculated, based on the assumptions described above, is 1.6 mrem for a year. About 1.2 mrem of this would come from ingestion, and most of the remaining dose would be from inhalation. It is unlikely that a casual adult user would receive more than this dose although scenarios can certainly be postulated that involve larger ingestion and therefore larger dose. This dose is less than 2% of the applicable all-pathway limit of 100 mrem. At such low doses, we conclude there would be no human health effects.

b. Ingestion of Radioactive Effluent from the Technical Area 50 Outfall. TA-50 discharges residual radioactive effluent to Mortandad Canyon. During 1999, the effluent included tritium, strontium-89; strontium-90; cesium-137; uranium-234; uranium-235; plutonium-238; plutonium-239, -240; and americium-241. No water is derived from Mortandad Canyon for drinking, industrial, or agricultural purposes, and comparisons with drinking water standards are not appropriate. However, because no physical barriers prevent public access to this canyon, it is possible, though unlikely, that an ingestion of the effluent could occur. The most likely scenario involves a very thirsty jogger or hiker who hears the water trickling and, in desperation, drinks from the end of the pipe. Rather than attempt to estimate a "reasonable" amount that someone might consume, we present the dose-per-liter consumed here so that others may draw conclusions about the radiological dose and relative hazard that this effluent represents. We calculated the dose from effluent consumed to be 1.0 mrem per liter, essentially the same as last year's reported dose of 0.99 mrem per liter (ESP 1999). The plutonium isotopes (-238 and -239, -240) and americium-241 contribute the majority of this calculated dose.

D. Estimation of Radiation Dose Equivalents for Naturally Occurring Radiation

Operations at LANL contribute radiation and radioactive materials to the environment. To understand the Laboratory's impact, it is important to understand its contribution relative to existing natural and man-made radiation and radioactive materials in the environment.

External radiation, which affects the body by exposure to sources external to the body (not from inhalation or ingestion), comes from two sources that are approximately equal: cosmic radiation from space and terrestrial gamma radiation from radionuclides naturally in the environment. Estimates of dose rates from natural radiation come from a comprehensive report by the National Council on Radiation Protection and Measurements (NCRP 1987b) and assume the dose from cosmic radiation dose is reduced 20% because of time spent indoors and the dose from terrestrial radiation sources is reduced by 30% because our bodies provide some shielding for our internal organs from terrestrial photons. In general, doses from direct radiation from cosmic and terrestrial sources are higher in Los Alamos than White Rock because White Rock is at a lower elevation and less cosmic radiation reaches the earth's surface. Actual annual external background radiation exposures vary depending on factors such as snow cover and fluctuations of solar radiation (NCRP 1975).

The largest component of our annual dose is from the decay of natural uranium. Uranium products occur naturally in soil and are commonly incorporated into building construction materials. Radon-222 is produced by decay of radium-226, which is a member of the uranium decay series. Inhalation of radon-222 results in a dose to the lung, which is the largest component of natural background radiation dose. We assume the dose from radon-222 decay products to local residents to be equal to the national average of 200 mrem per year. This estimate may be revised if a nationwide study of background levels of radon-222 in homes is undertaken or if we obtain reliable data on average radon concentrations in homes in northern New Mexico. The NCRP (NCRP 1984, 1987a) has recommended a national survey.

Another naturally occurring source of radiological dose to the body is from naturally occurring radioactive materials incorporated into the body. Most importantly, a small percentage of all potassium is radioactive potassium-40. Because our bodies require potassium, we have a certain amount of radioactive potassium within us, and the decay of this potassium-40 gives us a dose of about 18 mrem per year. Natural uranium and carbon-11 contribute another 21 mrem or so to give a total dose from internal radionuclides of about 40 mrem each year. Doses from the global fallout associated with aboveground nuclear testing, the accident at Chernobyl, venting of belowground nuclear tests, and burn-up of satellites are a small fraction of total environmental doses (<0.3% [NCRP 1987a]).

Finally, members of the US population receive an average dose of 53 mrem per year from medical and dental uses of radiation (NCRP 1987a). The various contributors to radiation dose to the maximally exposed individual in the Los Alamos area appear graphically in Figure 3-6. In the Los Alamos area, we receive roughly 120 mrem from terrestrial and cosmic external sources, 200 mrem from radon, 40 mrem from internal sources, 53 mrem from medical and dental procedures, and perhaps 1 mrem from global fallout to give a total “background” dose of about 414 mrem.

E. Risk to an Individual from Laboratory Operations

Health effects from radiation exposure have been observed in humans only at doses in excess of 10 rem delivered at high dose rates (HPS 1996). Doses resulting from LANL operations are typically in the low mrem or fractional mrem range and are generally delivered at low dose rates—gradually, throughout the year. Our conclusion is that these doses would cause no adverse health effects, including cancer. Therefore, we have not calculated risks associated with the low doses presented in this report. A reader may calculate risk by multiplying the doses reported here by a cancer risk factor. The factor should be in units of excess cancer death risk per mrem or be converted to these units. For example, the Environmental Protection Agency (EPA 1994) has published such a factor in units of risk per Sievert. A Sievert (Sv) is 100 rem or 100,000 mrem.

The doses calculated from natural background radiation and medical and dental radiation can be compared with the incremental dose caused by radiation from Laboratory operations. The average doses to residents of Los Alamos and White Rock from Laboratory activities were 0.6 mrem in each community. The exposure to average Los Alamos County residents from Laboratory operations is well within variations in exposure of these people to natural cosmic and terrestrial sources and global fallout. For example, variation in the amount of snow cover and in the solar sunspot cycle can cause a 10-mrem difference from year to year (NCRP 1975).

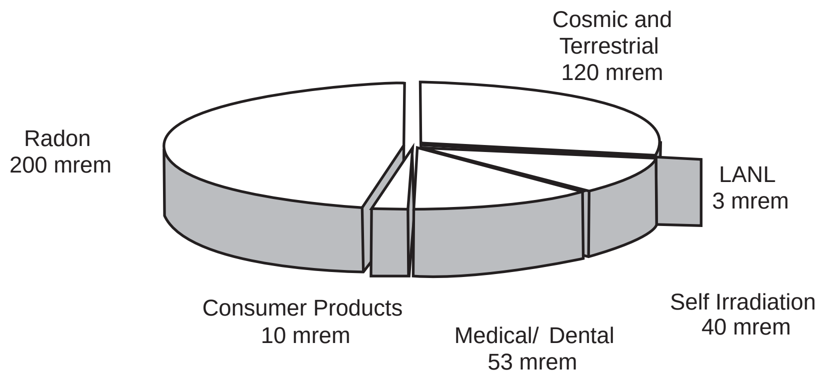

Figure 3-6. All contributions to the 1999 dose for the Laboratory’s maximally exposed individual.

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4. Air Surveillance

4. Air Surveillance

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Abstract

Los Alamos National Laboratory (LANL or the Laboratory) operations emit radioactive and nonradioactive air pollutants and direct penetrating radiation into the atmosphere. Air surveillance at Los Alamos includes monitoring emissions, ambient air quality, direct penetrating radiation, and meteorological parameters to determine the air quality impacts of Laboratory operations.

The ambient air quality in and around the Laboratory meets all Environmental Protection Agency (EPA) and Department of Energy (DOE) standards for protecting the public and workers.

During 1999, a greatly reduced run cycle at Los Alamos Neutron Science Center (LANSCE) resulted in radioactive air emissions that were less than one-fourth of 1998 emissions. Tritium emissions doubled over 1998 emissions; this increase is primarily due to tritium facility deactivation work. Plutonium emissions from the Chemistry and Metallurgy Research (CMR) building were higher in 1999 because of increased plutonium powder operations. No radioactive air emissions required reporting under EPA or the New Mexico Environment Department (NMED) requirements for unplanned releases. Criteria pollutant emissions for 1999 were larger than 1998 emissions because of a 20% increase in natural gas usage at the steam plants.

Radioactive ambient air quality off-site was similar to 1998. Highest air concentrations caused by Laboratory operations were measured at on-site locations: Technical Area (TA) 54, Area G; TA-21; and TA-16. Tritium concentrations increased and plutonium concentrations decreased at TA-21, reflecting changing operations. Several instances of elevated air concentrations were investigated in 1999. These elevated air concentrations were the result of routine Laboratory operations, and in one case, construction activity in the Los Alamos townsite, resuspending contaminants from the original Laboratory TA-1. None of these elevated air concentrations exceeded DOE or EPA protection standards for workers or the public.

During 1999, measurements of direct penetrating radiation were similar to 1998 values. Highest doses were measured at locations on-site at Mortandad Canyon, the LANSCE lagoons, and Area A at LANSCE. An evaluation of alternate direct penetrating radiation measurement systems supports the conclusion that our thermoluminescent dosimeters (TLDs) overrespond by about 50% to low-energy gamma radiation; therefore, actual doses at many TA-54, Area G, locations are smaller than reported here. We report one full year of albedo dosimeter (neutron) measurements, taken on-site in the vicinity of TA-18. For 1999, the neutron correction factor we used in determining neutron doses was revised, resulting in higher measured doses. The highest dose, 36.5 mrem, was measured in the parking lot directly east of TA-18.

Temperatures were somewhat above normal for 1999. Total precipitation for the year was 87% of normal; however, annual snowfall was only 49% of normal 30-year average values.

To Read About . . . **Turn to Page . . .**

4. Air Surveillance

A. Ambient Air Sampling *(Craig Eberhart and Jean Dewart)*

1. Introduction

The radiological air sampling network, referred to as AIRNET, at Los Alamos National Laboratory (LANL or the Laboratory) measures environmental levels of airborne radionuclides that may be released from Laboratory operations. Laboratory emissions include plutonium, americium, uranium, tritium, and activation products. Each AIRNET station collects two types of samples for analysis: a total particulate matter sample and a water vapor sample.

Natural atmospheric and fallout radioactivity levels fluctuate and affect measurements made by the Laboratory's air sampling program. Regional airborne radioactivity is largely composed of fallout from past atmospheric nuclear weapons tests by several countries, natural radioactive constituents in particulate matter such as uranium and thorium, terrestrial radon diffusing out of the earth and its subsequent decay products, and materials resulting from interactions with cosmic radiation (for example, natural tritiated water vapor produced by interactions of cosmic radiation and stable water). Table 4-1 summarizes regional levels of radioactivity in the atmosphere, which are useful in interpreting air sampling data.

Particulate matter in the atmosphere is primarily caused by aerosolized soil, which is dependent on meteorological conditions. Windy, dry days can increase the soil entrainment, but precipitation (rain or snow) can wash particulate matter out of the air. Consequently, changing meteorological conditions often cause large daily and seasonal fluctuations in airborne radioactivity concentrations.

Ambient air concentrations, as calculated from the AIRNET sample measurements, are compared with environmental compliance standards or workplace exposure standards depending on the location of the sampler. Concentrations in areas accessible to the public are usually compared with the 10 mrem concentration the Environmental Protection Agency (EPA) published in 40 CFR Part 61 Appendix E Table 2—"Concentration Levels for Environmental Compliance." Concentrations in controlled access areas are usually compared with Department of Energy (DOE) Derived Air Concentrations (DAC) for workplace exposure because access to these areas is generally limited to workers with a need to be in the controlled area. Finally, any doses in this section have been calculated by converting the individual isotopic concentrations using the EPA's 10 mrem concentrations. These doses are not necessarily comparable to the ones presented in Chapter 3 because additional data, such as water, food, and soil analyses, are used for estimating the Chapter 3 doses.

2. Air Monitoring Network

During 1999, the Laboratory operated more than 50 environmental air samplers to sample radionuclides by collecting water vapor and particulate matter. AIRNET sampling locations (Figures 4-1 through 4-4) are categorized as regional, pueblo, perimeter, quality assurance (QA), Technical Area (TA) 21, TA-15 and TA-36, TA-54 (Area G), or other on-site locations. Four regional sampling stations determine regional background and fallout levels of atmospheric radioactivity. These regional stations are located in Española and El Rancho and at two locations in Santa Fe. The pueblo monitoring stations are located at San Ildefonso and Jemez Pueblos. In 1999, more than 20 perimeter stations were within 4 km of the Laboratory boundary.

Because maximum concentrations of airborne releases of radionuclides would most likely occur on-site, more than 20 stations are within the Laboratory boundary. For QA purposes, two samplers are co-located as duplicate samplers, one at TA-54 and one at TA-49. In addition, a backup station is located at East Gate. Stations can also be classified as being inside or outside a controlled area. A controlled area is a posted area that potentially has radioactive materials or elevated radiation fields (DOE 1988a). The active waste disposal site at TA-54, Area G, is an example of a controlled area.

3. Sampling Procedures, Data Management, and Quality Assurance

a. Sampling Procedures. Generally, each AIRNET sampler continuously collects particulate matter and water vapor samples for approximately two weeks per sample. Particulate matter is collected on 47-mm polypropylene filters at an airflow rate of about 0.11 m^3 per minute. The vertically mounted canisters each contain about 135 grams of silica gel with an airflow rate of about 0.0002 m^3 per minute; the gel collects the water vapor samples. This silica gel is dried in a drying oven before use in the field to remove most residual water. The gel is a desiccant that removes moisture from the sampled air; the moisture is then distilled, condensed, collected as a liquid, and shipped to the analytical laboratory. The AIRNET project plan (ESH-17 1999) and the numerous procedures through which the plan is implemented provide details about the sample collection, sample management, chemical analysis, and data management activities.

b. Data Management. Using a palm-top microcomputer, we recorded the 1999 field data, including timer readings, volumetric airflow rates at the start and stop of the sampling period, and comments pertaining to these data, electronically in the field. We later transferred these data to an electronic table format within the Air Quality Group (ESH-17) AIRNET Microsoft Access database. We also received the analytical data described in the next section in electronic form and loaded them into the database.

c. Analytical Chemistry. A commercial laboratory analyzed each 1999 particulate matter filter for gross alpha and gross beta activities. These filters were also grouped across sites, designated "clumps," and analyzed for gamma-emitting radionuclides. For 1999, clumps ranged from six to nine filters. Gamma-emitting radionuclides were also measured at each Federal Facilities Compliance Agreement station by grouping the filters collected each quarter. We combined half filters from the six or seven sampling periods at each site during the quarter to prepare a quarterly composite for isotopic analyses for each AIRNET station. These composites were dissolved, separated chemically, and then analyzed for isotopes of americium, plutonium, and uranium using alpha spectroscopy. Every two weeks, ESH-17 staff distilled the water from the silica gel cartridges and submitted the distillate to a commercial laboratory for tritium determination by liquid scintillation spectrometry. All analytical procedures meet the requirements of 40 Code of Federal Regulations (CFR) 61, Appendix B, Method 114. The AIRNET project plan provides a summary of the target minimum detectable amounts (MDA) for the biweekly and quarterly samples.

d. Laboratory Quality Control Samples. For 1999, ESH-17 and the contractor analytical laboratories maintained a program of blank, spike, duplicate, and replicate analyses. This program provided information on the quality of the data received from analytical chemistry laboratories. The chemistry met the QA requirements for the AIRNET program.

4. Ambient Air Concentrations

a. Explanation of Reported Concentrations Including Negative Values. Tables 4-1 through 4-12 summarize the ambient air concentrations calculated from the field and analytical data. Table 4-1 summarizes the average background concentrations of airborne radioactivity. Tables 4-2 through 4-12 summarize ambient air concentrations by the type of radioactivity or by specific radionuclides. The summaries include the number of results; the number of these results less than the uncertainty; the maximum, minimum, and average concentrations; the sample standard deviation; and, for the group summaries, the 95% confidence intervals. The number of results are normally equal to the number of samples analyzed, whereas the number less than the uncertainty is the number of analyses that do not have a measurable amount of the material of interest. The MDA used in Tables 4-11 and 4-12 are the levels that the instrumentation could detect under ideal conditions. Finally, all AIRNET concentrations and doses are total measurements without any type of regional background subtractions or corrections unless otherwise stated.

All data in this AIRNET section, whether in the tables or the text, that are expressed as a value plus or minus (±) another value represent a 95% confidence interval. Because these confidence intervals are calculated with data from multiple sites and throughout the year, they include not only random measurement and analytical errors but also seasonal and spatial variations as well. As such, the calculated 95% confidence intervals are overestimated (wider) for the average concentrations and probably represent confidence intervals that are essentially 100%. In addition, the air concentration standard deviations in the tables represent one standard deviation as calculated from the sample data. All ambient concentrations are activity concentrations per actual cubic meter of sampled air.

Some values in the tables indicate that we measured negative concentrations of radionuclides in the ambient air, which, of course, is impossible. However, it is possible for the measured concentration to be negative because the measured concentration is a sum of the true value and all random errors. As the true value approaches zero, the measured value approaches the total random errors, which can be negative or positive and overwhelm the true value. Arbitrarily discarding negative values when the true value is near zero will result in overestimated ambient concentrations.

b. Gross Alpha and Beta Radioactivity. We use gross alpha and gross beta analyses primarily to evaluate general radiological air quality and to identify potential trends. If gross activity in a sample is consistent with past observations and background, immediate special analyses for specific radionuclides are not necessary. If the gross analytical results appear to be elevated, then immediate analyses for specific radionuclides may be performed to investigate a potential problem, such as an unplanned release. Gross alpha and beta activity in air exhibits considerable environmental variability and, for alpha measurements, analytical variability. These naturally occurring sources of variability generally overwhelm any Laboratory contributions.

The National Council on Radiation Protection and Measurements (NCRP) estimated the average concentration of long-lived gross alpha activity in air to be 2 fCi per cubic meter. The primary alpha activity is due to polonium-210 (a decay product of radon) and other naturally occurring radionuclides (NCRP 1975, NCRP 1987). The NCRP also estimated average concentration levels of long-lived gross beta activity in air to be 20 fCi per cubic meter. This activity is primarily because of the presence of lead-210 and bismuth-210 (also decay products of radon) and other naturally occurring radionuclides.

In 1999, we collected and analyzed more than 1,000 air samples for gross alpha and gross beta activity. As shown in Table 4-2, the annual mean for all of the stations is less than the NCRP's estimated average (2 fCi per cubic meter) for gross alpha concentrations. Two factors probably contribute to these seemingly lower concentrations: the use of actual sampled air volumes instead of converting to standard temperature and pressure volumes and the burial of alpha emitters in the filter that are not measured by front-face counting. Gross alpha activity is almost entirely from the decay of natural radionuclides, primarily radon, and is dependent on variations in natural conditions such as atmospheric pressure, atmospheric mixing, temperature, soil moisture, and the "age" of the radon. The differences among the groups may be attributable to these factors (NCRP 1975, NCRP 1987).

Table 4-3 shows gross beta concentrations within and around the Laboratory. These data show variability similar to the gross alpha concentrations. All of the annual averages are below 20 fCi per cubic meter, the NCRP estimated national average for beta concentrations, but the gross beta measurements include little if any lead-210 because of its low-energy beta emission. In addition, the gross beta measurements are also calculated on the actual sampled air volumes.

c. Tritium. Tritium is present in the environment primarily as the result of nuclear weapons tests and natural production by cosmogenic processes (Eisenbud and Gesell 1997). Tritium is released by the Laboratory in curie amounts; in 1999, Laboratory operations released approximately 1,600 curies of tritium. Tritium is released from Laboratory operations as hydrogen (HT or T_2) and as an oxide (HTO or T_2O). We measure the tritium as an oxide because the dose impact is about 14 thousand times higher than if it were hydrogen (DOE 1988b).

Estimating ambient levels of tritium as an oxide (water) requires two factors: water vapor concentrations in the air and tritium concentrations in the water vapor. Both of these need to be representative of the true concentrations to obtain an accurate estimate of the ambient tritium concentrations. In early 1998, it was found that the silica gel collection medium was not capable of removing all of the moisture from the atmosphere (see 1998 ESR 4.A.4.c) (Eberhart 1999). Collection efficiencies were as low as 10% to 20% in the middle of the summer when the ambient concentrations of water vapor were the highest. Because 100% of the water was not collected on the silica gel and we used this water to measure water vapor concentrations, the atmospheric water vapor, and therefore tritiated water, has been underestimated. However, data from the meteorological monitoring network provide accurate measurements of atmospheric water vapor concentrations and have been combined with the analytical results to calculate all ambient tritium concentrations in this report. The EPA approved use of this method for compliance calculations of atmospheric tritium concentrations in March 1999 (EPA 1999).

Table 4-4 presents the sampling results for tritiated water concentrations. The annual concentrations for 1999 at all of the on-site and perimeter stations were higher than all of the regional and pueblo stations. In addition, 15 of the 16 on-site stations in technical areas with tritium sources (TA-16, TA-21, and TA- 54) had higher annual concentrations than all of the perimeter stations. These data indicate that the Laboratory is a measurable source of tritium based on ambient concentrations. All annual mean concentrations at all sampling sites were well below the applicable EPA and the DOE guidelines.

The highest off-site annual concentration, 4.4 pCi per cubic meter, was at station 17 near the Bandelier fire lookout. This concentration is equivalent to about 0.3% of the EPA public dose limit. We calculated elevated concentrations at a number of on-site stations, with the highest maximum and annual mean concentrations at station 35 within TA-54, Area G. This sampler is located in a radiological control area, near shafts containing tritium-contaminated waste. The annual mean concentration, 768 pCi per cubic meter, is only 0.004% of the DOE DAC for worker exposure.

We also saw elevated annual air concentrations at other Area G stations, at TA-21 stations, and station 25 located at TA-16. Station 25 is located near a tritium facility, but the source of the higher tritium levels appears to be off-gassing from some used tritium processing equipment that is stored nearby. The TA-21 stations are located near operations that use tritium.

d. Plutonium. While plutonium occurs naturally at extremely low concentrations from cosmic radiation and spontaneous fission (Eisenbud and Gesell 1997), it is not naturally present in measurable quantities in the ambient air. All measurable sources are from plutonium research and development activities, nuclear weapons production and testing, the nuclear fuel cycle, and other related activities. With few exceptions, worldwide fallout from atmospheric testing of nuclear explosives is the primary source of plutonium in ambient air. Four isotopes of concern can be present in the atmosphere: plutonium-238, plutonium-239, plutonium-240, and plutonium-241. Plutonium-241 is not measured because it is a low-energy beta emitter that decays to americium-241, which we do measure. This beta decay is not only hard to measure, but the dose is small when compared to americium-241. Plutonium-239 and plutonium-240 are indistinguishable by alpha spectroscopy and are grouped together for analytical purposes. Therefore, any ambient air concentrations or analyses listed as plutonium-239 actually represent both plutonium-239 and plutonium-240.

Table 4-5 presents sampling results for plutonium-238. Most of the analytical results, including the on-site stations, were below the uncertainty level. The highest group summary mean was for the TA-54, Area G, stations, with an annual mean of 1.3 aCi/m^3. This result is less than 0.1% of the EPA public dose limit. The highest annual mean for an individual station was for station 34 at TA-54 with an annual mean activity of 5.9 aCi/m^3, which corresponds to 0.3% of the EPA public dose limit, or 0.03 mrem. Only two quarterly concentrations were above their uncertainties, and both were at station 34, which indicates that measurements at this site are quantitative and above background levels.

Sampling results for plutonium-239, -240 appear in Table 4-6. As with the plutonium-238 analyses, most of the analytical results were below their estimated uncertainties. The highest annual mean at any off-site station, and the only one with concentrations above the uncertainties, occurred at a perimeter sampler in the Los Alamos townsite (07) with an annual concentration of 7.4 aCi/m^3 of plutonium-239, -240. This concentration is equivalent to a dose of 0.04 millirems or 0.4% of the EPA public dose limit. This quantitative measurement appeared to be caused by soil disturbances associated with nearby construction activity in a former Laboratory technical site with contaminated soil that had been remediated. Undoubtedly trace amounts of contamination remained after cleanup, and the recent construction activity resuspended the contamination.

The TA-54, Area G, stations clearly had elevated ambient concentrations with an annual average of about 24 aCi/m^3. The annual average for station 27, which had been the highest concentration for the last two years, dropped from 73 aCi/m^3 in 1998 to 51 aCi/m^3 in 1999 apparently because the nearby gravel road was paved in early 1999. The source of these elevated levels, resuspension of contaminated particulate matter from material unearthed during a trenching operation, was originally mitigated in 1997 (Kraig and Conrad 2000, ESP 1998).

We recorded the highest annual concentration at station 34 in Area G. The concentration was 105 aCi/m^3, an increase of more than 27 times the 1998 concentrations for this site. This concentration is equivalent to a dose of 0.5 mrem, but it is only 0.005% of the DOE DAC for workplace exposure. See Section 4.A.5 for additional information.

e. Americium-241. Americium-241, a decay product of plutonium-241, is the primary source of radiation from this plutonium isotope. Nuclear explosions, the nuclear fuel cycle, and other processing of plutonium release plutonium-241 to the environment.

Table 4-7 presents the americium results. As with the plutonium isotopes, americium is present in very low concentrations in the environment as the low annual mean concentrations seen at the regional, pueblo, and perimeter station summaries show. One quarterly off-site measurement at station 32, the county landfill, was above its uncertainty level. The annual concentration at this site was 8.0 aCi/m^3, which is equivalent to a dose of 0.04 mrem or 0.4% of the EPA public dose limit. The cause(s) of this higher concentration were not identified.

The only other sites with measurements above the uncertainties were at Area G. The overall concentration at Area G was the highest for any group of samplers with an average of 16.5 aCi/m^3. The highest annual concentration was at station 34 at 89.7 aCi/m^3, which was nearly 6 times higher than the second highest annual concentration. The estimated dose from this concentration is 0.47 mrem or 0.004% of the DOE DAC for worker exposure. See Section 4.A.5 for additional information on the increase of plutonium and americium at station 34.

Station 27 concentrations dropped again this year. In 1997, the concentrations at station 27 had peaked at 469 aCi/m^3. By 1998, mitigation efforts had caused the concentrations to drop an order of magnitude to 48 aCi/m^3. The most recent mitigation, paving the nearby gravel road, reduced the 1999 concentrations to 15 aCi/m^3. The concentration at this Area G site, which is a controlled-access area, is equivalent to a dose of 0.08 mrem or only 0.0008% of the applicable DOE DAC.

f. Uranium. Three isotopes of uranium are normally found in nature: uranium-234, uranium-235, and uranium-238. The natural sources of uranium are crustal rocks and soils. Therefore, the ambient concentrations depend upon the mass of suspended particulate matter, the uranium concentrations in the parent material, and any local sources. Typical uranium crustal concentrations range from 0.5 ppm to 5 ppm, but local concentrations can be well above this range (Eisenbud and Gesell 1997). Relative isotopic abundances are constant and well characterized. Uranium-238 and uranium-234 are essentially in radioactive equilibrium, with a measured uranium-238 to uranium-234 isotopic activity ratio of 0.993 (as calculated from Walker et al., 1989). Thus, activity concentrations of these two isotopes are effectively the same in particulate matter derived from natural sources. Because known LANL uranium emissions are enriched (excess uranium-234 and -235) or depleted (excess uranium-238), we can use comparisons of isotopic concentrations to estimate LANL contributions. Using excess uranium-234 to detect the presence of enriched uranium may not seem suitable because the enrichment process is normally designed to increase uranium-235 concentrations. However, the enrichment process normally increases uranium-234 at a faster rate than uranium-235, and the dose from natural uranium is about an order of magnitude higher for uranium-234 than for uranium-235. Tables 4-8 through 4-10 give uranium results by isotope. The quarterly uranium-234 and -238 measurements that are above their uncertainties for both isotopes are plotted in Figure 4-5 along with a line representing the natural abundance of the two isotopes.

All annual mean concentrations of the three uranium isotopes were well below the applicable EPA and DOE guidelines. We measured all the maximum annual uranium concentrations in Area G. The maximum annual uranium-234 concentration was 116 aCi/m^3 at stations 27 and 50 in Area G, which is equivalent to a dose of about 0.15 mrem. The maximum annual uranium-235 concentration was 7.2 aCi/m^3 at station 27, which is equivalent to a dose of 0.01 mrem, but three of the four quarterly concentrations were below their uncertainties. The maximum annual uranium-238 concentration was 119 aCi/m^3, which is equivalent to a dose of about 0.14 mrem. Most of the uranium-235 measurements (93%), both on- and off-site, were below the uncertainties, whereas less than 7% of the uranium-234 and uranium-238 concentrations were below the MDA. Consequently, the uranium-235 data should not be considered quantitative measurements and will not be evaluated as such.

Both the regional and pueblo groupings had higher average concentrations of uranium-234 and uranium-238 than all of the other groupings except for the TA-54, Area G, stations. The higher concentrations for the regional and pueblo groups result from increased particulate matter concentrations associated with unpaved roads, unpaved parking lots, and other soil disturbances such as construction activities and even grazing but not any known “man-made” sources of uranium. Dry weather or a drier climate can also increase ambient concentrations of particulate matter and therefore uranium. Annual mean concentrations for both uranium-234 and uranium-238 were above 50 aCi/m^3 at five sites for 1999. Four of these stations are located at Area G (27, 38, 45, and 50), and one is located at the Los Alamos County Landfill (station 32).

We measured most of the quarterly uranium measurements above 50 aCi/m^3 at Area G or at the Los Alamos County Landfill. As noted earlier, the Area G sites also typically have plutonium and americium concentrations that are above background levels. However, comparable concentrations of uranium-238 and uranium-234 indicate that the higher uranium concentrations at the Area G sites and at the county landfill are attributable to natural uranium associated with higher levels of resuspended particulate matter from unpaved roads and the surface soil disturbances.

Station 77 at TA-36, which is located in an area where depleted uranium is still present as surface contamination from explosive tests, had uranium-238 concentrations that were more than double the uranium-234 concentrations. It has been previously identified as a location with excess ambient concentrations of uranium-238 (Eberhart et. al., 1999, and ESP 1999). The 1999 uranium-238 and uranium-234 concentrations at this site were 30 and 13 aCi/m^3 respectively. If we presume that all of the measured uranium-234 at this site is natural, then about 44% or 13 aCi/m^3 of the uranium-238 would also be natural. Therefore, the estimated LANL contribution is 17 aCi/m^3 of uranium-238, which is equivalent to an on-site dose of about 0.02 mrem or 0.0001% of the DOE DAC for workplace exposure. The National Emission Standards for Hazardous Pollutants (NESHAP) standard is 10 mrem for all radionuclides, so the maximum measured dose from LANL uranium emissions would be about 0.2% of the standard if it were a public exposure. The other AIRNET samplers in this area do not show similar patterns, an indication that the excess uranium-238 is small, localized, and not caused by current explosive tests.

g. Gamma Spectroscopy Measurements. In 1999, gamma spectroscopy measurements were made on groups of filters including analyses of “clumps” (biweekly filters grouped across sites for a single sampling period) and quarterly composites (biweekly filters grouped across time for a single site). Even though these gamma emitters have no action levels *per se*, we would investigate any measurement above the MDA, other than beryllium-7 and lead-210, because the existing data indicate that such a measurement is highly unlikely except after an accidental release. Instead of action levels, the AIRNET Sampling and Analysis Plan (ESH-17 1999) lists the minimum detection levels for 16 gamma emitters that could either be released from Laboratory operations or that occur naturally in measurable amounts (beryllium-7 and lead-210). The minimum levels are equivalent to a dose of 0.5 mrem. The beryllium-7 and lead-210 measurements were the only isotopes above their minimum detectable activities.

Table 4-11 summarizes the “less than” concentrations. The average annual MDA for every radionuclide in this table meets the required minimum detection levels. Because every value used to calculate the average annual MDA was a “less than” value for the 14 radionuclides listed in the table, it is likely that the actual concentrations are 3 or more standard deviations away from the average MDA. As such, the ambient concentrations, which were calculated from the MDA values, are expressed as “much less” (<<) values.

Table 4-12 summarizes the beryllium-7 and lead-210 data. Both beryllium-7 and lead-210 occur naturally in the atmosphere. Beryllium-7 is cosmogenically produced, whereas lead-210 is a decay product of radon-222. Some lead-210 is related to suspension of terrestrial particulate matter, but the primary source is atmospheric decay of radon-222. Even though the beryllium-7 and lead-210 are derived from gases, both become elements that are present as solids or particulate matter. These radionuclides will quickly coalesce into fine particles and also deposit on the surfaces of other suspended particles. The effective source is cosmic for beryllium-7 and terrestrial for lead-210, so the ratio of the two concentrations will vary, but they should be relatively constant for a given sampling period. Because all of the other radionuclides measured by gamma spectroscopy are “less than” values, measurements of these two radionuclides provide verification that the sample analysis process is working properly.

5. Investigation of Elevated Air Concentrations

Upon receiving the analytical chemistry data for biweekly and quarterly data, ESH-17 personnel calculated air concentrations and reviewed them to determine if any values indicated an unplanned release. Two action levels have been established: investigation and alert. Investigation levels are based on historical measurements and are designed to indicate that an air concentration is higher than expected. Alert levels are based on dose and require a more thorough, immediate follow-up. During 1999, ESH-17 reviewed the effectiveness of existing action levels and decided to recalculate them to provide more useful information. We calculated new action levels for plutonium, americium, and tritium, based on a more robust statistical treatment of outliers and an evaluation of seasonal fluctuations of tritium from Area G. We developed new methods for determining action levels for gross alpha, gross beta, and uranium and will implement them in 2000. See the discussion of how we determined action levels on the Air Quality Group Web site: *http://www.air-quality.LANL.gov*.

In 1999, a number of air sampling values exceeded ESH-17 investigation levels. When a measured air concentration exceeds an investigation level, ESH-17 verifies that the calculations were done correctly and that the sampled air concentrations are likely to be representative, i.e., that no cross contamination has taken place. Next, we work with personnel from the appropriate operations to assess potential sources and possible mitigation for the elevated concentrations.

Numerous tritium measurements continued to exceed action levels because tritium concentrations are now calculated using absolute humidity from meteorological measurements (see ESP 1999, 4.A.4.c). We based the revised (August 1999) investigation levels on tritium concentrations calculated using absolute humidity, which eliminated this problem.

A number of uranium measurements exceeded action levels during 1999. In each case, the follow-up investigation demonstrated that natural uranium associated with higher levels of suspended particulate matter produced the elevated uranium concentrations. We reached this conclusion by comparing the ratio of measured uranium-234 and uranium-238 air concentrations with the ratio in naturally occurring uranium. Therefore, no Laboratory source of increased uranium emissions was identified.

The following sections identify six incidents of elevated air concentrations that warrant further discussion.

a. Elevated Plutonium-239 and Americium-241 at Station 34 at TA-54, Area G, during the First and Second Quarters of 1999. The 1999 first quarter air concentrations at station 34, at the northeast corner of Area G, were elevated above normal for americium-241 (24 aCi/m^3) and plutonium-239 (206 aCi/m^3). The measured concentrations were well above the six-year averages for these radionuclides: 5 and 19 aCi/m^3, respectively. Concentrations of plutonium-238 were also elevated. Discussions with operations staff at Area G revealed the following.

On March 15, 1999, a 55-gal. drum was retrieved as part of the Transuranic Waste Inspectable Storage Project (TWISP) at TA-54. Inspection revealed a small hole on the bottom, and alpha contamination was detected. Workers removed surface contamination and sealed the drum within a second drum. However, before the contamination was remediated, small amounts of radionuclides were released to the air. These releases caused increased concentrations at station 34, which is very close to the operations. If the releases had been large or widespread, we would have seen increases at other air monitoring stations nearby.

The operations group instituted radiologically engineered controls to help minimize future releases to the air during these activities. These features included more complete monitoring of drum surfaces at each step of drum handling, immediate bagging of drums with suspected contamination, continuous local air sampling, enhanced area swiping to identify contamination, and training of all employees in the new operation procedures.

In spite of these mitigation measures, air concentrations increased during second quarter, with americium-241 and plutonium-239 concentrations of 265 and 197 aCi/m^3, respectively. The operations group evaluated additional mitigation measures and implemented them during the third quarter. Plutonium concentrations returned to pre-1999 concentrations during the third quarter. Americium concentrations declined greatly by the third (68 aCi/m^3) and fourth quarters (32 aCi/m^3) but still remained elevated in comparison to pre-1999 concentrations (1–12 aCi/m^3). The annual average air concentrations of plutonium-239 and americium-241 at station 34 are both less than 0.01% of the DACs for workers.

b. Elevated Tritium near TA-33 during 1999. From the end of 1998 through 1999, decontamination and decommissioning operations at TA-33, Bldg. 86, produced increased tritium emissions that the AIRNET system detected. These operations, which were exhausted through a monitored stack, included characterization and depressurization of formerly used lines and vessels and were necessary before the building could be demolished.

These emissions resulted in exceedances of investigation levels at several stations in the vicinity of TA-33, Bandelier, and White Rock during the first quarter, in July, and in September. The Bandelier AIRNET station recorded peak concentrations of 14 pCi/m^3 in January. If this concentration had occurred for an entire year, the resulting dose would be less than 0.1 mrem.

Before initiating these operations, all environmental groups, including ESH-17, conducted a review of impacts. As a result of this review, ESH-17 worked with facility personnel to determine potential levels of emissions and to set limits on annual emissions. The decontamination and decommissioning operations are well within these limits and are considerably less than regulatory limits.

c. Elevated Tritium at the County Landfill during January and February 1999. Measurements at the county landfill exceeded investigation levels for tritium during the last two weeks of January and the first two weeks of February. The highest concentration measured was 9 pCi/m^3, which, if it had occurred for an entire year, would result in a concentration less than 0.06 mrem. No cause for these elevated concentrations was identified. Following this four-week period, concentrations were at typical levels for the remainder of the year.

d. Elevated Plutonium-239 at Station 07 during the Third and Fourth Quarters of 1999. During the third and fourth quarter of 1999, elevated concentrations of plutonium-239 were measured at station 07 (Shell Station) in the townsite. These higher measurements (12.6 and 14.0 aCi/m^3 respectively) appear to have been caused by soil disturbances associated with nearby construction activity at a former Laboratory technical site (TA-1) with contaminated soil that was subsequently remediated. Undoubtedly, trace amounts of contamination remained after cleanup, and the recent construction activity had resuspended the contamination. If these concentrations had been measured for an entire year, the dose impact would have been 0.07 mrem. Measurements of uranium-234 and uranium-238 concentrations were also elevated at this location during the fourth quarter, further demonstrating construction-related increases in resuspended particulate matter.

e. Elevated Tritium near TA-21 in December 1999. In December 1999, cleanup activities at the Tritium Science and Fabrication Facility (TA-21-209) produced higher than average tritium emissions. One on-site station (75) recorded a concentration of 22.5 pCi/m^3, exceeding an investigation level, and several nearby stations in the townsite measured higher than normal air concentrations. The annual average air concentration of tritium at station 75, 7.3 pCi/m^3, is more than one million times less than the DAC for occupational workers.

Before initiating these operations, all environmental groups, including ESH-17, conducted a review of impacts. As a result of this review, ESH-17 worked with facility personnel to determine potential levels of emissions and to set limits on annual emissions. The cleanup operations are well within these limits and are considerably less than regulatory limits.

f. Elevated Plutonium-239 at Station 45 TA-54, Area G, during the Fourth Quarter of 1999. During the fourth quarter of 1999, station 45 at TA-54, Area G, recorded an elevated plutonium-239 concentration. The concentration of 52 aCi/m^3 was the highest value recorded during 1999 but was similar to the highest values recorded in 1997 and 1998 at this station. The probable cause of this elevated value is resuspension of residual soil contamination at the eastern end of Area G. The annual average air concentration of plutonium-239 at station 45, 24.5 aCi/m^3 is about 0.001% of the DAC for workers.

g. Ongoing Investigations. A number of stations have measured elevated concentrations from Laboratory operations in past years. Several of these stations continue to measure somewhat elevated concentrations that we continue to monitor. We refer the reader to the earlier Environmental Surveillance Reports for a complete discussion of the sources of elevated emissions.

Elevated plutonium and americium concentrations continue to occur at TA-54, Area G, at stations 27 and 38, although much reduced from 1997 levels. Tritium concentrations at TA-16 at station 25 remained elevated during 1999. However, the peak concentration (104 pCi/m^3) is less than 1/10 of the 1998 peak (1528 pCi/m^3). The annual average air concentration of tritium at station 25, 55.1 pCi/m^3, is about 0.001% of the DAC for workers.

6. Long-Term Trends

Previous Environmental Surveillance Reports covered long-term trends for isotopic measurements (ESP 1997) and tritium (ESP 1998 and ESP 1999). Gross alpha, gross beta, and gamma measurements are evaluated here. Future reports will rotate between these three general categories.

The primary purpose of the AIRNET monitoring system is to provide measurements of air contaminants that are potentially released by LANL. However, most of the measurements are normally dominated by naturally occurring radionuclides: alpha measurements by the decay of polonium-210; beta measurements by the decay of bismuth-210; and gamma activity measurements by the decay of beryllium-7 and lead-210.

These naturally occurring radionuclides are present in the atmosphere as particulate matter, but essentially all are attributable to radioactive decay of atmospheric radon-222 (Figure 4-6), which is a gas, or cosmogenic production of beryllium-7 from cosmic ray interaction with common atmospheric gases. These radionuclides are derived from gas-phase stable isotopes that are either already well mixed such as nitrogen or become well mixed as a result of a relatively “long” half-life

(3.8 days for radon-222) compared to atmospheric turbulence. Ambient concentrations are relatively uninfluenced by particulate matter emissions, concentrations, or resuspension. In addition, these radionuclides are concentrated on fine particles and, as such, little affected by atmospheric deposition. Concentrations may vary regionally, but local concentrations of alpha, beta, and gamma emitters are comparable except when local sources become significant or when air sampling problems are encountered. Graphs of the gross alpha (Figure 4-7), gross beta (Figure 4-8), beryllium-7 (Figure 4-9), and lead-210 data (Figure 4-9) show the relatively low spatial variation when compared with the variation over time.

Historically, one of the primary advantages of measuring gross alpha, gross beta, and gamma radiation has been the promptness of the results and the subsequent assurance that no large releases were undetected. However, problems in the sampling and analytical processes reduced our ability in the past to use these data in this way. Improvements in the last four years, followed by extensive data analyses, have allowed us to use these data more effectively in our environmental surveillance program.

We have used the gross alpha measurements to retroactively identify local releases of plutonium and americium by using the gross alpha data from stations 27 and 38 above the 3-sigma control limits as shown in Figure 4-7. These two sites, which are co-located at Area G, represent only about 4% of the gross alpha measurements from 1997 through 1999, yet they account for nearly half of concentrations that are greater than the control limits. We originally identified this contamination when measured atmospheric concentrations of plutonium and americium had increased by about two orders of magnitude. Follow-up investigations found that a localized area of contaminated soil had been exposed during a trenching operation and that some of the contaminated material had been incorporated into a dirt road (Kraig and Conrad 2000). If a similar situation occurs in the future, comparison of the gross alpha measurements to the control limits may provide an indication of the problem before isotopic results are available.

LANL has no sources of beta radiation that could significantly increase the gross beta measurements, but the naturally occurring bismuth-210, which is the primary gross beta source, is easily detected. Lead-210, which decays to bismuth-210, is also a beta emitter, but it is not usually detected by the gross beta measurement process because of its low-energy beta emission. Gross beta measurements have been and still are used to correct errors in airflow measurements and calculations because the concentrations are comparable from site to site as with other decay products. More recently, we identified low beta concentrations outside the 3-sigma control limits at several stations (27, 32, and 38) as shown in Figure 4-7. These sites, which are located at Area G (27 and 38) and the county landfill (32), have high particulate matter concentrations. Even though they represent only about 6% of the gross beta measurements from 1997 through 1999, they account for more than half of the concentrations that are lower than the control limits. Many of these low beta measurements occurred in late 1998 and early 1999 when the weather was unusually dry (0.42 inches of precipitation were recorded at Area G from November 1, 1998, through February 28, 1999), which apparently increased the local particulate matter concentrations. Resolution of this problem is still in progress, but several possible causes have been identified.

Until recently our gamma measurements have not been useful for quantifying ambient concentrations of gamma emitters. Detection limits varied greatly and were generally so high that environmentally significant concentrations may have been missed. However, after working with our contract laboratories, increasing count times, and grouping filters together for analysis, the gamma measurements now represent an important component of our ability to detect unanticipated releases. The consistent and explainable measurements of lead-210 and beryllium-7 as shown in Figure 4-9 indicate that our sampling and analysis activities are performing as expected, and the low detection limits ensure that no significant releases of gamma emitters go undetected. Stations 27 and 38 are included in the TA-54 group, which had low beryllium-7 and lead-210 during early 1999 similar to the beta measurements pattern; these results once again indicate an air sampling problem for sites with high particulate matter concentrations.

B. Stack Air Sampling for Radionuclides *(Scott Miller)*

1. Introduction

Radioactive materials are an integral part of many activities at the Laboratory. Some operations may vent these materials to the environment through a stack or other forced air release point. Air Quality personnel at the Laboratory evaluate these operations to determine impacts on the public and the environment. If this evaluation shows that emissions from a stack may potentially result in a member of the public receiving 0.1 mrem or greater in a year, the Laboratory must sample the stack in accordance with Title 40 CFR 61, Subpart H, “National Emission Standards for Emissions of Radionuclides Other than Radon from Department of Energy Facilities” (EPA 1989). As of the end of 1999, 29 stacks met this criterion. An additional two sampling systems were in place to meet DOE requirements for nuclear facilities prescribed in their respective technical or operational safety requirements. Where sampling is not required, we estimate emissions using engineering calculations and radionuclide materials usage information.

2. Sampling Methodology

As of the end of 1999, LANL continuously sampled 31 stacks for the emission of radioactive material to the ambient air. LANL has identified four types of radioactive stack emissions: (1) particulate matter, (2) vaporous activation products (VAP), (3) tritium, and (4) gaseous/mixed air activation products (G/MAP). For each of these emission types, the Laboratory employs an appropriate sampling method, as described below.

Operations at facilities such as the Chemistry and Metallurgy Research Building (CMR) and TA-55 generate emissions of radioactive particulate matter that are sampled using a glass-fiber filter. A continuous sample of stack air is pulled through the filter, which captures small particles of radioactive material. These samples are analyzed weekly using gross alpha/beta counting and gamma spectroscopy to identify any increase in emissions and to identify short-lived radioactive materials. Every six months, ESH-17 composites these samples to be shipped to an off-site laboratory. That laboratory analyzes these composited samples to determine the total activity of materials such as uranium-234, -235, and -238; plutonium-238, plutonium-239, -240; and americium-241. ESH-17 then uses these data to calculate emissions.

Los Alamos Neutron Science Center (LANSCE) operations and hot cell activities at CMR and TA-48 generate VAP emissions such as selenium-75 and bromine-77 that are sampled with a charcoal cartridge. A continuous sample of stack air is pulled through a charcoal filter that adsorbs vaporous emissions of radionuclides. Gamma spectroscopy determines the amount and identity of the radionuclide(s) present on the filter.

A collection device known as a bubbler measures tritium emissions from the Laboratory’s tritium facilities. This device enables the Laboratory to determine not only the total amount of tritium released but also whether it is in the elemental (HT) or oxide (HTO) form. The bubbler pulls a continuous sample of air from the stack, which then “bubbles” through three sequential vials containing ethylene glycol. The ethylene glycol collects the water vapor from the sample of air, including any tritium that may be part of a water molecule (HTO). “Bubbling” through these three vials removes essentially all HTO from the air, leaving only elemental tritium. The sample containing the elemental tritium passes through a palladium catalyst that converts the elemental tritium to HTO. The sample is then pulled through three additional vials containing ethylene glycol to collect the newly formed HTO. The amount of HTO and HT is determined by analyzing the ethylene glycol for the presence of tritium using liquid scintillation counting (LSC).

Although the tritium bubbler described above is the Laboratory’s preferred method for measuring tritium emissions, we employ a silica gel sampler at the LANSCE facility. A sample of stack air is pulled through a cartridge containing silica gel. The silica gel collects the water vapor from the air, including any HTO. After the water is distilled from the sample, we analyze the water with LSC to determine the amount of HTO. Using silica gel is necessary because the ethylene glycol also collects some of the gaseous emissions other than tritium from LANSCE. These additional radionuclides interfere with the determination of tritium, resulting in less accurate results. Also, because the primary source for tritium is activated water, sampling for only HTO is appropriate.

We measure G/MAP emissions that result from activities at LANSCE using real-time monitoring data. A sample of stack air passes through an ionization chamber that measures the total amount of radioactivity in the sample. Gamma spectroscopy and decay curves identify specific radioisotopes.

3. Sampling Procedure and Data Management

Sampling and Analysis. We chose our analytical methods for compliance with EPA requirements (40 CFR 61, Appendix B, [EPA 19] Method 114). General discussions on the sampling and analysis methods for each of LANL’s emissions follow.

Particulate Matter Emissions. We generally removed and replaced weekly glass-fiber filters that sampled facilities with significant potential for radioactive particulate emissions and transported them to the Health Physics Analysis Laboratory (HPAL). Before screening the samples for the presence of alpha and beta activity, the HPAL allowed approximately 72 hours for the short-lived progeny of radon to decay. These initial screening analyses checked that potential emissions were within normal values. Final analyses were performed after the sample had been allowed to decay for approximately one week. In addition to alpha and beta analyses, the HPAL identified the energies of gamma ray emissions from the samples with gamma spectroscopy.

Because the energy of decay is specific to a given radioactive isotope, the HPAL could determine the identity of any isotopes detected by the gamma spectroscopy. The amount, or activity, of an isotope could then be found by noting the number of photons detected during analysis. HPAL analyzed glass-fiber filters from LANSCE using only gamma spectroscopy.

Because gross alpha/beta counting cannot identify specific radionuclides, the glass-fiber filters were composited every six months for radiochemical analysis at an off-site commercial laboratory. The data from these composite analyses quantified emissions of radionuclides such as the isotopes of uranium and plutonium. To ensure that the analyses requested (e.g., uranium-234, -235, -238; plutonium-238, -239, etc.) identified all significant activity in the composites, ESH-17 compares the results of the isotopic analysis to gross activity measurements.

VAP Emissions. We generally removed and replaced weekly the charcoal canisters that sampled facilities with the potential for significant VAP emissions. These samples went to the HPAL where gamma spectroscopy identified and quantified the presence of vaporous radioactive isotopes.

Tritium Emissions. We also generally collected and transported to the HPAL on a weekly basis the tritium bubbler samples from facilities with the potential for significant elemental and oxide tritium emissions. The HPAL added an aliquot of each sample to a liquid scintillation cocktail and determined the amount of tritium in each vial by LSC.

We used silica gel for sampling facilities with the potential for significant tritium emissions in the oxide form only where the bubbler system would not be appropriate. We transported these samples to the Inorganic Trace Analysis Group (CST-9). CST-9 staff distilled the water from the silica gel and determined the amount of tritium in the sample using LSC.

G/MAP Emissions. We used continuous monitoring to record and report G/MAP emissions for two reasons. First, the nature of the emissions is such that standard filter paper and charcoal filters will not collect the radionuclides of interest. Second, the half-lives of these radionuclides are so short that the activity would decay away before any sample could be analyzed off line. The G/MAP monitoring system includes a flow-through ionization chamber in series with a gamma spectroscopy system. We measured total G/MAP emissions with the ionization chamber. The real-time current this ionization chamber measured was recorded on a strip chart, and the total amount of charge collected in the chamber over the entire beam operating cycle was integrated on a daily basis. The composition of these G/MAP emissions was analyzed with the gamma spectroscopy system. Using decay curves and energy spectra to identify the various radionuclides, LANSCE personnel determined the relative composition of the emissions. They typically took decay curves one to three times per week based on accelerator operational parameters. When LANSCE made major ventilation configuration changes, new decay curves and energy spectra were recorded.

4. Analytical Results

Measurements of Laboratory stack emissions during 1999 totaled 1,900 Ci. Of this total, tritium emissions composed approximately 1,600 Ci, and air activation products from LANSCE contributed 300 Ci. Combined airborne emissions of materials such as plutonium, uranium, americium, and particulate/vapor activation products were approximately 0.007 Ci. Table 4-13 provides detailed emissions data for Laboratory buildings with sampled stacks**.** Table 4-14 provides a detailed listing of the constituent radionuclides in the groupings of G/MAP and particulate/vapor activation products (P/VAP). Table 4-15 presents the half-lives of the radionuclides emitted by the Laboratory. During 1999, nonpoint source emissions of activated air from the LANSCE facility (TA-53) comprised 17 Ci carbon-11 and 0.7 Ci argon-41, while TA-18 contributed 0.49 Ci argon-41.

5. Long-Term Trends

See Figures 4-10 through 4-13 for radioactive emissions from sampled Laboratory stacks. These figures illustrate trends in measured emissions for plutonium, uranium, tritium, and G/MAP emissions, respectively. As the figures demonstrate, emissions of uranium and G/MAP showed decreases while emissions of plutonium and tritium showed increases.

Figure 4-14 shows the total contribution of each of these emission types to the total Laboratory emissions. It clearly demonstrates that G/MAP emissions and tritium emissions make up the vast majority of radioactive stack emissions. In 1999, however, we notice that the relative percentages of G/MAP and tritium have exchanged places. This change is driven by two factors related to the operations of two facilities. Historically, the LANSCE stack has contributed greater than 90% of LANL's emissions; however, the LANSCE facility curtailed 1999 operations in the area that generates the majority of the short-lived activation products. As a result, emissions at LANSCE in 1999 totaled less than 5% of emissions reported in 1998. While operations at LANSCE were curtailed, cleanup efforts at a no longer used tritium facility increased. This facility, which historically housed high-pressure tritium operations at TA-33, has been shut down for several years. As facility personnel prepare to transfer the facility for decontamination and decommissioning, releases of tritium have increased. These increases result from activities such as opening pipes and containers to demonstrate that significant tritium has been removed. In total, these operations increased tritium emissions from 65 Ci in 1998 to slightly over 900 Ci in 1999. To ensure that emissions from these planned operations did not cause the Laboratory to approach the regulatory limit of 10 mrem/yr, these operations were administratively controlled not to exceed 1,500 Ci, which would have a dose impact < 0.1 mrem.

As described above, changes in emissions for tritium and G/MAP are related to operations. The same is true for the increase in plutonium emissions. The majority of these emissions resulted from operations at the CMR Facility involving plutonium powders. In all cases where increased emissions were detected, they are still well below the amounts that could result in an off-site individual receiving a dose equal to the regulatory limit of 10 mrem/yr.

C. Cosmic, Gamma, and Neutron Radiation Monitoring Program *(Mike McNaughton)*

1. Introduction

ESH-17 monitors gamma and neutron radiation in the environment, that is, outside of the workplace, according to the criteria specified in McNaughton et al., 2000.

This radiation consists of both naturally occurring and man-made radiation. Naturally occurring radiation originates from terrestrial and cosmic sources. Because the natural radiation doses are generally much larger than those from man-made sources, it is extremely difficult to distinguish man-made sources from the natural background.

Naturally occurring terrestrial radiation varies seasonally and geographically. Radiation levels can vary up to 25% at a given location because of changes in soil moisture and snow cover that reduce or block the radiation from terrestrial sources (NCRP 1975). Spatial variation also results from the soil type. For example, dosimeters that are placed in a canyon will receive radiation from the sidewalls of the canyon as well as from the canyon bottom and will record higher radiation exposures than those dosimeters on a mesa top that don't receive exposure from the walls. The aerial survey of Los Alamos (DOE/NV 1998) shows variations of more than a factor of two, from about 60 mrem/yr on the mesa tops to 140 mrem/yr in some canyons.

Naturally occurring ionizing radiation from cosmic sources increases with elevation because of reduced atmospheric shielding (NCRP 1975). At sea level, the dose rate from cosmic sources is 27 mrem/yr. Los Alamos, with a mean elevation of about 2.2 km, receives 70 mrem/yr from cosmic sources, whereas White Rock, at an elevation of 1.9 km, receives 60 mrem/yr. Other locations in the region range in elevation from 1.7 km at Española to 2.7 km at the Pajarito Ski Hill, resulting in a corresponding range of 50 to 90 mrem/yr from cosmic sources. Cosmic sources can also vary ±10% because of solar modulations (NCRP 1987). These fluctuations along with those from terrestrial sources make it difficult to detect an increase in radiation levels from man-made sources, especially when the increase is small relative to the magnitude of natural fluctuations.

In summary, the dose rate from natural terrestrial and cosmic sources varies from about 100 to 200 mrem/yr. In publicly accessible locations, the dose rate from man-made radiation is much smaller than, and difficult to distinguish from, natural radiation.

2. Monitoring Network

a. Regional, Perimeter, and On-Site Areas. In an attempt to distinguish any impact from Laboratory operations, ESH-17 has located 97 thermoluminescent dosimeter (TLD) stations around the Laboratory and in the surrounding communities. This network of dosimeters is divided into three groups: (1) The regional group has five locations ranging from approximately 6 to 20 km from the Laboratory boundary. These regional stations are located in the neighboring communities of Española, El Rancho, Santa Fe, San Ildefonso Pueblo, and Santa Clara Pueblo. (2) The perimeter group has 29 locations within 4 km of the Laboratory boundary (see Figure 4-15). (3) The 63 on-site locations are within Laboratory boundaries, generally around operations that may produce ionizing radiation.

b. LANSCE. We monitor external penetrating radiation from airborne gases, particles, and vapors resulting from operations of LANSCE at TA-53 with a network of 24 TLD stations. Twelve of these monitoring locations are approximately 800 m (0.5 mi) north of and downwind from the LANSCE stack. The other 12 TLD stations are about 9 km (5.5 mi) from LANSCE, near the southern boundary of the Laboratory, and serve as a background measurement.

c. Low-Level Radioactive Waste Management Areas. The Laboratory has 10 inactive and 1 active (TA-54, Area G) low-level radioactive waste management areas. To monitor external penetrating radiation from these areas, we have placed 97 dosimeters around the perimeter of these waste management areas. All waste management areas are controlled-access areas and are not accessible to the general public.

d. Technical Area 18 Albedo Dosimeters. We monitor potential neutron doses from criticality experiments at TA-18 with seven albedo TLD stations. We maintain these stations on the north, south, and east sides of TA-18. Albedo dosimeters are sensitive to neutrons and use a polyethylene phantom to simulate the human body, which causes neutron backscatter.

Each monitoring station has two albedo TLDs. If Pajarito Road closes during TA-18 experiments, one of the dosimeters is removed and stored at a control location until the road reopens. This procedure allows for a comparison of the total annual dose measured at these stations with the total annual dose that a member of the public could receive at these stations. Background stations are located at Santa Fe and TA-49, and a control dosimeter is kept in a shielded vault.

e. Direct-Penetrating-Radiation (DPR) Dosimeter Locations. Beginning in January 2000, the number of DPR-monitoring locations decreased from 240 to 140 as a consequence of the recommendations in McNaughton et al., 2000. The retired locations do not meet the criteria defined in the report. Typical reasons for retiring a location were as follows: some locations were too far from the Laboratory, e.g., the location at the Pajarito Ski Hill; some locations became redundant when the facility being monitored was closed, e.g., the Ion Beam Facility; some locations do not have a significant source of radiation, e.g., TA-59; and some locations are not accessible to the public, e.g., Area AB at TA-49. Three locations near the old LANSCE lagoons were moved to the new lagoons because the old lagoons are locked and no longer being used. McNaughton et al., 2000 contains details of these changes.

3. Sampling Procedures, Data Management, and Quality Assurance.

The environmental TLDs that the Laboratory uses are composed of natural lithium fluoride crystals, referred to by their trade name of TLD-100. After exposure to radiation, the TLD chips are collected, then heated in a laboratory to release the energy stored in the crystal. This stored energy is released in the form of light that is proportional to the amount of radiation the TLD has absorbed. The light released is measured and recorded.

ESH-17’s operating procedures (ESH-17 1997) contain procedures that outline the QA/QC (quality assurance/quality control) protocols; placement and retrieval of the dosimeters; and reading of the dosimeters, data handling, validation and tabulation.

We encountered and corrected two problems that affected the data quality for 1999. During the second quarter of 1999, a new method of annealing the TLDs caused some of the dosimeters to emit 40% of the usual amount of light. A correction factor was derived using redundant dosimeters placed at the same location and also by comparing with previous data. The second problem concerned fading of the TLD signals during the three months in the field. The fade corrections were larger than usual (up to 27%) and also showed a larger variation than usual with an average standard deviation of 10%.

We estimated the uncertainty in the TLD-100 data by combining the uncertainties from three sources: the variation of individual TLD chips (3%), the light-output-to-dose calibration (8%), and the fade (10%). The overall one-standard-deviation uncertainty reported in Tables 4-16 and 4-17 is 13%.

The albedo dosimeters, provided by the Health Physics Measurements Group (ESH-4), are accredited by the DOE Laboratory Accreditation Program. ESH-4 provides quality assurance for the albedo dosimeters.

4. Analytical Results

a. Regional, Perimeter, and On-Site Areas. Table 4-16 presents the results for the regional, perimeter, and on-site locations. For some stations, one or more quarters of data are not available as a result of dosimeter loss. The missing data have been replaced by the average of the other quarters, as indicated in the footnote.

The annual dose equivalents at the perimeter and regional stations ranged from 100 to 180 mrem. These dose rates are consistent with natural background radiation and with previous measurements. The largest dose rates are in areas to the northeast, in particular at stations 10, 20, 24, 37, and 51, where terrestrial background is high (DOE/NV/11718-107). None of these measurements indicates a contribution from Laboratory operations.

The annual dose rates at most on-site locations listed in Table 4-16 are less than 180 mrem, which is consistent with the dose rate expected from natural terrestrial and cosmic sources. The locations with doses greater than 200 mrem are at TA-53 and Mortandad Canyon.

Stations 61, 62, 63, and 104 are close to the TA-53 lagoons. As the water evaporates from the lagoons, the shielding is less and the dose rate increases, so the 1999 doses are larger than in previous years. Access to the lagoons is restricted to radiological workers with a written permit. Stations 64 and 65 are close to the TA-53 “boneyard” where radioactive materials are stored. The 1999 doses are similar to the doses in previous years.

Stations 69 and 97, 98, and 99 are in Mortandad Canyon, which receives treated effluent from the liquid-waste treatment plant at TA-50. These locations are not normally accessible to the public. The 1999 doses are similar to the 1998 values.

b. LANSCE. We compared the TLD measurements collected at the 12 stations located directly to the north of LANSCE with the 12 background stations at TA-49. The ratio of the dose north of LANSCE stations to the background stations was 1.02 ± 0.11 mrem. Therefore, there is no statistically significant difference between the site and background TLD measurements, which means that the man-made dose at this location was too small to measure using TLDs.

c. Low-Level Radioactive Waste Management Areas. Table 4-17 presents the results from monitoring the waste management areas. Annual doses at most locations were within the range 100 to 180 mrem, which is the expected range of doses from natural terrestrial and cosmic radiation. Higher doses, indicative of man-made radiation, were measured at one location in Area T and about half the locations at Area G.

The annual dose at station 323 at Area T is about twice the expected dose from natural terrestrial and cosmic radiation. This level is consistent with the measurements of soil contamination reported in LANL 1991, which indicate 50 pCi/g of cesium-137 in the soil at this location. The origin and type of the contamination is also discussed in LANL 1990 and Rogers 1977. Area T is not accessible to the public.

The highest waste management area doses for 1999 were measured at TA-54, Area G, LANL’s only active low-level radioactive waste area. The 35 environmental surveillance TLDs at TA-54, Area G, are located within the waste site and along the security fence. The doses measured at this site are representative of storage and disposal operations that occur at the facility. Evaluation of these data is useful in minimizing occupational doses. However, Area G is a controlled-access area, and these measurements are not representative of a potential public dose.

The readings from TLD stations at TA-54, Area G, in the vicinity of the TWISP were higher than in previous years. The TWISP project entails bringing transuranic (TRU) waste out of belowground storage for further characterization and ultimate shipment to the Waste Isolation Pilot Plant (WIPP). The radiological constituents of these drums vary greatly, and the drum inventory near the TLDs is changing constantly. Until the drums are shipped to WIPP, external penetrating radiation doses near the project are expected to increase.

The TLD locations at Area G are not in an area that members of the public are capable of routinely accessing. Calculations and measurements show that the dose from Area G is not detectable at the DOE boundary, 350 m to the north. Nevertheless, we are continuing to monitor these dose rates closely.

We have two systems deployed at Area G for monitoring the DPR: TLDs or electrets ion chambers (EIC). Because of large differences between the two systems at locations near certain TWISP operations, we performed tests to assess TLD and EIC response to gamma energy levels similar to those in TRU waste. We found that our TLD dosimeters overrespond by about 50% to the low-energy gamma radiation from TRU materials (Kraig et al., 1999). Therefore, some of the results reported in Table 4-17 reflect this over-response. Actual doses at many Area G locations are smaller than reported.

d. Technical Area 18 Albedo Dosimeters. Table 4-18 presents the monitoring results from the TA-18 albedo dosimeter monitoring network. Two dosimeters were placed at each of the seven locations around TA-18. In previous years, we removed one dosimeter whenever Pajarito Road was closed. In 1999, Pajarito Road was never closed, so both dosimeters were continuously in place and received the same dose. The difference between the two dosimeter readings indicates the typical uncertainty from random processes such as variability of individual TLDs and fading during the three months in the field. This uncertainty is estimated to be ± 4 mrem.

An additional uncertainty of about a factor of two comes from the neutron correction factor, NCF. The neutron dose a dosimeter measures depends on the neutron-energy spectrum. The actual neutron dose is obtained by multiplying the dosimeter reading by the NCF. The albedo dosimeter data reported in the 1997 and 1998 environmental surveillance reports were calculated with NCF = 0.07. We calculated the data in the present report with NCF = 0.145, which corresponds to the neutron energy spectrum from the DOE-standard D_2O-moderated neutron spectrum from californium-252. Given the uncertainty in the neutron energies from TA-18, we do not have a perfect measurement of the NCF. We chose the higher value because it is more conservative, and it derives from a DOE standard (McNaughton 2000).

The maximum value in Table 4-18 is 36.5 mrem, which occurred at station 03, the parking lot to the east of TA-18. Routine public access is usually confined to locations 4–7, along Pajarito Road. For these locations, the maximum is 16.4 mrem.

The values in Table 4-18 would apply to a hypothetical individual who remains continuously at the specified location. According to Table 4 (page 65) of NCRP Report No. 49 (NCRP 1976), an occupancy factor of 1/16 is appropriate for “outside areas used only for pedestrians or vehicular traffic.” Under this assumption, the neutron dose would be about 2 mrem.

D. Nonradioactive Emissions Monitoring *(Jean Dewart, Craig Eberhart)*

1. Introduction

The Laboratory, in comparison with industrial sources such as power plants, semiconductor manufacturing plants, and refineries, is a relatively small source of nonradioactive air pollutants. Thus, opacity monitoring was the only nonradioactive air emissions monitoring we performed as required by state or federal air quality regulations during 1999.

We calculated emissions from industrial-type sources annually as the New Mexico Environment Department (NMED) required. These sources are responsible for the majority of all the nonradiological air pollutant emissions at the Laboratory. See Chapter 2 for these data. Research sources vary continuously and have very low emissions. As such, they are not calculated annually; instead, each new or modified research source is addressed in the new source review process.

Because Laboratory nonradioactive air emissions are small, the ambient monitoring program is limited in scope. We conduct particulate matter sampling during wildland fires in the vicinity of the Laboratory. NMED permits for prescribed burns for forest fire management require particulate matter sampling; the Laboratory conducted one prescribed burn in November 1999. We also performed ambient sampling for beryllium to determine the impact of Laboratory beryllium emissions.

2. Particulate Matter Sampling

We took particulate matter (PM-10) samples (particles less than 10 µm in aerodynamic diameter) on West Jemez Road during a prescribed burn in November 1999. The measured value on November 6 was 10.2 ug/m^3. This reading is well below the 24-hour National Ambient Air Quality Standard for PM-10 of 150 ug/m^3.

3. Detonation and Burning of Explosives

a. Total Quantities. The Laboratory tests explosives by detonating them at firing sites that the Dynamic Testing Division operates. The Laboratory maintains monthly shot records that include the type of explosives used as well as other material expended at each site. Table 4-19 summarizes the amounts of expended materials. The Laboratory also burns scrap and waste explosives because of treatment requirements and safety concerns. In 1999, the Laboratory burned 3.8 tons of high explosives.

An assessment of the ambient impacts of high-explosives testing, presented in the Site-Wide Environmental Impact Statement for Los Alamos (DOE 1999), indicates that high-explosives testing produces no adverse air quality impacts. The actual quantities of materials detonated during 1999 were less than the amounts for which impacts are analyzed in the Site-Wide Environmental Impact Statement.

b. Beryllium Quantities. In the early 1990s, we analyzed a limited number of AIRNET samples for beryllium in an attempt to detect potential impact from regulated sources and releases from explosive testing. All values were well below the New Mexico 30-day ambient air quality standard of 10 nanograms per cubic meter. With the recent heightened interest in the health effects of beryllium, AIRNET samples are again being analyzed for this contaminant.

However, New Mexico no longer has an ambient air quality standard for beryllium for comparison with AIRNET measurements. Therefore, we selected another air quality standard to use for comparison purposes: the NESHAP standard of 10 ng/m^3 (40 CFR Part 61 Subpart C National Emission Standard for Beryllium) can be, with EPA approval, an alternative to meeting the emission standard for beryllium. LANL is not required to use this alternative standard because the permitted sources meet the emission standards, but it is used in this case for comparative purposes.

We analyzed quarterly composited samples from 23 sites for beryllium in 1999, an increase in four locations from the 1998 program. We selected the original 19 sites because they were located near potential beryllium sources or in nearby communities. The 1998 results indicated that the source of beryllium in our AIRNET samplers was naturally occurring beryllium in resuspended dust. Dust may be resuspended mechanically, by vehicle traffic on dirt roads or construction activities, or by the wind in dry periods. To verify this conclusion, we added seven additional sampling locations (including two QA stations for nine samplers total), four of which are routinely impacted by above normal amounts of resuspended dust. The locations selected for high resuspended dust were at Jemez Pueblo and three locations at TA-54, Area G. The Jemez Pueblo station is located in a dirt parking lot near the visitor's center, next to a dirt road. The TA-54, Area G, sites are located near dirt roads and earthmoving activities. In addition, each of these four locations is in an area with lower rainfall, where the wind resuspends more dust than in a wetter area. Three stations that monitored an environmental restoration project at TA-49 were discontinued at the end of 1998.

Air concentrations for 1999, shown in Table 4-20 are, on average, higher than the 1998 values. These higher concentrations are due to a number of reasons: the selecting of additional sampling locations highly impacted by resuspended dust, discontinuing of sampling locations with relatively low impact from resuspended dust, drier conditions in 1999 than in 1998, and a major construction project taking place near AIRNET station 07. All values are less than 7% of the NESHAP standard. It should be noted that these quarterly concentrations have not been corrected for the small amounts of beryllium present in the filter material.

The highest measured beryllium concentrations occur at TA-54, Area G. These stations also routinely measure the highest amounts of naturally occurring uranium. Because this site has no beryllium handling operations, the source of the beryllium is most likely from naturally occurring beryllium in the soils, resuspended by the wind or by vehicles on dirt roads and earthmoving/construction operations. TA-54, Area G, is located in the drier portion of the Laboratory, making wind resuspension a more important contributor than at other Laboratory locations. The next highest beryllium concentrations were measured at the county landfill and at station 07. The earth-moving operations and vehicle traffic on dirt roads at the county landfill are the largest sources of resuspended dust impacting the AIRNET station. A construction project began immediately adjacent to station 07 during 1999, causing a large increase in the amount of resuspended dust and, therefore, beryllium in comparison with 1998.

Earlier in this chapter, we used the ratio of uranium-238 to uranium-234 to detect impacts from LANL because these isotopes are naturally present at a constant ratio. No comparable situation exists for beryllium isotopes, but the ratio of beryllium to other elements or radionuclides will be relatively constant if the local sources of particulate matter are similar. Because most of our sites are located on the Pajarito Plateau, a direct relationship between the ambient concentrations of uranium-234 and beryllium is likely unless there are naturally occurring local variations or releases to the environment. The direct correlation of beryllium to uranium-234 for all 1999 samples, as shown in Figure 4-16, indicates no unexpectedly high beryllium concentrations at any of the 23 sampling locations, including the TA-15-36 sites where beryllium has been used in explosives testing.

We performed cerium analyses on AIRNET filters, beginning in the second quarter of 1999, to assist in the interpretation of measured beryllium concentrations. Because LANL could be a source of uranium-234, potentially undermining the comparison of beryllium and uranium-234, AIRNET filters were analyzed for cerium, a rare earth element occurring in our soils and not emitted by Laboratory activities. The three quarters of cerium results correlate with beryllium in a fashion almost identical to uranium-234, supporting the conclusion that beryllium concentrations are from natural levels in resuspended soils. A full year of cerium data will be published for CY2000.

E. Meteorological Monitoring *(George Fenton)*

1. Introduction

Data obtained from the meteorological monitoring network support many Laboratory activities, including emergency management and response, regulatory compliance, safety analysis, engineering studies, and environmental surveillance programs. To accommodate the broad demands for weather data at the Laboratory, we measure a wide variety of meteorological variables across the network, including wind, temperature, pressure, relative humidity and dewpoint, precipitation, and solar and terrestrial radiation. The Meteorological Monitoring Plan (Baars et al., 1998) provides the details of the meteorological monitoring program. An electronic copy of the Meteorological Monitoring Plan is available on the World Wide Web at *http://www.weather.LANL.gov/monplan/mmp1998.pdf*.

2. Climatology

Los Alamos has a temperate, semiarid mountain climate. However, large differences in locally observed temperature and precipitation exist because of the 1,000-ft elevation change across the Laboratory site.

Four distinct seasons occur in Los Alamos. Winters are generally mild, with occasional winter storms. Spring is the windiest season. Summer is the rainy season, with frequent afternoon thunderstorms. Fall is marked by drier, cooler, and calmer weather. The climate statistics summarized below are from analyses provided in Bowen (1990 and 1992).

Several factors influence temperatures in Los Alamos. Despite its southern location, summertime temperatures at the Laboratory (elevation 7,400 feet) are cooler than nearby locations at lower elevations. The sloped terrain of the Pajarito Plateau causes cooled air to drain off the plateau at night; thus nighttime low temperatures on the plateau are often warmer than those at lower elevations. Also, the Sangre De Cristo Mountains to the east act as a barrier to arctic air masses affecting the central United States, although the temperature does occasionally drop below 0°F. Another factor affecting local temperature is the lack of moisture in the atmosphere. With less moisture, cloud cover is less and the atmosphere has a lower capacity to store heat, promoting daytime solar heating and nighttime radiative cooling. Wide variations in daily temperatures (a 23°F range on average) result from this diurnal heating and cooling cycle.

Winter temperatures range from 30°F to 50°F during the daytime and from 15°F to 25°F during the nighttime, with a record low temperature of –18°F. Winds during the winter are relatively light, so extreme windchills are uncommon. Summer temperatures range from 70°F to 88°F during the daytime and from 50°F to 59°F during the nighttime, with a record high temperature of 95°F.

The average annual precipitation (which includes both rain and the water equivalent for frozen precipitation) is 18.73 in. The average annual snowfall is 58.9 in., with freezing rain and sleet occurring rarely.

Winter precipitation in Los Alamos is often the result of storms approaching from the Pacific Ocean or of cyclones forming and/or intensifying leeward of the Rocky Mountains. Large snowfalls may occur locally from orographic lifting of the storms by the Jemez Mountains. The record single day snowfall is 22 in., and the record single season snowfall is 153 in. The snow is usually a dry, fluffy powder, with an equivalent water-to-snowfall ratio of 1:20.

The summer rainy season accounts for 37% of the annual precipitation. From July to August, afternoon thunderstorms form as a result of moist air advected from the Pacific Ocean and the Gulf of Mexico that convects and/or is orographically lifted by the Jemez Mountains. These thunderstorms can yield hail, large downpours, strong winds, and lightning. Local lightning density, among the highest in the USA, is estimated at 7 to 22 strikes per square mile per year. Approximately 90% of the detected local lightning activity (within a 30-mile radius) occurs from May to August.

The complex topography of Los Alamos influences local-scale wind patterns, notable in the absence of large-scale disturbances. Often a distinct diurnal cycle of winds is observed. Daytime upslope flow of heated air on the Pajarito Plateau adds a southeasterly component to the winds on the plateau. Nighttime downslope flow of cooled air from the mountain and plateau adds a light westerly to northwesterly component to local winds. Flow in the canyons of the Pajarito Plateau is very complex and different from flow over the plateau. Canyon flows are often aligned with the canyon axes, usually from the west as drainage flow. Canyon winds occasionally exhibit a rotating pattern, caused by an interaction of drainage flow down the canyon and mesa-top flows across the tops of the canyons.

3. Monitoring Network

A network of six towers gathers meteorological data (winds, atmospheric state, precipitation, and fluxes) at the Laboratory (see Fig. 13.1 in the Meteorological Monitoring Plan [Baars et al., 1998]). Four of the towers are located on mesa tops (TA-6, -49, -53, -54), one is in a canyon (TA-41), and one is on top of Pajarito Mountain (PJMT). The TA-6 tower is the official meteorological measurement site for the Laboratory. A sonic detection and ranging (SODAR) instrument is also located adjacent to the TA-6 meteorological tower. Precipitation is measured at TA-16, TA-74, and in the North Community of the Los Alamos townsite, in addition to each of the tower sites.

4. Sampling Procedures, Data Management, and Quality Assurance

Instruments in the meteorological network are sited in areas with good exposure to the elements being measured, usually in open fields, to avoid wake effects (from trees and structures) on wind and precipitation measurements. Open fields also prevent the obstruction of radiometers measuring solar and terrestrial radiation (ultraviolet to infrared spectra).

Temperature and wind are measured at multiple levels on open lattice towers. Instruments are positioned on west-pointing booms (toward the prevailing wind), at a distance of at least two times the tower width (to reduce tower wake effects). The multiple levels provide a vertical profile of conditions important in assessing boundary layer flow and stability conditions. The multiple levels also provide redundant measurements, which support data quality checks. The boom-mounted temperature sensors are shielded and aspirated to minimize solar heating effects.

Data loggers at the tower sites sample most of the meteorological variables at 0.33 Hz, store the data, then average the samples over a 15-minute period and transmit the data to a Hewlett Packard workstation by telephone or cell phone. The workstation automatically edits measurements that fall outside of allowable ranges and generates time series plots of the data for data quality review by a meteorologist. Daily statistics of certain meteorological variables (i.e., daily minimum and maximum temperatures, daily total precipitation, maximum wind gust, etc.) are also generated and checked for quality.

All meteorological instruments are refurbished and calibrated annually during an internal audit/inspection. Field instruments are replaced with backup instruments, and we check the replaced instruments to verify that they remained in calibration while in service. All instrument calibrations are traceable to the National Institute of Standards and Technology. An external audit is typically performed once every two or three years; the most recent audit took place during the summer of 1999. Initial results indicated no significant anomalies with the instruments in the network.

5. Analytical Results

For a graphical summary of Los Alamos weather for 1999, see Figure 4-17. The figure depicts the year's monthly average temperature ranges and monthly precipitation and monthly snowfall totals, compared with monthly normals (averaged from 1961–1990).

Climatologically, Los Alamos weather for 1999 was warmer and dryer than normal. Patterns were consistent with "La Niña" conditions, particularly during the winter months. Persistent high pressure over the Four Corners area frequently diverted storm systems away from Los Alamos, resulting in clear skies, decreased precipitation, warmer days, and cool nights.

Temperatures were 4° to 6°F above normal in January, February, March, October, and November and 2°F below normal from April through July. The average maximum of 58°F in November was the highest on record for Los Alamos. The year's average maximum and mean temperatures were 2°F and 1°F above normal, respectively, while the average minimum temperature was normal.

Monthly precipitation totals were 5% to 50% of normal for January, February, August, October, November, and December, whereas March through June, September, and October were 120% to 220% of normal. For the year, total precipitation was 87% of normal at 16.65 inches (see Table 4-21). Because of the dry winter, the annual snowfall total was 49% of normal at 28.8 inches. Snowfall totals for March and

April were 130% of normal, but the other months ranged from only 0% to 40% of normal.

Wind statistics, based upon 15-minute averaged wind observations at the four Pajarito Plateau towers and the Pajarito Mountain tower for 1999, appear as wind roses in Figures 4-18, 4-19, and 4-20. Wind roses depict the percentage of time that the wind blows from each of 16 compass rose points. The wind roses also show the distributions of wind speed for each of the 16 directions, displayed by shading of the rose barbs (see the wind rose legends). For example, at the TA-6 tower for all times (day and night, Figure 4-18), the most frequent wind direction was west-northwesterly, occurring 12% of the time. The winds were from the WNW at 0.5 to 2.5 m/s for 4.5% of the time, 5 to 7.5 m/s for 5.5% of the time, and greater than 7.5 m/s for about 1% of the time. Winds at TA-6 were calm 0 to 0.5 m/s (not attributable to a specific direction) for 1% of the time.

The four Pajarito Plateau towers measured daytime winds (sunrise to sunset) as predominately from the south because of upslope flow of heated daytime air (see Figure 4-19). Nighttime winds (sunset to sunrise) on the Pajarito Plateau were lighter and more variable than daytime winds and typically from the west, as a result of a combination of prevailing winds from the west and downslope drainage flow of cooled mountain air (see Figure 4-20). Winds atop Pajarito Mountain are more representative of upper-level flows and primarily ranged from the northwest to the southwest, largely because of the prevailing westerly winds.

F. Quality Assurance Program in the Air Quality Group *(Terry Morgan)*

1. Quality Assurance Program Development

During 1999, ESH-17 revised three quality plans that affect collection and use of air quality compliance data: the group Quality Management Plan, the project plan for the AIRNET system, and the project plan for the Meteorology Monitoring Project. The revisions reflect a new structure for the quality documents within the group. We also revised numerous implementing procedures to reflect the constant improvements in the processes. For example, we revised approximately 43 procedures related to environmental monitoring during 1999. QA plans for sampling systems follow the EPA QA-R/5 data quality objective process and incorporate required elements of DOE QA programs. Together, these plans and procedures describe or prescribe all the planned and systematic activities believed necessary to provide adequate confidence that ESH-17 processes perform satisfactorily.

2. Analytical Laboratory Assessments

During 1999, two external laboratories performed all chemical analyses reported for AIRNET samples. The Wastren-Grand Junction analytical laboratory, associated with the DOE's Grand Junction Project Office, provided biweekly gross alpha, gross beta, and isotopic gamma analytical services. Paragon Analytics, Inc., Fort Collins, Colorado, provided biweekly AIRNET tritium analytical services. Wastren-Grand Junction also provided analytical chemistry services for alpha-emitting isotopes (americium, plutonium, and uranium) and stable beryllium on AIRNET quarterly composite samples. Our on-site Health Physics Analytical Laboratory performed all instrumental analyses (gross alpha, gross beta, isotopic gamma, and tritium) reported for stack emissions and in-stack samples. The Wastern-Grand Junction site analyzed semester composites of in-stack filters for alpha and beta emitting isotopes.

Application of the data quality objectives process led to definition of analytical chemistry requirements. The statements of work we used to procure chemical analyses from the commercial laboratories summarized these requirements. Before awarding the purchases, ESH-17 evaluated the lab procedures, quality plans, and national performance evaluation program results of these suppliers and found that they met purchase requirements. ESH-17 also performed formal on-site assessments at all three laboratories during 1999 (Gladney 2000a, Gladney 2000b).

All three analytical laboratories participated in national performance evaluation studies during 1999. The DOE Environmental Measurements Laboratory in New York, NY, sponsors a DOE-wide environmental intercomparison study, sending spiked air filters twice a year to the participating laboratories. Other commercial and state agencies also produce materials and sponsor intercomparison programs. The results of these performance evaluations are included in each assessment report.

G. Unplanned Releases *(Scott Miller)*

During 1999, the Laboratory had no instances of increased airborne emissions of radioactive or nonradioactive materials that required reporting to either NMED or EPA.

Two instances of increased emissions in 1999 resulted from process problems. First, during the week of June 4, 1999, a small release of a radioactive form of silicon, silicon-32, occurred at the Radiochemistry facility, TA-48. This release comprised 5 microcuries and had a dose impact less than 1 microrem (0.001 mrem).

The second unplanned release was noted during the week of June 25, 1999. An operation at the CMR facility resulted in a small release of a radioactive form of technetium, technetium-99. An operation involving the heating of enriched uranium volatized technetium-99 present in the sample. An equipment malfunction allowed this technetium-99 to be released to the room and subsequently vented through the stack. This release comprised 50 microcuries and had a dose impact less than 1 microrem (0.001 mrem).

H. Special Studies—Neighborhood Environmental Watch Network Community Monitoring Stations

Neighborhood Environmental Watch Network (NEWNET) is a LANL Nonproliferation and International Security Division program for radiological monitoring in local communities. It establishes meteorological and external penetrating radiation monitoring stations in local communities and around radiological sources. These stations are the responsibility of a station manager from the local community. The stations have a local readout, and the data can be downloaded onto a personal computer at the station if this process is coordinated with the station manager.

Station measurements include wind speed and wind direction, ambient temperature, relative humidity, and barometric pressure. Also, the station measures gross gamma radiation using a pressurized ion chamber; the radiation sensors are sampled at 5-second intervals and averaged every 15 minutes.

The data from these stations are transmitted via satellite communications to a downlink station at LANL. The data are converted to engineering units, checked and annotated for transmission errors or station problems, stored in a public access database, and presented on the World Wide Web. The data from all the stations are available to the public with, at most, a 24-hour delay. The NEWNET web page also includes a Spanish language version.

More information about NEWNET and the data is available at *http://newnet.LANL.gov/* on the World Wide Web.

I. Tables

Table 4-1. Average Background Concentrations of Radioactivity in the Regional Atmosphere

	Units	Northern New Mexico (LANL)[a] 1999	EPA Concentration Limit[b]
Gross Alpha	fCi/m^3	1.0	NA[c]
Gross Beta	fCi/m^3	13.4	NA
^{234}U	aCi/m^3	19.2	7,700
^{235}U	aCi/m^3	2.1	7,100
^{238}U	aCi/m^3	17.3	8,300
^{238}Pu	aCi/m^3	–0.1	2,100
$^{239,240}Pu$	aCi/m^3	0.7	2,000
Tritium	pCi/m^3	0.3	1,500
^{241}Am	aCi/m^3	2.2	1,900

[a] Data from regional air sampling stations operated by LANL at Santa Fe (2 sites), El Rancho, and Española.
[b] Each EPA limit equals 10 mrem/yr.
[c] NA = not applicable.

Table 4-2. Airborne Long-Lived Gross Alpha Concentrations for 1999

Station Location		Number of Results	Number of Results <Uncertainty	Maximum (fCi/m^3)	Minimum (fCi/m^3)	Mean (fCi/m^3)	Sample Standard Deviation
Regional Stations							
01	Española	26	0	1.86	0.39	0.96	0.41
03	Santa Fe	26	0	1.47	0.51	0.94	0.32
55	Santa Fe West (Buckman Booster #4)	26	0	2.09	0.41	0.94	0.51
56	El Rancho	25	0	2.05	0.37	1.02	0.54
Pueblo Stations							
41	San Ildefonso Pueblo	26	0	1.70	0.39	0.99	0.44
59	Jemez Pueblo-Visitor's Center	25	0	2.51	0.48	1.09	0.51
Perimeter Stations							
04	Barranca School	26	0	1.90	0.44	0.89	0.41
05	Urban Park	26	0	1.79	0.40	0.93	0.34
06	48th Street	26	0	1.62	0.39	0.79	0.30
07	Gulf/Exxon/Shell Station	26	0	1.97	0.60	1.15	0.36
08	McDonald's Restaurant	26	0	1.57	0.25	0.91	0.33
09	Los Alamos Airport	26	0	1.79	0.35	0.81	0.40
10	East Gate	25	0	2.03	0.43	0.92	0.42
11	Well PM-1 (E. Jemez Road)	26	0	1.97	0.32	0.90	0.43
12	Royal Crest Trailer Court	26	1	2.01	0.26	0.89	0.46
13	Rocket Park	26	0	2.04	0.29	0.86	0.48
14	Pajarito Acres	26	0	1.65	0.29	0.81	0.37
15	White Rock Fire Station	26	0	2.18	0.45	0.98	0.49
16	White Rock Nazarene Church	26	1	1.61	0.17	0.83	0.39
17	Bandelier Fire Lookout	26	0	2.17	0.30	0.87	0.45
26	TA-49	26	0	2.00	0.30	0.86	0.42
32	County Landfill (TA-48)	26	0	1.76	0.49	1.08	0.33
54	TA-33 East	26	0	2.43	0.25	0.95	0.53
60	LA Canyon	26	0	1.60	0.54	0.99	0.32
61	LA Hospital	26	0	1.97	0.42	0.95	0.37
62	Crossroads Bible Church	26	0	1.91	0.28	0.87	0.44
63	Monte Rey South	26	0	1.91	0.33	0.85	0.43
90	East Gate-Backup	1	0	1.79	1.79	1.79	
TA-15 and TA-36 Stations							
76	TA-15-41 (formerly 15-61)	26	0	1.62	0.41	0.82	0.37
77	TA-36 IJ Site	26	0	1.79	0.35	0.79	0.41
78	TA-15-N	26	0	1.89	0.30	0.77	0.39
TA-21 Stations							
20	TA-21 Area B	26	0	1.48	0.32	0.85	0.31
71	TA-21.01 (NW Bldg 344)	26	0	1.76	0.32	0.84	0.42
72	TA-21.02 (N Bldg 344)	25	0	1.84	0.36	0.81	0.43
73	TA-21.03 (NE Bldg 344)	25	0	2.03	0.26	0.84	0.43
74	TA-21.04 (SE Bldg 344)	26	1	1.94	0.18	0.88	0.46
75	TA-21.05 (S Bldg 344)	26	0	1.54	0.38	0.84	0.33

Table 4-2. Airborne Long-Lived Gross Alpha Concentrations for 1999 (Cont.)

Station Location		Number of Results	Number of Results <Uncertainty	Maximum (fCi/m^3)	Minimum (fCi/m^3)	Mean (fCi/m^3)	Sample Standard Deviation
TA-54 Area G Stations							
27	Area G (by QA)	26	0	2.27	0.50	1.24	0.54
34	Area G-1 (behind trailer)	26	0	1.92	0.42	1.14	0.39
35	Area G-2 (back fence)	26	0	2.12	0.48	1.01	0.49
36	Area G-3 (by office)	26	0	1.64	0.44	0.98	0.39
45	Area G/South East Perimeter	26	0	2.25	0.79	1.33	0.36
47	Area G/North Perimeter	26	0	1.91	0.49	1.03	0.39
50	Area G-expansion	26	0	2.40	0.66	1.35	0.43
51	Area G-expansion pit	26	0	2.33	0.56	1.13	0.44
Other On-Site Stations							
23	TA-5	26	0	3.12	0.32	1.04	0.59
25	TA-16-450	26	0	1.48	0.29	0.85	0.31
30	Pajarito Booster 2 (P-2)	26	0	1.99	0.48	1.05	0.44
31	TA-3	26	0	1.83	0.40	0.99	0.40
33	TA-49 Area AB	1	0	0.74	0.74	0.74	
49	Pajarito Road (TA-36)	26	0	2.13	0.46	1.03	0.49
QA Stations							
38	TA-54 Area G-QA (next to #27)	26	0	4.60	0.46	1.25	0.85
39	TA-49-QA (next to #26)	26	0	1.76	0.48	0.90	0.36

Group Summaries

Station Location	Number of Results	Number of Results <Uncertainty	Maximum (fCi/m^3)	Minimum (fCi/m^3)	Mean (fCi/m^3)	95% Confidence Interval[a]	Sample Standard Deviation
Regional	103	0	2.09	0.37	0.96	±0.09	0.45
Pueblo	51	0	2.51	0.39	1.04	±0.13	0.47
Perimeter	546	2	2.43	0.17	0.91	±0.03	0.41
TA-15 and TA-36	78	0	1.89	0.30	0.79	±0.09	0.39
TA-21	154	1	2.03	0.18	0.84	±0.06	0.39
TA-54 Area G	208	0	2.40	0.42	1.15	±0.06	0.45
Other On-Site	131	0	3.12	0.29	0.99	±0.08	0.45

Concentration Guidelines

Concentration guidelines are not available for gross alpha concentrations.

[a] 95% confidence intervals are calculated using all calculated sample concentrations from every site within the group.

Table 4-3. Airborne Long-Lived Gross Beta Concentrations for 1999

Station Location		Number of Results	Number of Results <Uncertainty	Maximum (fCi/m^3)	Minimum (fCi/m^3)	Mean (fCi/m^3)	Sample Standard Deviation
Regional Stations							
01	Española	26	0	25.2	8.1	14.3	4.7
03	Santa Fe	26	0	21.3	8.5	13.0	3.6
55	Santa Fe West (Buckman Booster #4)	26	0	24.0	5.8	13.2	4.4
56	El Rancho	25	0	22.9	7.7	13.2	4.2
Pueblo Stations							
41	San Ildefonso Pueblo	26	0	25.3	6.2	13.7	4.8
59	Jemez Pueblo-Visitor’s Center	25	0	17.2	7.9	11.7	2.6
Perimeter Stations							
04	Barranca School	26	0	21.3	7.6	12.5	3.3
05	Urban Park	26	0	18.6	8.0	11.8	2.7
06	48th Street	26	0	18.3	7.3	11.3	2.9
07	Gulf/Exxon/Shell Station	26	0	23.0	8.8	12.9	3.1
08	McDonald’s Restaurant	26	0	21.1	8.1	12.4	3.3
09	Los Alamos Airport	26	0	21.2	7.6	12.5	3.8
10	East Gate	25	0	23.5	7.9	12.8	3.9
11	Well PM-1 (E. Jemez Road)	26	0	22.3	7.0	11.7	4.0
12	Royal Crest Trailer Court	26	0	19.8	7.9	12.5	3.2
13	Rocket Park	26	0	22.5	7.5	13.0	4.1
14	Pajarito Acres	26	0	20.4	7.6	12.5	3.5
15	White Rock Fire Station	26	0	22.8	7.2	13.0	4.4
16	White Rock Nazarene Church	26	0	20.8	7.3	12.3	3.6
17	Bandelier Fire Lookout	26	0	22.5	7.8	13.3	4.0
26	TA-49	26	0	21.3	6.8	12.1	3.2
32	County Landfill (TA-48)	26	0	20.4	4.1	11.4	4.0
54	TA-33 East	26	0	22.4	7.7	13.4	4.2
60	LA Canyon	26	0	19.7	8.2	11.8	3.1
61	LA Hospital	26	0	21.8	7.8	12.6	3.7
62	Crossroads Bible Church	26	0	21.5	7.3	13.0	3.9
63	Monte Rey South	26	0	20.4	7.4	12.7	3.8
90	East Gate-Backup	1	0	18.6	18.6	18.6	
TA-15 and TA-36 Stations							
76	TA-15-41 (formerly 15-61)	26	0	22.8	7.3	12.4	3.8
77	TA-36 IJ Site	26	0	22.3	7.8	12.5	3.7
78	TA-15-N	26	0	23.2	7.7	12.2	3.8
TA-21 Stations							
20	TA-21 Area B	26	0	21.4	8.3	12.7	3.3
71	TA-21.01 (NW Bldg 344)	26	0	22.0	8.0	12.6	3.6
72	TA-21.02 (N Bldg 344)	25	0	22.1	7.8	12.8	3.7
73	TA-21.03 (NE Bldg 344)	25	0	22.3	8.1	13.0	3.8
74	TA-21.04 (SE Bldg 344)	26	0	20.8	6.7	12.7	3.6
75	TA-21.05 (S Bldg 344)	26	0	21.8	7.7	12.9	3.7

Table 4-3. Airborne Long-Lived Gross Beta Concentrations for 1999 (Cont.)

Station Location		Number of Results	Number of Results <Uncertainty	Maximum (fCi/m^3)	Minimum (fCi/m^3)	Mean (fCi/m^3)	Sample Standard Deviation
TA-54 Area G Stations							
27	Area G (by QA)	26	0	24.3	4.1	11.6	5.2
34	Area G-1 (behind trailer)	26	0	19.7	7.5	12.7	3.5
35	Area G-2 (back fence)	26	0	20.3	7.5	12.1	3.6
36	Area G-3 (by office)	26	0	19.8	7.0	12.4	3.7
45	Area G/South East Perimeter	26	0	23.7	7.4	12.8	4.1
47	Area G/North Perimeter	26	0	22.3	7.3	12.5	3.8
50	Area G-expansion	26	0	22.2	8.3	13.0	3.8
51	Area G-expansion pit	26	0	21.6	7.8	12.3	3.5
Other On-Site Stations							
23	TA-5	26	0	20.7	8.0	12.8	3.5
25	TA-16-450	26	0	20.9	6.7	12.4	3.4
30	Pajarito Booster 2 (P-2)	26	0	21.6	6.6	12.7	3.9
31	TA-3	26	0	19.7	7.7	12.0	3.1
33	TA-49 Area AB	1	0	11.7	11.7	11.7	
49	Pajarito Road (TA-36)	26	0	24.0	7.6	13.1	4.2
QA Stations							
38	TA-54 Area G-QA (next to #27)	26	0	19.9	3.4	10.7	4.5
39	TA-49-QA (next to #26)	26	0	19.3	6.7	12.2	3.3

Group Summaries

Station Location	Number of Results	Number of Results <Uncertainty	Maximum (fCi/m^3)	Minimum (fCi/m^3)	Mean (fCi/m^3)	95% Confidence Interval[a]	Sample Standard Deviation
Regional	103	0	25.2	5.8	13.4	±0.8	4.2
Pueblo	51	0	25.3	6.2	12.7	±1.1	4.0
Perimeter	546	0	23.5	4.1	12.5	±0.3	3.6
TA-15 and TA-36	78	0	23.2	7.3	12.4	±0.8	3.7
TA-21	154	0	22.3	6.7	12.8	±0.6	3.6
TA-54 Area G	208	0	24.3	4.1	12.4	±0.5	3.9
Other On-Site	131	0	24.0	6.6	12.6	±0.6	3.6

Concentration Guidelines

Concentration guidelines are not available for gross beta concentrations.

[a] 95% confidence intervals are calculated using all calculated sample concentrations from every site within the group.

Table 4-4. Airborne Tritium as Tritiated Water Concentrations for 1999

Station Location		Number of Results	Number of Results <Uncertainty	Maximum (pCi/m^3)	Minimum (pCi/m^3)	Mean (pCi/m^3)	Sample Standard Deviation
Regional Stations							
01	Española	24	21	2.5	–1.3[a]	0.3	0.8
03	Santa Fe	25	19	3.5	–2.5	0.3	1.1
55	Santa Fe West (Buckman Booster #4)	25	20	1.3	–1.5	0.2	0.6
56	El Rancho	25	19	1.9	–0.9	0.4	0.6
Pueblo Stations							
41	San Ildefonso Pueblo	26	15	1.9	–0.9	0.6	0.8
59	Jemez Pueblo-Visitor’s Center	26	22	1.6	–1.0	0.1	0.7
Perimeter Stations							
04	Barranca School	26	6	3.7	–0.4	1.5	0.9
05	Urban Park	26	13	2.4	–1.2	0.7	0.8
06	48th Street	26	9	2.4	–1.6	0.9	0.9
07	Gulf/Exxon/Shell Station	26	5	2.9	–0.6	1.4	0.9
08	McDonald’s Restaurant	26	1	5.9	0.8	2.6	1.2
09	Los Alamos Airport	26	1	9.6	0.0	3.6	1.9
10	East Gate	25	0	6.6	1.0	3.8	1.4
11	Well PM-1 (E. Jemez Road)	26	2	5.3	0.5	2.1	1.2
12	Royal Crest Trailer Court	26	4	3.7	0.5	1.8	1.0
13	Rocket Park	26	2	6.7	0.7	3.5	1.5
14	Pajarito Acres	26	2	6.5	0.5	2.4	1.6
15	White Rock Fire Station	26	4	4.6	0.7	2.2	1.1
16	White Rock Nazarene Church	26	2	8.3	0.8	3.5	2.1
17	Bandelier Fire Lookout	26	1	13.8	1.2	4.4	3.2
26	TA-49	26	1	8.3	1.1	3.6	1.6
32	County Landfill (TA-48)	26	5	8.6	–0.6	2.2	2.0
54	TA-33 East	26	1	11.9	0.9	4.0	2.9
60	LA Canyon	26	7	3.2	0.3	1.5	0.7
61	LA Hospital	26	10	3.0	–2.1	1.2	1.1
62	Crossroads Bible Church	26	6	6.5	–0.4	2.0	1.6
63	Monte Rey South	26	5	7.4	0.0	2.3	1.8
90	East Gate-Backup	1	0	6.1	6.1	6.1	
TA-15 and TA-36 Stations							
76	TA-15-41 (formerly 15-61)	26	8	3.5	–1.1	1.4	1.2
77	TA-36 IJ Site	26	7	4.0	–1.1	1.7	1.2
78	TA-15-N	26	3	4.2	0.8	2.0	0.9
TA-21 Stations							
20	TA-21 Area B	26	0	9.6	1.9	4.5	2.1
71	TA-21.01 (NW Bldg 344)	26	1	10.6	0.6	3.7	2.0
72	TA-21.02 (N Bldg 344)	25	0	11.8	2.0	4.9	2.4
73	TA-21.03 (NE Bldg 344)	25	0	25.4	4.3	10.6	4.9
74	TA-21.04 (SE Bldg 344)	26	0	16.3	2.3	5.8	3.0
75	TA-21.05 (S Bldg 344)	26	1	22.5	0.6	7.3	4.8

Table 4-4. Airborne Tritium as Tritiated Water Concentrations for 1999 (Cont.)

Station Location		Number of Results	Number of Results <Uncertainty	Maximum (pCi/m^3)	Minimum (pCi/m^3)	Mean (pCi/m^3)	Sample Standard Deviation
TA-54 Area G Stations							
27	Area G (by QA)	26	0	65.1	3.7	18.3	16.3
34	Area G-1 (behind trailer)	26	0	30.8	4.6	12.7	7.0
35	Area G-2 (back fence)	25	0	3,654.3	39.4	767.8	1,001.1
36	Area G-3 (by office)	26	0	59.3	7.8	25.6	11.6
45	Area G/South East Perimeter	26	0	31.0	2.7	12.7	8.2
47	Area G/North Perimeter	26	0	61.3	3.7	19.1	16.1
50	Area G-expansion	25	0	36.6	3.9	13.5	8.0
51	Area G-expansion pit	26	0	19.8	2.7	9.7	4.6
Other On-Site Stations							
23	TA-5	26	5	4.7	–0.3	2.2	1.2
25	TA-16-450	26	0	113.2	12.8	55.1	28.6
30	Pajarito Booster 2 (P-2)	26	7	5.4	0.1	1.8	1.2
31	TA-3	26	2	6.8	1.2	2.7	1.4
33	TA-49 Area AB	1	0	2.7	2.7	2.7	
49	Pajarito Road (TA-36)	26	5	3.6	–0.8	1.7	1.1
QA Stations							
38	TA-54 Area G-QA (next to #27)	26	0	67.3	4.3	18.7	16.0
39	TA-49-QA (next to #26)	26	0	9.4	1.9	3.9	1.7

Group Summaries

Station Location	Number of Results	Number of Results <Uncertainty	Maximum (pCi/m^3)	Minimum (pCi/m^3)	Mean (pCi/m^3)	95% Confidence Interval[b]	Sample Standard Deviation
Regional	99	79	3.5	–2.5	0.3	±0.2	0.8
Pueblo	52	37	1.9	–1.0	0.4	±0.2	0.8
Perimeter	546	87	13.8	–2.1	2.4	±0.2	1.9
TA-15 and TA-36	78	18	4.2	–1.1	1.7	±0.2	1.1
TA-21	154	2	25.4	0.6	6.1	±0.6	4.1
TA-54 Area G	206	0	3,654.3	2.7	107.2	±57.6	421.9
Other On-Site	131	19	113.2	–0.8	12.6	±4.3	24.7

Concentration Guidelines

DOE Derived Air Concentration (DAC) Guide for workplace exposure is 20,000,000 pCi/m^3. See Appendix A.
EPA 40 CFR 61 Concentration Guide 1,500 pCi/m^3.

[a] See Section A.4.a of this chapter and Appendix B for an explanation of negative values.
[b] 95% confidence intervals are calculated using all calculated sample concentrations from every site within the group.

Table 4-5. Airborne Plutonium-238 Concentrations for 1999

Station Location		Number of Results	Number of Results <Uncertainty	Maximum (aCi/m^3)	Minimum (aCi/m^3)	Mean (aCi/m^3)	Sample Standard Deviation
Regional Stations							
01	Española	4	4	0.1	–0.5[a]	–0.1	0.3
03	Santa Fe	4	4	0.0	–0.3	–0.1	0.1
55	Santa Fe West (Buckman Booster #4)	4	4	0.3	–0.3	0.0	0.2
56	El Rancho	4	4	0.5	–0.5	–0.1	0.4
Pueblo Stations							
41	San Ildefonso Pueblo	4	4	0.4	–0.4	0.1	0.3
59	Jemez Pueblo-Visitor's Center	4	4	0.3	–0.3	0.1	0.3
Perimeter Stations							
04	Barranca School	4	4	0.4	–0.3	0.0	0.3
05	Urban Park	4	4	0.7	0.0	0.4	0.3
06	48th Street	4	4	0.4	–0.3	–0.1	0.3
07	Gulf/Exxon/Shell Station	4	4	0.6	–0.1	0.2	0.3
08	McDonald's Restaurant	4	4	0.0	–0.5	–0.3	0.2
09	Los Alamos Airport	4	4	0.1	–0.2	0.0	0.1
10	East Gate	4	4	0.5	–0.6	–0.1	0.5
11	Well PM-1 (E. Jemez Road)	4	4	0.3	–0.3	0.0	0.3
12	Royal Crest Trailer Court	4	4	1.9	–0.2	0.5	0.9
13	Rocket Park	4	4	0.6	–0.4	0.1	0.5
14	Pajarito Acres	4	4	0.0	–0.3	–0.2	0.1
15	White Rock Fire Station	4	4	0.4	–0.3	0.0	0.3
16	White Rock Nazarene Church	4	4	0.3	–0.6	–0.1	0.4
17	Bandelier Fire Lookout	4	4	1.4	0.1	0.5	0.6
26	TA-49	4	4	0.1	–0.3	–0.1	0.2
32	County Landfill (TA-48)	4	4	0.9	–0.6	0.2	0.6
54	TA-33 East	4	4	0.7	–0.3	0.0	0.4
60	LA Canyon	4	4	0.5	–0.3	0.1	0.3
61	LA Hospital	4	4	0.5	–0.6	0.0	0.5
62	Crossroads Bible Church	4	4	0.4	–0.5	0.0	0.4
63	Monte Rey South	4	4	0.5	0.0	0.2	0.3
TA-15 and TA-36 Stations							
76	TA-15-41 (formerly 15-61)	4	4	0.9	–0.4	0.1	0.6
77	TA-36 IJ Site	4	4	0.5	–0.1	0.2	0.3
78	TA-15-N	4	4	0.3	–0.3	0.0	0.3
TA-21 Stations							
20	TA-21 Area B	4	4	0.2	–0.3	–0.1	0.3
71	TA-21.01 (NW Bldg 344)	4	4	0.2	–0.6	–0.2	0.3
72	TA-21.02 (N Bldg 344)	4	4	1.6	0.5	0.8	0.5
73	TA-21.03 (NE Bldg 344)	4	4	1.6	0.5	0.9	0.5
74	TA-21.04 (SE Bldg 344)	4	4	0.0	–0.8	–0.3	0.3
75	TA-21.05 (S Bldg 344)	4	4	0.4	–0.4	0.0	0.4

Table 4-5. Airborne Plutonium-238 Concentrations for 1999 (Cont.)

Station Location	Number of Results	Number of Results <Uncertainty	Maximum (aCi/m^3)	Minimum (aCi/m^3)	Mean (aCi/m^3)	Sample Standard Deviation
TA-54 Area G Stations						
27 Area G (by QA)	4	4	3.9	0.2	1.2	1.8
34 Area G-1 (behind trailer)	4	2	12.2	0.1	5.9	5.6
35 Area G-2 (back fence)	4	4	0.7	–0.1	0.3	0.4
36 Area G-3 (by office)	4	4	0.6	0.1	0.4	0.2
45 AreaG/South East Perimeter	4	4	2.1	0.0	1.2	1.0
47 Area G/North Perimeter	4	4	0.8	0.0	0.5	0.4
50 Area G-expansion	4	4	1.1	–0.3	0.4	0.6
51 Area G-expansion pit	4	4	0.4	–0.3	0.0	0.3
Other On-Site Stations						
23 TA-5	4	4	0.0	–0.8	–0.4	0.4
25 TA-16-450	4	4	0.0	–0.1	–0.1	0.1
30 Pajarito Booster 2 (P-2)	4	4	0.0	–0.8	–0.3	0.3
31 TA-3	4	4	1.8	0.0	0.8	0.8
49 Pajarito Road (TA-36)	4	4	1.4	–0.5	0.7	0.8
QA Stations						
38 TA-54 Area G-QA (next to #27)	4	4	1.5	–0.5	0.6	1.0
39 TA-49-QA (next to #26)	4	4	1.2	–0.8	–0.1	0.9

Group Summaries

Station Location	Number of Results	Number of Results <Uncertainty	Maximum (aCi/m^3)	Minimum (aCi/m^3)	Mean (aCi/m^3)	95% Confidence Interval[b]	Sample Standard Deviation
Regional	16	16	0.5	–0.5	–0.1	±0.1	0.3
Pueblo	8	8	0.4	–0.4	0.1	±0.2	0.3
Perimeter	84	84	1.9	–0.6	0.1	±0.1	0.4
TA-15 and TA-36	12	12	0.9	–0.4	0.1	±0.3	0.4
TA-21	24	24	1.6	–0.8	0.2	±0.3	0.6
TA-54 Area G	32	30	12.2	–0.3	1.3	±0.9	2.6
Other On-Site	20	20	1.8	–0.8	0.1	±0.3	0.7

Concentration Guidelines

DOE Derived Air Concentration (DAC) Guide for workplace exposure is 3,000,000 aCi/m^3. See Appendix A.
EPA 40 CFR 61 Concentration Guide 2,100 aCi/m^3.

[a] See Section A.4.a of this chapter and Appendix B for an explanation of negative values.
[b] 95% confidence intervals are calculated using all calculated sample concentrations from every site within the group.

Table 4-6. Airborne Plutonium-239 Concentrations for 1999

Station Location	Number of Results	Number of Results <Uncertainty	Maximum (aCi/m^3)	Minimum (aCi/m^3)	Mean (aCi/m^3)	Sample Standard Deviation
Regional Stations						
01 Española	4	4	2.1	–0.9[a]	0.5	1.3
03 Santa Fe	4	4	1.9	–0.6	0.8	1.1
55 Santa Fe West (Buckman Booster #4)	4	4	1.6	–0.2	0.8	0.8
56 El Rancho	4	4	2.1	–1.4	0.6	1.5
Pueblo Stations						
41 San Ildefonso Pueblo	4	4	0.5	–0.7	0.1	0.5
59 Jemez Pueblo-Visitor’s Center	4	4	3.7	–0.1	1.1	1.7
Perimeter Stations						
04 Barranca School	4	4	0.7	–1.2	–0.1	0.9
05 Urban Park	4	4	1.2	0.0	0.6	0.5
06 48th Street	4	4	1.3	0.5	0.9	0.4
07 Gulf/Exxon/Shell Station	4	2	14.0	0.8	7.4	6.9
08 McDonald’s Restaurant	4	4	0.9	–0.1	0.4	0.4
09 Los Alamos Airport	4	4	2.9	0.0	1.7	1.4
10 East Gate	4	4	2.3	0.1	1.1	0.9
11 Well PM-1 (E. Jemez Road)	4	4	1.8	0.0	1.2	0.8
12 Royal Crest Trailer Court	4	4	1.3	–0.3	0.4	0.8
13 Rocket Park	4	4	1.0	0.1	0.4	0.4
14 Pajarito Acres	4	4	1.4	–0.3	0.6	0.7
15 White Rock Fire Station	4	4	1.2	0.1	0.7	0.5
16 White Rock Nazarene Church	4	4	3.0	–0.2	0.9	1.4
17 Bandelier Fire Lookout	4	4	1.1	–0.1	0.5	0.6
26 TA-49	4	4	1.3	0.1	0.6	0.5
32 County Landfill (TA-48)	4	4	8.1	2.4	4.0	2.7
54 TA-33 East	4	4	2.0	0.4	1.2	0.7
60 LA Canyon	4	4	1.6	0.0	1.0	0.7
61 LA Hospital	4	4	2.0	1.3	1.6	0.3
62 Crossroads Bible Church	4	4	1.7	0.1	0.6	0.7
63 Monte Rey South	4	4	1.9	0.0	0.9	0.8
TA-15 and TA-36 Stations						
76 TA-15-41 (formerly 15-61)	4	4	1.9	–1.3	0.9	1.4
77 TA-36 IJ Site	4	4	1.1	–1.2	–0.1	1.0
78 TA-15-N	4	4	2.5	–1.2	0.6	1.5
TA-21 Stations						
20 TA-21 Area B	4	4	2.7	0.2	1.5	1.0
71 TA-21.01 (NW Bldg 344)	4	4	1.4	0.0	0.9	0.6
72 TA-21.02 (N Bldg 344)	4	4	6.5	0.5	3.4	2.5
73 TA-21.03 (NE Bldg 344)	4	2	10.9	–0.2	5.4	5.1
74 TA-21.04 (SE Bldg 344)	4	3	9.2	4.4	5.6	2.4
75 TA-21.05 (S Bldg 344)	4	4	4.3	2.0	2.9	1.0

Table 4-6. Airborne Plutonium-239 Concentrations for 1999 (Cont.)

Station Location		Number of Results	Number of Results <Uncertainty	Maximum (aCi/m^3)	Minimum (aCi/m^3)	Mean (aCi/m^3)	Sample Standard Deviation
TA-54 Area G Stations							
27	Area G (by QA)	4	1	166.7	4.9	51.9	77.1
34	Area G-1 (behind trailer)	4	1	205.6	7.5	105.0	111.3
35	Area G-2 (back fence)	4	4	1.4	0.8	1.2	0.3
36	Area G-3 (by office)	4	4	1.5	–0.2	0.8	0.7
45	Area G/South East Perimeter	4	0	52.4	7.8	24.5	20.7
47	Area G/North Perimeter	4	4	4.8	0.6	3.2	1.9
50	Area G-expansion	4	4	6.9	2.3	4.7	1.9
51	Area G-expansion pit	4	4	3.1	–0.9	1.2	1.6
Other On-Site Stations							
23	TA-5	4	4	0.6	–0.1	0.2	0.3
25	TA-16-450	4	4	1.6	0.6	1.2	0.4
30	Pajarito Booster 2 (P-2)	4	4	1.5	0.0	0.7	0.6
31	TA-3	4	4	5.7	0.1	1.9	2.6
49	Pajarito Road (TA-36)	4	4	1.4	–0.6	0.1	0.9
QA Stations							
38	TA-54 Area G-QA (next to #27)	4	2	25.8	3.3	12.7	10.8
39	TA-49-QA (next to #26)	4	4	0.9	–0.1	0.3	0.4

Group Summaries

Station Location	Number of Results	Number of Results <Uncertainty	Maximum (aCi/m^3)	Minimum (aCi/m^3)	Mean (aCi/m^3)	95% Confidence Interval[b]	Sample Standard Deviation
Regional	16	16	2.1	–1.4	0.7	±0.6	1.1
Pueblo	8	8	3.7	–0.7	0.6	±1.1	1.3
Perimeter	84	82	14.0	–1.2	1.3	±0.5	2.2
TA-15 and TA-36	12	12	2.5	–1.3	0.5	±0.8	1.3
TA-21	24	21	10.9	–0.2	3.3	±1.2	2.9
TA-54 Area G	32	22	205.6	–0.9	24.1	±20.0	55.4
Other On-Site	20	20	5.7	–0.6	0.8	±0.6	1.3

Concentration Guidelines

DOE Derived Air Concentration (DAC) Guide for workplace exposure is 2,000,000 aCi/m^3. See Appendix A.
EPA 40 CFR 61 Concentration Guide 2,000 aCi/m^3.

[a] See Section A.4.a of this chapter and Appendix B for an explanation of negative values.
[b] 95% confidence intervals are calculated using all calculated sample concentrations from every site within the group.

Table 4-7. Airborne Americium-241 Concentrations for 1999

Station Location		Number of Results	Number of Results <Uncertainty	Maximum (aCi/m^3)	Minimum (aCi/m^3)	Mean (aCi/m^3)	Sample Standard Deviation
Regional Stations							
01	Española	4	4	2.7	1.9	2.3	0.4
03	Santa Fe	4	4	3.8	1.6	2.4	1.0
55	Santa Fe West (Buckman Booster #4)	4	4	4.1	0.9	2.5	1.3
56	El Rancho	4	4	2.5	0.9	1.7	0.8
Pueblo Stations							
41	San Ildefonso Pueblo	4	4	2.2	0.7	1.7	0.7
59	Jemez Pueblo-Visitor's Center	4	4	9.0	1.0	3.5	3.7
Perimeter Stations							
04	Barranca School	4	4	1.6	0.8	1.2	0.3
05	Urban Park	4	4	3.2	1.1	2.2	0.9
06	48th Street	4	4	5.0	1.3	3.2	1.6
07	Gulf/Exxon/Shell Station	4	4	5.9	1.6	2.9	2.1
08	McDonald's Restaurant	4	4	4.3	1.9	2.9	1.1
09	Los Alamos Airport	4	4	3.8	2.0	2.8	0.8
10	East Gate	4	4	3.5	2.1	2.7	0.6
11	Well PM-1 (E. Jemez Road)	4	4	1.9	0.5	1.3	0.6
12	Royal Crest Trailer Court	4	4	3.0	1.2	1.9	0.8
13	Rocket Park	4	4	3.5	1.2	2.6	1.0
14	Pajarito Acres	4	4	4.2	1.3	2.5	1.3
15	White Rock Fire Station	4	4	3.8	1.3	2.5	1.1
16	White Rock Nazarene Church	4	4	2.6	0.3	1.5	1.0
17	Bandelier Fire Lookout	4	4	3.0	1.4	2.3	0.8
26	TA-49	4	4	5.5	0.9	3.0	2.0
32	County Landfill (TA-48)	4	3	20.4	2.2	8.0	8.4
54	TA-33 East	4	4	4.3	0.9	2.5	1.4
60	LA Canyon	4	4	5.0	1.4	2.5	1.7
61	LA Hospital	4	4	3.4	1.6	2.4	0.9
62	Crossroads Bible Church	4	4	3.6	1.2	2.0	1.1
63	Monte Rey South	4	4	2.8	0.8	2.1	1.0
TA-15 and TA-36 Stations							
76	TA-15-41 (formerly15-61)	4	4	4.3	1.4	3.1	1.2
77	TA-36 IJ Site	4	4	5.9	1.2	3.7	2.0
78	TA-15-N	4	4	2.4	0.6	1.4	0.8
TA-21 Stations							
20	TA-21 Area B	4	4	5.3	1.3	2.9	1.7
71	TA-21.01 (NW Bldg 344)	4	4	2.9	0.4	1.3	1.1
72	TA-21.02 (N Bldg 344)	4	4	5.0	1.5	3.1	1.6
73	TA-21.03 (NE Bldg 344)	4	4	6.1	2.1	4.1	1.9
74	TA-21.04 (SE Bldg 344)	4	4	3.1	1.4	2.5	0.8
75	TA-21.05 (S Bldg 344)	4	4	4.9	2.5	3.5	1.0

Table 4-7. Airborne Americium-241 Concentrations for 1999 (Cont.)

Station Location		Number of Results	Number of Results <Uncertainty	Maximum (aCi/m^3)	Minimum (aCi/m^3)	Mean (aCi/m^3)	Sample Standard Deviation
TA-54 Area G Stations							
27	Area G (by QA)	4	1	28.0	6.6	15.2	9.3
34	Area G-1 (behind trailer)	4	0	234.6	24.0	89.7	98.5
35	Area G-2 (back fence)	4	4	4.4	1.8	3.3	1.1
36	Area G-3 (by office)	4	4	4.2	1.3	2.6	1.4
45	Area G/South East Perimeter	4	1	13.1	7.0	10.9	2.7
47	Area G/North Perimeter	4	3	7.8	1.9	4.4	2.5
50	Area G-expansion	4	4	5.7	2.4	3.8	1.4
51	Area G-expansion pit	4	4	3.4	1.4	2.3	0.9
Other On-Site Stations							
23	TA-5	4	4	4.7	2.2	3.6	1.0
25	TA-16-450	4	4	5.2	1.7	3.2	1.7
30	Pajarito Booster 2 (P-2)	4	4	4.4	1.0	2.9	1.5
31	TA-3	4	4	2.7	1.8	2.2	0.4
49	Pajarito Road (TA-36)	4	4	4.5	1.7	3.4	1.3
QA Stations							
38	TA-54 Area G-QA (next to #27)	4	2	16.4	5.0	10.2	5.1
39	TA-49-QA (next to #26)	4	4	4.7	1.5	2.5	1.5

Group Summaries

Station Location	Number of Results	Number of Results <Uncertainty	Maximum (aCi/m^3)	Minimum (aCi/m^3)	Mean (aCi/m^3)	95% Confidence Interval[a]	Sample Standard Deviation
Regional	16	16	4.1	0.9	2.2	±0.5	0.9
Pueblo	8	8	9.0	0.7	2.6	±2.2	2.7
Perimeter	84	83	20.4	0.3	2.6	±0.5	2.3
TA-15 and TA-36	12	12	5.9	0.6	2.7	±1.1	1.7
TA-21	24	24	6.1	0.4	2.9	±0.7	1.5
TA-54 Area G	32	21	234.6	1.3	16.5	±15.1	41.9
Other On-Site	20	20	5.2	1.0	3.1	±0.6	1.2

Concentration Guidelines

DOE Derived Air Concentration (DAC) Guide for workplace exposure is 2,000,000 aCi/m^3. See Appendix A.
EPA 40 CFR 61 Concentration Guide 1,900 aCi/m^3.

[a] 95% confidence intervals are calculated using all calculated sample concentrations from every site within the group.

Table 4-8. Airborne Uranium-234 Concentrations for 1999

Station Location		Number of Results	Number of Results <Uncertainty	Maximum (aCi/m^3)	Minimum (aCi/m^3)	Mean (aCi/m^3)	Sample Standard Deviation
Regional Stations							
01	Española	4	0	25.9	10.5	20.5	6.9
03	Santa Fe	4	0	41.1	14.9	25.6	11.7
55	Santa Fe West (Buckman Booster #4)	4	0	16.1	10.8	13.2	2.3
56	El Rancho	4	0	21.7	11.8	17.6	4.9
Pueblo Stations							
41	San Ildefonso Pueblo	4	0	32.8	11.8	26.0	9.6
59	Jemez Pueblo-Visitor’s Center	4	0	49.7	29.6	37.5	8.6
Perimeter Stations							
04	Barranca School	4	0	14.4	7.9	11.8	2.8
05	Urban Park	4	0	25.3	9.3	19.4	7.0
06	48th Street	4	1	7.6	5.3	6.3	1.0
07	Gulf/Exxon/Shell Station	4	0	70.2	20.2	35.3	23.4
08	McDonald’s Restaurant	4	0	11.6	7.6	9.9	1.7
09	Los Alamos Airport	4	1	13.6	5.7	8.4	3.5
10	East Gate	4	0	18.4	5.3	11.1	5.6
11	Well PM-1 (E. Jemez Road)	4	1	10.0	5.2	7.7	2.3
12	Royal Crest Trailer Court	4	0	15.3	8.2	11.4	3.1
13	Rocket Park	4	0	9.6	7.3	8.4	1.0
14	Pajarito Acres	4	0	9.4	6.0	8.0	1.5
15	White Rock Fire Station	4	0	15.7	6.5	11.6	4.1
16	White Rock Nazarene Church	4	1	11.5	5.5	9.0	2.6
17	Bandelier Fire Lookout	4	2	9.3	5.4	7.1	2.0
26	TA-49	4	2	13.7	4.8	8.3	4.1
32	County Landfill (TA-48)	4	0	75.6	39.0	58.1	19.5
54	TA-33 East	4	0	11.9	6.3	9.2	2.6
60	LA Canyon	4	0	15.7	5.7	11.6	4.2
61	LA Hospital	4	0	32.0	9.1	18.3	9.7
62	Crossroads Bible Church	4	1	10.9	5.3	8.3	2.3
63	Monte Rey South	4	0	11.5	6.1	9.3	2.3
TA-15 and TA-36 Stations							
76	TA-15-41 (formerly 15-61)	4	2	12.3	4.4	6.9	3.7
77	TA-36 IJ Site	4	0	16.5	11.1	13.1	2.3
78	TA-15-N	4	0	10.9	4.1	8.2	2.9
TA-21 Stations							
20	TA-21 Area B	4	0	40.5	6.8	15.7	16.5
71	TA-21.01 (NW Bldg 344)	4	1	14.3	6.4	9.1	3.5
72	TA-21.02 (N Bldg 344)	4	0	13.9	6.4	9.0	3.4
73	TA-21.03 (NE Bldg 344)	4	1	11.2	8.2	10.0	1.3
74	TA-21.04 (SE Bldg 344)	4	1	17.4	5.3	9.8	5.3
75	TA-21.05 (S Bldg 344)	4	0	14.7	5.7	10.1	3.8

Table 4-8. Airborne Uranium-234 Concentrations for 1999 (Cont.)

Station Location		Number of Results	Number of Results <Uncertainty	Maximum (aCi/m^3)	Minimum (aCi/m^3)	Mean (aCi/m^3)	Sample Standard Deviation
TA-54 Area G Stations							
27	Area G (by QA)	4	0	304.7	29.8	115.6	129.1
34	Area G-1 (behind trailer)	4	0	63.9	17.5	34.4	20.4
35	Area G-2 (back fence)	4	0	25.6	9.1	19.7	7.5
36	Area G-3 (by office)	4	0	51.8	18.1	28.9	15.7
45	Area G/South East Perimeter	4	0	72.7	44.1	58.7	12.1
47	Area G/North Perimeter	4	0	30.1	8.1	19.5	10.3
50	Area G-expansion	4	0	249.9	49.2	115.5	91.9
51	Area G-expansion pit	4	0	96.5	21.2	47.4	33.6
Other On-Site Stations							
23	TA-5	4	0	11.5	7.8	9.8	1.6
25	TA-16-450	4	0	8.9	5.4	7.4	1.4
30	Pajarito Booster 2 (P-2)	4	0	11.4	6.5	8.7	2.2
31	TA-3	4	0	10.6	6.6	8.8	2.1
49	Pajarito Road (TA-36)	4	0	16.1	5.7	11.0	5.0
QA Stations							
38	TA-54 Area G-QA (next to #27)	4	0	138.7	28.5	69.7	52.0
39	TA-49-QA (next to #26)	4	1	15.8	3.5	8.3	5.3

Group Summaries

Station Location	Number of Results	Number of Results <Uncertainty	Maximum (aCi/m^3)	Minimum (aCi/m^3)	Mean (aCi/m^3)	95% Confidence Interval[a]	Sample Standard Deviation
Regional	16	0	41.1	10.5	19.2	±4.3	8.1
Pueblo	8	0	49.7	11.8	31.7	±8.7	10.4
Perimeter	84	9	75.6	4.8	13.7	±2.9	13.5
TA-15 and TA-36	12	2	16.5	4.1	9.4	±2.5	3.9
TA-21	24	3	40.5	5.3	10.6	±3.0	7.1
TA-54 Area G	32	0	304.7	8.1	55.0	±23.0	63.7
Other On-Site	20	0	16.1	5.4	9.1	±1.3	2.8

Concentration Guidelines

DOE Derived Air Concentation (DAC) Guide for workplace exposure is 20,000,000 aCi/m^3. See Appendix A.
EPA 40 CFR 61 Concentration Guide 7,700 a Ci/m^3.

[a] 95% confidence intervals are calculated using all calculated sample concentrations from every site within the group.

Table 4-9. Airborne Uranium-235 Concentrations for 1999

Station Location	Number of Results	Number of Results <Uncertainty	Maximum (aCi/m^3)	Minimum (aCi/m^3)	Mean (aCi/m^3)	Sample Standard Deviation
Regional Stations						
01 Española	4	4	2.1	1.0	1.6	0.6
03 Santa Fe	4	4	4.8	2.9	3.6	0.9
55 Santa Fe West (Buckman Booster #4)	4	4	2.2	0.2	1.3	0.8
56 El Rancho	4	4	1.9	1.4	1.7	0.3
Pueblo Stations						
41 San Ildefonso Pueblo	4	4	2.5	0.8	1.6	0.7
59 Jemez Pueblo-Visitor's Center	4	3	7.3	2.3	4.1	2.2
Perimeter Stations						
04 Barranca School	4	4	1.2	0.0	0.6	0.5
05 Urban Park	4	4	2.2	0.3	1.1	0.9
06 48th Street	4	4	2.0	0.4	1.3	0.7
07 Gulf/Exxon/Shell Station	4	3	5.9	1.3	3.0	2.2
08 McDonald's Restaurant	4	4	1.2	0.5	0.9	0.3
09 Los Alamos Airport	4	4	2.2	0.4	1.1	0.8
10 East Gate	4	4	1.6	0.6	1.2	0.5
11 Well PM-1 (E. Jemez Road)	4	4	2.1	1.0	1.5	0.5
12 Royal Crest Trailer Court	4	4	1.5	0.0	0.9	0.6
13 Rocket Park	4	4	2.3	0.6	1.3	0.7
14 Pajarito Acres	4	4	2.5	–0.5[a]	1.0	1.3
15 White Rock Fire Station	4	4	1.9	1.6	1.8	0.1
16 White Rock Nazarene Church	4	4	2.7	0.3	1.2	1.1
17 Bandelier Fire Lookout	4	4	2.0	1.6	1.8	0.2
26 TA-49	4	4	2.1	0.2	1.1	0.8
32 County Landfill (TA-48)	4	3	4.9	1.9	3.0	1.4
54 TA-33 East	4	4	3.3	0.2	1.3	1.3
60 LA Canyon	4	4	3.7	1.2	2.1	1.1
61 LA Hospital	4	4	2.9	1.3	1.8	0.8
62 Crossroads Bible Church	4	4	2.4	0.4	1.1	0.9
63 Monte Rey South	4	4	1.9	0.0	1.1	0.8
TA-15 and TA-36 Stations						
76 TA-15-41 (formerly 15-61)	4	4	1.8	0.5	1.2	0.5
77 TA-36 IJ Site	4	4	2.5	0.9	1.5	0.7
78 TA-15-N	4	4	2.5	–0.3	1.3	1.2
TA-21 Stations						
20 TA-21 Area B	4	4	2.0	–0.5	1.3	1.2
71 TA-21.01 (NW Bldg 344)	4	4	2.3	–0.1	1.3	1.1
72 TA-21.02 (N Bldg 344)	4	4	2.2	0.4	1.2	0.9
73 TA-21.03 (NE Bldg 344)	4	4	2.9	0.0	1.3	1.3
74 TA-21.04 (SE Bldg 344)	4	4	2.6	–0.1	1.3	1.2
75 TA-21.05 (S Bldg 344)	4	4	0.8	0.0	0.5	0.4

Table 4-9. Airborne Uranium-235 Concentrations for 1999 (Cont.)

Station Location	Number of Results	Number of Results <Uncertainty	Maximum (aCi/m^3)	Minimum (aCi/m^3)	Mean (aCi/m^3)	Sample Standard Deviation
TA-54 Area G Stations						
27 Area G (by QA)	4	3	19.7	2.3	7.2	8.4
34 Area G-1 (behind trailer)	4	3	4.9	0.6	2.0	1.9
35 Area G-2 (back fence)	4	4	1.7	0.1	0.9	0.8
36 Area G-3 (by office)	4	3	4.3	0.0	1.6	1.9
45 Area G/South East Perimeter	4	1	5.1	2.2	3.7	1.2
47 Area G/North Perimeter	4	4	2.6	1.0	1.6	0.7
50 Area G-expansion	4	1	12.6	1.5	6.7	4.8
51 Area G-expansion pit	4	3	6.5	1.3	3.2	2.4
Other On-Site Stations						
23 TA-5	4	4	2.8	1.1	1.9	0.7
25 TA-16-450	4	4	2.1	0.5	1.2	0.7
30 Pajarito Booster 2 (P-2)	4	4	1.6	0.3	1.2	0.6
31 TA-3	4	4	1.8	–0.3	0.9	0.9
49 Pajarito Road (TA-36)	4	4	3.4	0.8	2.1	1.3
QA Stations						
38 TA-54 Area G-QA (next to #27)	4	3	12.1	1.0	4.5	5.1
39 TA-49-QA (next to #26)	4	4	1.1	0.5	0.7	0.3

Group Summaries

Station Location	Number of Results	Number of Results <Uncertainty	Maximum (aCi/m^3)	Minimum (aCi/m^3)	Mean (aCi/m^3)	95% Confidence Interval[b]	Sample Standard Deviation
Regional	16	16	4.8	0.2	2.1	±0.6	1.1
Pueblo	8	7	7.3	0.8	2.8	±1.7	2.0
Perimeter	84	82	5.9	–0.5	1.4	±0.2	1.0
TA-15 and TA-36	12	12	2.5	–0.3	1.3	±0.5	0.8
TA-21	24	24	2.9	–0.5	1.1	±0.4	1.0
TA-54 Area G	32	22	19.7	0.0	3.4	±1.4	4.0
Other On-Site	20	20	3.4	–0.3	1.5	±0.4	0.9

Concentration Guidelines

DOE Derived Air Concentration (DAC) Guide for workplace exposure is 20,000,000 aCi/m^3. See Appendix A.
EPA 40 CFR 61 Concentration Guide 7,100 aCi/m^3.

[a] See Section A.4.a of this chapter and Appendix B for an explanation of negative values.
[b] 95% confidence intervals are calculated using all calculated sample concentrations from every site within the group.

Table 4-10. Airborne Uranium-238 Concentrations for 1999

Station Location		Number of Results	Number of Results <Uncertainty	Maximum (aCi/m^3)	Minimum (aCi/m^3)	Mean (aCi/m^3)	Sample Standard Deviation
Regional Stations							
01	Española	4	0	25.3	11.8	20.9	6.2
03	Santa Fe	4	0	35.4	9.7	21.3	11.7
55	Santa Fe West (Buckman Booster #4)	4	0	13.4	8.3	11.7	2.4
56	El Rancho	4	0	17.5	12.7	15.4	2.0
Pueblo Stations							
41	San Ildefonso Pueblo	4	0	33.0	13.6	24.5	8.0
59	Jemez Pueblo-Visitor's Center	4	0	50.8	27.0	36.8	10.0
Perimeter Stations							
04	Barranca School	4	0	15.5	11.0	12.7	1.9
05	Urban Park	4	0	24.7	7.9	18.2	7.3
06	48th Street	4	1	6.5	4.8	5.7	0.9
07	Gulf/Exxon/Shell Station	4	0	68.9	19.9	33.1	23.9
08	McDonald's Restaurant	4	0	12.2	9.6	10.6	1.1
09	Los Alamos Airport	4	0	10.9	7.2	8.8	1.6
10	East Gate	4	0	20.0	7.6	12.5	5.3
11	Well PM-1 (E. Jemez Road)	4	0	7.9	6.3	6.8	0.8
12	Royal Crest Trailer Court	4	0	19.4	9.1	13.7	4.2
13	Rocket Park	4	0	10.6	6.5	8.5	1.8
14	Pajarito Acres	4	0	18.4	6.1	10.6	5.5
15	White Rock Fire Station	4	0	13.5	9.0	12.2	2.1
16	White Rock Nazarene Church	4	0	10.6	6.1	8.8	1.9
17	Bandelier Fire Lookout	4	1	10.0	3.6	7.5	2.8
26	TA-49	4	0	14.8	6.3	9.2	4.0
32	County Landfill (TA-48)	4	0	73.7	41.3	57.4	18.6
54	TA-33 East	4	0	11.5	7.0	9.6	1.9
60	LA Canyon	4	0	14.2	6.1	10.4	3.3
61	LA Hospital	4	0	26.7	9.0	16.1	7.7
62	Crossroads Bible Church	4	0	10.3	6.2	8.9	1.8
63	Monte Rey South	4	0	27.0	4.7	11.4	10.4
TA-15 and TA-36 Stations							
76	TA-15-41 (formerly 15-61)	4	1	11.7	7.1	8.6	2.1
77	TA-36 IJ Site	4	0	40.5	20.4	30.2	8.8
78	TA-15-N	4	2	24.7	2.7	11.9	9.8
TA-21 Stations							
20	TA-21 Area B	4	1	38.1	4.0	14.6	15.8
71	TA-21.01 (NW Bldg 344)	4	0	10.8	8.3	9.7	1.2
72	TA-21.02 (N Bldg 344)	4	0	10.1	6.0	7.9	2.1
73	TA-21.03 (NE Bldg 344)	4	0	14.0	10.3	11.8	1.7
74	TA-21.04 (SE Bldg 344)	4	0	10.2	6.5	8.2	1.6
75	TA-21.05 (S Bldg 344)	4	1	9.6	5.5	7.8	1.8

Table 4-10. Airborne Uranium-238 Concentrations for 1999 (Cont.)

Station Location	Number of Results	Number of Results <Uncertainty	Maximum (aCi/m^3)	Minimum (aCi/m^3)	Mean (aCi/m^3)	Sample Standard Deviation
TA-54 Area G Stations						
27 Area G (by QA)	4	0	296.6	30.5	114.4	125.2
34 Area G-1 (behind trailer)	4	0	71.3	21.8	36.7	23.2
35 Area G-2 (back fence)	4	0	24.8	11.0	19.4	6.0
36 Area G-3 (by office)	4	0	49.5	24.1	37.5	13.5
45 Area G/South East Perimeter	4	0	75.0	51.3	62.6	11.2
47 Area G/North Perimeter	4	0	27.8	10.2	19.6	8.4
50 Area G-expansion	4	0	261.0	50.1	118.7	97.2
51 Area G-expansion pit	4	0	102.8	25.5	50.4	35.3
Other On-Site Stations						
23 TA-5	4	1	13.5	5.6	9.6	3.2
25 TA-16-450	4	0	8.6	3.1	6.6	2.5
30 Pajarito Booster 2 (P-2)	4	0	12.8	7.9	9.8	2.3
31 TA-3	4	0	11.5	5.1	9.0	3.0
49 Pajarito Road (TA-36)	4	0	16.0	8.7	12.0	3.5
QA Stations						
38 TA-54 Area G-QA (next to #27)	4	0	140.8	30.9	70.4	52.1
39 TA-49-QA (next to #26)	4	1	13.8	5.0	8.6	4.1

Group Summaries

Station Location	Number of Results	Number of Results <Uncertainty	Maximum (aCi/m^3)	Minimum (aCi/m^3)	Mean (aCi/m^3)	95% Confidence Interval[a]	Sample Standard Deviation
Regional	16	0	35.4	8.3	17.3	±3.9	7.4
Pueblo	8	0	50.8	13.6	30.6	±8.9	10.7
Perimeter	84	2	73.7	3.6	13.9	±2.9	13.2
TA-15 and TA-36	12	3	40.5	2.7	16.9	±7.7	12.1
TA-21	24	2	38.1	4.0	10.0	±2.7	6.4
TA-54 Area G	32	0	296.6	10.2	57.4	±22.9	63.5
Other On-Site	20	1	16.0	3.1	9.4	±1.5	3.2

Concentration Guidelines

DOE Derived Air Concentration (DAC) Guide for workplace exposure is 20,000,000 aCi/m^3. See Appendix A.
EPA 40 CFR 61 Concentration Guide 8,300 aCi/m^3.

[a] 95% confidence intervals are calculated using all calculated sample concentrations from every site within the group.

Table 4-11. Airborne Gamma-Emitting Radionuclides that Are Potentially Released by LANL Operations

Gamma Emitting Radionuclide	Number of Results	Number of Results ≤MDA	Mean (fCi/m^3)	Measured Average MDA as a Percent of the Required MDA
^{73}As	324	324	<<0.75	0.1
^{74}As	324	324	<<0.63	0.6
^{109}Cd	324	324	<<0.07	0.3
^{57}Co	324	324	<<0.13	0.2
^{60}Co	324	324	<<0.29	34.6
^{134}Cs	324	324	<<0.27	20.0
^{137}Cs	324	324	<<0.24	25.5
^{54}Mn	324	324	<<0.28	2.0
^{22}Na	324	324	<<0.30	23.2
^{83}Rb	324	324	<<0.51	3.0
^{86}Rb	324	324	<<4.96	17.7
^{103}Ru	324	324	<<0.26	0.2
^{75}Se	324	324	<<0.21	2.4
^{65}Zn	324	324	<<0.61	13.4

Table 4-12. Airborne Concentrations of Gamma-Emitting Radionuclides that Naturally Occur in Measurable Quantities

Gamma Emitting Radionuclide	Number of Results	Number of Results <MDA	Mean (fCi/m^3)	Estimated Dose (mrem)
^{7}Be	324	0	85	0.04
^{210}Pb	324	0	11	41

Table 4-13. Airborne Radioactive Emissions from Laboratory Buildings with Sampled Stacks in 1999 (Ci)

TA-Building	^{3}H[a]	^{241}Am	Pu[b]	U[c]	Th	P/VAP[d]	G/MAP[e]
TA-03-029		2.6×10^{-6}	2.1×10^{-5}	6.1×10^{-6}	2.1×10^{-7}		
TA-03-035				1.2×10^{-6}	6.4×10^{-9}		
TA-03-102				3.3×10^{-7}	3.8×10^{-9}		
TA-16-205	1.6×10^{2}						
TA-21-155	6.6×10^{1}						
TA-21-209	4.2×10^{2}						
TA-33-086	9.4×10^{2}						
TA-41-004	1.3×10^{1}						
TA-48-001				6.1×10^{-10}		3.9×10^{-3}	
TA-50-001		1.3×10^{-7}	5.1×10^{-8}		3.7×10^{-8}		
TA-50-037				1.9×10^{-8}			
TA-50-069			9.9×10^{-11}				
TA-53-003	1.8×10^{0}						4.3×10^{0}
TA-53-007	4.5×10^{-1}					2.5×10^{-3}	3.0×10^{2}
TA-55-004	1.8×10^{0}	5.4×10^{-8}	6.3×10^{-8}	7.1×10^{-8}			

[a] Includes both gaseous and oxide forms of tritium.
[b] Includes ^{238}Pu, ^{239}Pu, and ^{240}Pu.
[c] Includes ^{234}U, ^{235}U, and ^{238}U.
[d] P/VAP—Particulate/vapor activation products.
[e] G/MAP—Gaseous/mixed activation products.

Table 4-14. Detailed Listing of Activation Products Released from Sampled Laboratory Stacks in 1999 (Ci)

TA-Building	Radionuclide	Emission
TA-48-001	^{73}As	1.83×10^{-5}
TA-48-001	^{74}As	4.49×10^{-5}
TA-48-001	^{77}Br	1.15×10^{-5}
TA-48-001	^{68}Ga	1.73×10^{-3}
TA-48-001	^{68}Ge	1.73×10^{-3}
TA-48-001	^{75}Se	3.50×10^{-4}
TA-53-003	^{41}Ar	1.50×10^{-1}
TA-53-003	^{11}C	4.11×10^{0}
TA-53-007	^{41}Ar	1.29×10^{1}
TA-53-007	^{76}Br	2.32×10^{-4}
TA-53-007	^{82}Br	6.27×10^{-4}
TA-53-007	^{10}C	4.24×10^{-2}
TA-53-007	^{11}C	2.62×10^{2}
TA-53-007	^{60}Co	3.97×10^{-6}
TA-53-007	^{197}Hg	1.60×10^{-3}
TA-53-007	^{13}N	1.59×10^{0}
TA-53-007	^{16}N	1.50×10^{-2}
TA-53-007	^{14}O	1.00×10^{-1}
TA-53-007	^{15}O	1.89×10^{1}

Table 4-15. Radionuclide: Half-Life Information

Nuclide	Half-Life
^{3}H	12.3 yr
^{7}Be	53.4 d
^{10}C	19.3 s
^{11}C	20.5 min
^{13}N	10.0 min
^{16}N	7.13 s
^{14}O	70.6 s
^{15}O	122.2 s
^{22}Na	2.6 yr
^{24}Na	14.96 h
^{32}P	14.3 d
^{40}K	1,277,000,000 yr
^{41}Ar	1.83 h
^{54}Mn	312.7 d
^{56}Co	78.8 d
^{57}Co	270.9 d
^{58}Co	70.8 d
^{60}Co	5.3 yr
^{72}As	26 h
^{73}As	80.3 d
^{74}As	17.78 d
^{76}Br	16 h
^{77}Br	2.4 d
^{82}Br	1.47 d
^{75}Se	119.8 d
^{85}Sr	64.8 d
^{89}Sr	50.6 d
^{90}Sr	28.6 yr
^{131}I	8 d
^{134}Cs	2.06 yr
^{137}Cs	30.2 yr
^{183}Os	13 h
^{185}Os	93.6 d
^{191}Os	15.4 d
^{193}Hg	3.8 hr
^{195}Hg	9.5 hr
^{195m}Hg	1.67 d
^{197}Hg	2.67 d
^{197m}Hg	23.8 hr
^{234}U	244,500 yr
^{235}U	703,800,000 yr
^{238}U	4,468,000,000 yr
^{238}Pu	87.7 yr
^{239}Pu	24,131 yr
^{240}Pu	6,569 yr
^{241}Pu	14.4 yr
^{241}Am	432 yr

Table 4-16. Thermoluminescent Dosimeter (TLD) Measurements of External Radiation 1998–1999

	TLD Station ID #	Location	1998 Annual Dose (mrem)	1999 Quarters Monitored	1999 Annual Dose (mrem)
Regional	01	Española	NA[a]	1–4	110 ± 14
	53	San Ildefonso Pueblo	121 ± 7	1–4	116 ± 15
	95	El Rancho	NA[a]	1–4	133 ± 17
	101	Santa Fe West	138 ± 8	1–4	127 ± 17
	103	Santa Clara Pueblo	NA[a]	1–4	145 ± 19
Perimeter	05	Barranca School, Los Alamos	148 ± 8	1–4	134 ± 17
	07	Cumbres School, Los Alamos	140 ± 8	1–4	132 ± 17
	08	48th Street, Los Alamos	159 ± 9	1–4	156 ± 20
	09	Los Alamos Airport	140 ± 9	1–4	154 ± 20
	10	Bayo Canyon, Los Alamos	182 ± 10	1–4	171 ± 22
	11	Shell Station, Los Alamos	161 ± 9	1–4	158 ± 21
	12	Royal Crest Trailer Court, Los Alamos	148 ± 8	1–4	139 ± 18
	13	White Rock Fire Station	149 ± 9	1–4	140 ± 18
	14	Pajarito Acres, White Rock	141 ± 8	1–4	136 ± 18
	15	Bandelier National Monument	160 ± 9	1–4	157 ± 20
	16	Pajarito Ski Area	NA[a]	2–4[b]	142 ± 18
	41	McDonald’s Restaurant, Los Alamos	162 ± 9	1–4	147 ± 19
	42	Los Alamos Airport-South	162 ± 10	1–4	135 ± 18
	43	East Gate Business Park, Los Alamos	155 ± 9	1,4[b]	126 ± 16
	44	Big Rock Loop, Los Alamos	186 ± 11	1–4	170 ± 22
	45	Cheyenne Street, Los Alamos	176 ± 10	1–4	156 ± 20
	46	Los Pueblos Street, Los Alamos	174 ± 10	1–4	153 ± 20
	47	Urban Park, Los Alamos	154 ± 9	1–4	143 ± 19
	49	Piñon School (Rocket Park) White Rock	105 ± 7	1–4	130 ± 17
	50	White Rock Church of the Nazarene	100 ± 6	1–4	130 ± 17
	51	Bayo Canyon Well, Los Alamos	177 ± 10	1–4	168 ± 22
	55	Monte Rey South, White Rock	136 ± 7	1–4	132 ± 17
	56	East Gate (mid station)	175 ± 10	1–4	160 ± 21
	60	Piedra Drive, White Rock	135 ± 8	1–4	133 ± 17
	66	East Gate	NA[a]	1–4	150 ± 19
	67	Los Alamos Hospital	NA[a]	2–4[b]	134 ± 17
	68	Trinity (Crossroads) Bible Church	169 ± 10	1–4	156 ± 20
	80	TA-16 SR4 Back Gate	152 ± 9	1–4	148 ± 19
	81	TA-16 SR4 Ponderosa Camp	143 ± 20	1–4	147 ± 19
On-Site	17	TA-21 (DP West)	172 ± 10	1–4	154 ± 20
	18	TA-6 (Two Mile Mesa)	154 ± 9	1–4	145 ± 19
	19	TA-53 (LANSCE)	190 ± 11	1–4	158 ± 21
	20	Well PM-1 (SR4 and Truck Rt.)	179 ± 10	1–4	169 ± 22
	21	TA-16 (S-Site)	146 ± 10	1–4	154 ± 20
	22	Booster P-2	155 ± 9	1–4	154 ± 20
	23	TA-3 East Gate of SM 43	NA[a]	1–4	122 ± 16
	24	State Highway 4	194 ± 11	1–4	182 ± 24
	25	TA-49 (Frijoles Mesa)	150 ± 8	1–4	140 ± 18
	26	TA-2 (Omega Stack)	156 ± 9	1–4	135 ± 18
	28	TA-18 (Pajarito Site)	NA[a]	1–4	189 ± 25

Table 4-16. Thermoluminescent Dosimeter (TLD) Measurements of External Radiation 1998–1999 (Cont.)

	TLD Station ID #	Location	1998 Annual Dose (mrem)	1999 Quarters Monitored	1999 Annual Dose (mrem)
On-Site (Cont.)	29	TA-35 (Ten Site A)	137 ± 8	1–4	131 ± 17
	30	TA-35 (Ten Site B)	133 ± 8	1–4	130 ± 17
	31	TA-59 (Occupational Health Lab)	NA[a]	1–4	145 ± 19
	32	TA-3-16 (Van de Graaff)	158 ± 9	1–4	144 ± 19
	33	TA-3-316 (Ion Beam Bldg.)	156 ± 9	1–4	145 ± 19
	34	TA-3-440 (CAS)	174 ± 10	1–4	171 ± 22
	35	TA-3-420 (CMR Bldg. West Fence)	146 ± 8	1–4	133 ± 17
	36	TA-3-102 (Shop)	149 ± 9	1–4	141 ± 18
	37	TA-72 (Pistol Range)	168 ± 10	1–4	177 ± 23
	38	TA-55 (Plutonium Facility South)	164 ± 8	1–4	162 ± 21
	39	TA-55 (Plutonium Facility West)	183 ± 10	1–4	165 ± 21
	40	TA-55 (Plutonium Facility North)	142 ± 8	1–4	143 ± 19
	48	Los Alamos County Landfill	148 ± 9	1–4	140 ± 18
	56	East Gate Mid Station	175 ± 10	1–4	160 ± 21
	57	TA-54 West (TLD Lab)	182 ± 10	1–4	150 ± 19
	58	TA-54 Lagoon (TA-36 Pajarito Road)	170 ± 10	1–4	167 ± 22
	59	Los Alamos Canyon	NA[a]	1–4	167 ± 22
	61	S. LANSCE Lagoons	NA[a]	1–4	2,157 ± 280
	62	N. LANSCE Lagoons	NA[a]	1–4	347 ± 45
	63	E. LANSCE Lagoons	NA[a]	1–4	3,122 ± 406
	64	NE LANSCE Area A Stack	NA[a]	1–4	240 ± 31
	65	NW LANSCE Area A Stack	NA[a]	1–4	219 ± 28
	69	TA-50 Old Outfall	189 ± 10	1–4	185 ± 24
	70	TA-50 Dirt Road to Outfall	163 ± 9	1,2,4[b]	175 ± 23
	71	TA-50 Dirt Road Turnoff	159 ± 9	1–4	157 ± 20
	72	TA-50 East Fence, S. Corner	157 ± 9	1–4	166 ± 22
	73	TA-50 East Fence, N. Corner	142 ± 8	1–4	148 ± 19
	74	TA-50 Pecos Drive	146 ± 8	1–4	141 ± 18
	75	TA-50-37 West	155 ± 9	1–4	158 ± 21
	76	TA-16-450 WETF	159 ± 9	1–4	141 ± 18
	77	TA-16-210 Guard Station	159 ± 9	1–4	147 ± 19
	78	Fitness Trail SW TA-8-24	154 ± 14	1–4	158 ± 21
	79	Fitness Trail SE TA-8-24	162 ± 9	1–4	157 ± 20
	82	TA-15 Phermex N TA-15-185	169 ± 10	1–4	163 ± 21
	83	TA-15 Phermex Entrance	144 ± 10	1,2,4[b]	120 ± 16
	84	TA-15 Phermex NNE Entrance	151 ± 9	1,2,4[b]	132 ± 17
	85	TA-15 Phermex N DAHRT	149 ± 10	1–4	146 ± 19
	86	TA-15-312 DAHRT Entrance	155 ± 9	1,2,4[b]	146 ± 19
	87	TA-15-183 Access Control	174 ± 10	1–4	157 ± 20
	88	TA-15 R-Site Road	163 ± 10	1–4	150 ± 20
	89	TA-15-45 SW	169 ± 10	1–4	153 ± 20
	90	TA-15-306 North	NA[a]	1–4	152 ± 20
	91	TA-15, IJ Firing Point	164 ± 9	1–4	151 ± 20
	92	TA-36 Kappa Site	NA[a]	1–4	160 ± 21
	93	TA-15 Ridge Road Gate	141 ± 8	1–4	138 ± 18
	94	TA-33 East (VLBA Dish)	129 ± 8	1–4	124 ± 16
	96	TA-54 Meteorological Tower	NA[a]	1–4	148 ± 19

Table 4-16. Thermoluminescent Dosimeter (TLD) Measurements of External Radiation 1998–1999 (Cont.)

	TLD Station ID #	Location	1998 Annual Dose (mrem)	1999 Quarters Monitored	1999Annual Dose (mrem)
On-Site (Cont.)	97	TA-50 GS-1-1, Mortandad Canyon	182 ± 11	1–4	180 ± 23
	98	TA-50 GS-1-2, Mortandad Canyon	426 ± 22	1–4	379 ± 49
	99	Mortandad Canyon, MCO-5	447 ± 24	1–4	418 ± 54
	100	Mortandad Canyon, MCO-13	175 ± 8	1–4	155 ± 20
	104	E. LANSCE Lagoons	NA[a]	2–4[b]	242 ± 31

[a]NA = not applicable—the 1998 data for this station were incomplete.
[b]Data for the missing quarter(s) have been replaced with an average of the data for the other quarters.

Table 4-17. Thermoluminescent Dosimeter (TLD) Measurements of External Radiation at Waste Disposal Areas during 1998–1999

	TLD Station ID #	Location	1998 Annual Dose (mrem)	1999 Quarters Monitored	1999 Annual Dose (mrem)
Area A	201	TA-21 Area A-1	141 ± 9	1–4	140 ± 18
	202	TA-21 Area A-2	159 ± 9	1–4	157 ± 20
	203	TA-21 Area A-3	155 ± 8	1–4	155 ± 20
	204	TA-21 Area A-4	154 ± 9	1–4	141 ± 18
	205	TA-21 Area A-5	150 ± 9	1–4	146 ± 19
Area AB	221	TA-49 AB-1	142 ± 9	1–4	158 ± 21
	222	TA-49 AB-2	149 ± 9	1–4	163 ± 21
	223	TA-49 AB-3	151 ± 9	1–4	153 ± 20
	224	TA-49 AB-4	143 ± 9	1–4	155 ± 20
	225	TA-49 AB-5	142 ± 9	1–4	150 ± 19
	226	TA-49 AB-6	146 ± 8	1–4	150 ± 19
	227	TA-49 AB-7	141 ± 8	1–4	153 ± 20
	228	TA-49 AB-8	NA[a]	1–4	142 ± 19
	229	TA-49 AB-9	141 ± 8	1–4	149 ± 19
	230	TA-49 AB-10	142 ± 8	1–4	164 ± 21
Area B	241	TA-21 Area B-1	158 ± 15	1–4	147 ± 19
	242	TA-21 Area B-2	161 ± 9	1–4	157 ± 20
	243	TA-21 Area B-3	158 ± 9	1–4	147 ± 19
	244	TA-21 Area B-4	NA[a]	1–4	147 ± 19
	245	TA-21 Area B-5	NA[a]	1–4	140 ± 18
	246	TA-21 Area B-6	152 ± 8	1–4	148 ± 19
	247	TA-21 Area B-7	NA[a]	1–4	151 ± 20
	248	TA-21 Area B-8	161 ± 9	1–4	155 ± 20
	249	TA-21 Area B-9	157 ± 9	1–4	155 ± 20
	250	TA-21 Area B-10	157 ± 8	1–4	153 ± 20
	251	TA-21 Area B-11	163 ± 8	1–4	154 ± 20
	252	TA-21 Area B-12	167 ± 9	1–4	157 ± 20
	253	TA-21 Area B-13	164 ± 9	1–4	158 ± 21
	254	TA-21 Area B-14	171 ± 9	1–4	153 ± 20
Area C	261	TA-50 N Area C-1	150 ± 8	1–4	138 ± 18
	262	TA-50 N Area C-2	162 ± 9	1–4	166 ± 22
	263	TA-50 Area C-3	160 ± 10	1–4	167 ± 22
	264	TA-50 Area C-4	165 ± 9	1–4	181 ± 23
	265	TA-50 SE Area C-5	163 ± 10	1–4	159 ± 21
	266	TA-50 Area C-6	164 ± 9	1–4	164 ± 21
	267	TA-50 Area C-7	151 ± 8	1–4	154 ± 20
	268	TA-50 S Area C-8	147 ± 9	1–4	139 ± 18
	269	TA-50 Area C-9	159 ± 9	1–4	152 ± 20
	270	TA-50 W Area C-10	157 ± 8	1–4	161 ± 21
Area E	281	TA-33 Area E-1	155 ± 9	1–4	152 ± 20
	282	TA-33 Area E-2	162 ± 9	1–4	161 ± 21
	283	TA-33 Area E-3	168 ± 10	1–4	166 ± 22
	284	TA-33 Area E-4	169 ± 10	1–4	184 ± 24

Table 4-17. Thermoluminescent Dosimeter (TLD) Measurements of External Radiation at Waste Disposal Areas during 1998–1999 (Cont.)

	TLD Station ID #	Location	1998 Annual Dose (mrem)	1999 Quarters Monitored	1999 Annual Dose (mrem)
Area F	301	TA-6 Area F-1	135 ± 8	1–4	148 ± 19
	302	TA-6 Area F-2	142 ± 9	1–4	144 ± 19
	303	TA-6 Area F-3	143 ± 8	1–4	146 ± 19
	304	TA-6 Area F-4	159 ± 9	1–4	146 ± 19
Area G	601	TA-54 Area G-1	179 ± 10	1–4	192 ± 25
	602	TA-54 Area G-2	289 ± 16	1–4	291 ± 38
	603	TA-54 Area G-3	178 ± 12	1–4	184 ± 24
	604	TA-54 Area G-4	163 ± 9	1–4	180 ± 23
	605	TA-54 Area G-5	190 ± 13	1–4	198 ± 26
	606	TA-54 Area G-6	175 ± 10	1–4	295 ± 38
	607	TA-54 Area G-7	224 ± 15	1–4	245 ± 32
	608	TA-54 Area G-8	261 ± 16	1–4	254 ± 33
	610	TA-54 Area G-10	224 ± 12	1–4	236 ± 31
	611	TA-54 Area G-11	355 ± 21	1–4	473 ± 61
	613	TA-54 Area G-13	297 ± 17	1–4	357 ± 46
	614	TA-54 Area G-14	252 ± 14	1–4	291 ± 38
	615	TA-54 Area G-15	186 ± 10	1–4	192 ± 25
	616	TA-54 Area G-16	177 ± 13	1–4	184 ± 24
	617	TA-54 Area G-17	189 ± 18	1–4	185 ± 24
	618	TA-54 Area G-18	189 ± 12	1–4	179 ± 23
	619	TA-54 Area G-19	219 ± 11	1–4	219 ± 28
	620	TA-54 Area G-20	168 ± 11	2–4[b]	200 ± 26
	622	TA-54 Area G-22	245 ± 14	1–4	242 ± 31
	623	TA-54 Area G-23	168 ± 12	1–4	215 ± 28
	624	TA-54 Area G-24	172 ± 9	1–4	170 ± 22
	625	TA-54 Area G-25	207 ± 11	1–4	199 ± 26
	626	TA-54 Area G-26	178 ± 10	1–4	173 ± 22
	628	TA-54 Area G-28	208 ± 12	1–4	235 ± 31
	629	TA-54 Area G-29	197 ± 12	1–4	215 ± 29
	630	TA-54 Area G-30	241 ± 14	1,4[b]	257 ± 33
	631	TA-54 Area G-31	204 ± 13	1–4	190 ± 25
	634	TA-54 Area G-34	289 ± 16	1–4	269 ± 35
	635	TA-54 Area G-35	251 ± 15	2–4[b]	260 ± 34
	636	TA-54 Area G-36	176 ± 10	1–4	186 ± 24
	637	TA-54 Area G-37	184 ± 10	2–4[b]	183 ± 24
	638	TA-54 Area G-38	190 ± 11	1–4	166 ± 22
	639	TA-54 Area G-38	NA[a]	1–4	300 ± 39
	640	TA-54 Area G-38	NA[a]	1–4	271 ± 35
	641	TA-54 Area G-38	NA[a]	1–4	278 ± 36
Area T	321	TA-21 Area T-1	162 ± 9	1–4	160 ± 21
	322	TA-21 Area T-2	154 ± 8	1–4	153 ± 20
	323	TA-21 Area T-3	295 ± 17	1–4	297 ± 39
	324	TA-21 Area T-4	158 ± 11	1–4	151 ± 20
	325	TA-21 Area T-5	131 ± 7	1–4	135 ± 18
	326	TA-21 Area T-6	153 ± 9	1–4	148 ± 19
	327	TA-21 Area T-7	165 ± 9	1–4	152 ± 20

Table 4-17. Thermoluminescent Dosimeter (TLD) Measurements of External Radiation at Waste Disposal Areas during 1998–1999 (Cont.)

	TLD Station ID #	Location	1998 Annual Dose (mrem)	1999 Quarters Monitored	1999 Annual Dose (mrem)
Area U	341	TA-21 Area U-1	152 ± 8	1–4	140 ± 18
	342	TA-21 Area U-2	169 ± 9	1–4	154 ± 20
	343	TA-21 Area U-3	147 ± 9	1–4	149 ± 19
	344	TA-21 Area U-4	154 ± 9	1–4	144 ± 19
Area V	361	TA-21 Area V-1	143 ± 9	1–4	133 ± 17
	362	TA-21 Area V-2	152 ± 8	1–4	153 ± 20
	363	TA-21 Area V-3	156 ± 9	1–4	154 ± 20
	364	TA-21 Area V-4	154 ± 8	1–4	153 ± 20
Area W	381	TA-35 Area W-1	141 ± 8	1–4	138 ± 18
	382	TA-35 Area W-2	NA[a]	1–4	170 ± 22
	383	TA-35 Area X	139 ± 8	1–4	131 ± 17

[a]NA = not applicable—the 1998 data for this station were incomplete.
[b]Data for the missing quarter(s) have been replaced with an average of the data for the other quarters.

Table 4-18. TA-18 Albedo Dosimeter Network

Location ID#	Location	Dosimeter #1 (mrem)	Dosimeter #2 (mrem)
1	NEWNET Kappa Site	10.2	11.0
2	TA-36 Entrance	16.4	10.6
3	TA-18 Personnel Gate at Parking Lot	36.5	31.3
4	P2 Booster Station at TA-54 Entrance	8.5	6.6
5	TA-51 Entrance	5.0	3.3
6	Pajarito Hill West of TA-18 Entrance	9.9	10.8
7	TA-18 Entrance at Pajarito Road	17.0	16.0
8.1	TA-49 Background	3.9	NA[a]
8.2	Santa Fe Background	3.9	NA[a]
9	Vault Control	1.2	NA[a]

[a] NA = not applicable—background or control location with one dosimeter.

Table 4-19. DX Division Firing Sites Expenditures for Calendar Year 1999

(All units are in kilograms unless otherwise noted.)

CY 1999 Materials Expended	Material Totals
HE	1298
Aluminum	688
Beryllium	0.5
Brass	48
Copper	41
Depleted Uranium	67
Lead	0.5
Lexan	1
Uranium Oxide	0.075
Steel (RHA)	10
Stainless Steel	159
Tantalum	0.18
Teflon	0.005

Table 4-20. Airborne Beryllium Concentrations

Station Location	Number of Results	Maximum (ng/m^3)	Minimum (ng/m^3)	Mean (ng/m^3)	Sample Standard Deviation
Regional/Pueblo Stations					
01 Española	4	0.038	0.016	0.029	0.010
03 Santa Fe	4	0.053	0.021	0.033	0.015
41 San Ildefonso Pueblo	4	0.039	0.018	0.031	0.009
55 Santa Fe West (Buckman Booster #4)	4	0.016	0.012	0.014	0.002
56 El Rancho	4	0.022	0.011	0.017	0.005
59 Jemez Pueblo-Visitor's Center	4	0.096	0.059	0.077	0.015
Perimeter Stations					
04 Barranca School	4	0.024	0.009	0.017	0.006
07 Gulf/Exxon/Shell Station	4	0.121	0.025	0.057	0.044
09 Los Alamos Airport	4	0.013	0.006	0.010	0.003
10 East Gate	4	0.028	0.008	0.017	0.009
12 Royal Crest Trailer Court	4	0.017	0.008	0.012	0.005
16 White Rock Nazarene Church	4	0.012	0.005	0.009	0.003
26 TA-49	4	0.016	0.004	0.009	0.005
32 County Landfill (TA-48)	4	0.136	0.079	0.107	0.029
39 TA-49-QA (next to #26)	4	0.013	0.004	0.007	0.004
61 LA Hospital	4	0.033	0.013	0.022	0.009
On-Site Stations					
23 TA-5	4	0.013	0.008	0.010	0.002
31 TA-3	4	0.014	0.008	0.010	0.003
76 TA-15-41 (formerly 15-61)	4	0.010	0.005	0.007	0.002
77 TA-36 IJ Site	4	0.011	0.008	0.009	0.001
78 TA-15-N	4	0.009	0.004	0.006	0.002
TA-54 Area G Stations					
27 Area G (by QA)	4	0.693	0.060	0.260	0.296
35 Area G-2 (back fence)	4	0.053	0.018	0.039	0.015
36 Area G-3 (by office)	4	0.098	0.026	0.052	0.032
38 Area G-QA (next to #27)	4	0.312	0.056	0.152	0.120

Group Summaries

Station Location	Number of Results	Maximum (ng/m^3)	Minimum (ng/m^3)	Mean (ng/m^3)	95% Confidence Interval[a]	Sample Standard Deviation
Regional/Pueblo Stations	24	0.096	0.011	0.034	±0.009	0.023
Perimeter Stations	40	0.136	0.004	0.027	±0.011	0.034
On-Site Stations	20	0.014	0.004	0.009	±0.001	0.003
TA-54 Area G Stations	16	0.693	0.018	0.126	±0.084	0.171

[a] 95% confidence intervals are calculated using all calculated sample concentrations from every site within the group.

Table 4-21. 1999 Precipitation (in.)

	TA-6	TA-16	TA-49	TA-53	TA-54	TA-74	North Community
January	0.15	0.18	0.08	0.17	0.08	0.00	0.14
February	0.07	0.13	0.05	0.07	0.02	0.00	0.01
March	1.44	1.55	1.36	1.25	1.11	0.38	1.34
April	2.41	3.41	2.17	2.01	2.19	1.98	2.62
May	1.81	2.57	1.63	1.13	1.66	2.56	2.07
June	1.72	2.18	1.86	1.50	3.75	2.83	1.41
July	3.01	4.49	2.65	1.44	1.70	1.80	4.10
August	2.06	2.06	3.15	3.05	4.10	3.57	3.16
September	2.71	2.30	1.88	1.29	1.45	1.26	2.23
October	0.57	1.74	0.51	0.45	0.50	0.41	0.50
November	0.36	0.03	0.01	0.03	0.29	0.04	0.04
December	0.34	0.48	0.33	0.26	0.24	0.22	0.23
Total	16.65	21.12	15.68	12.65	17.09	15.05	17.85

J. Figures

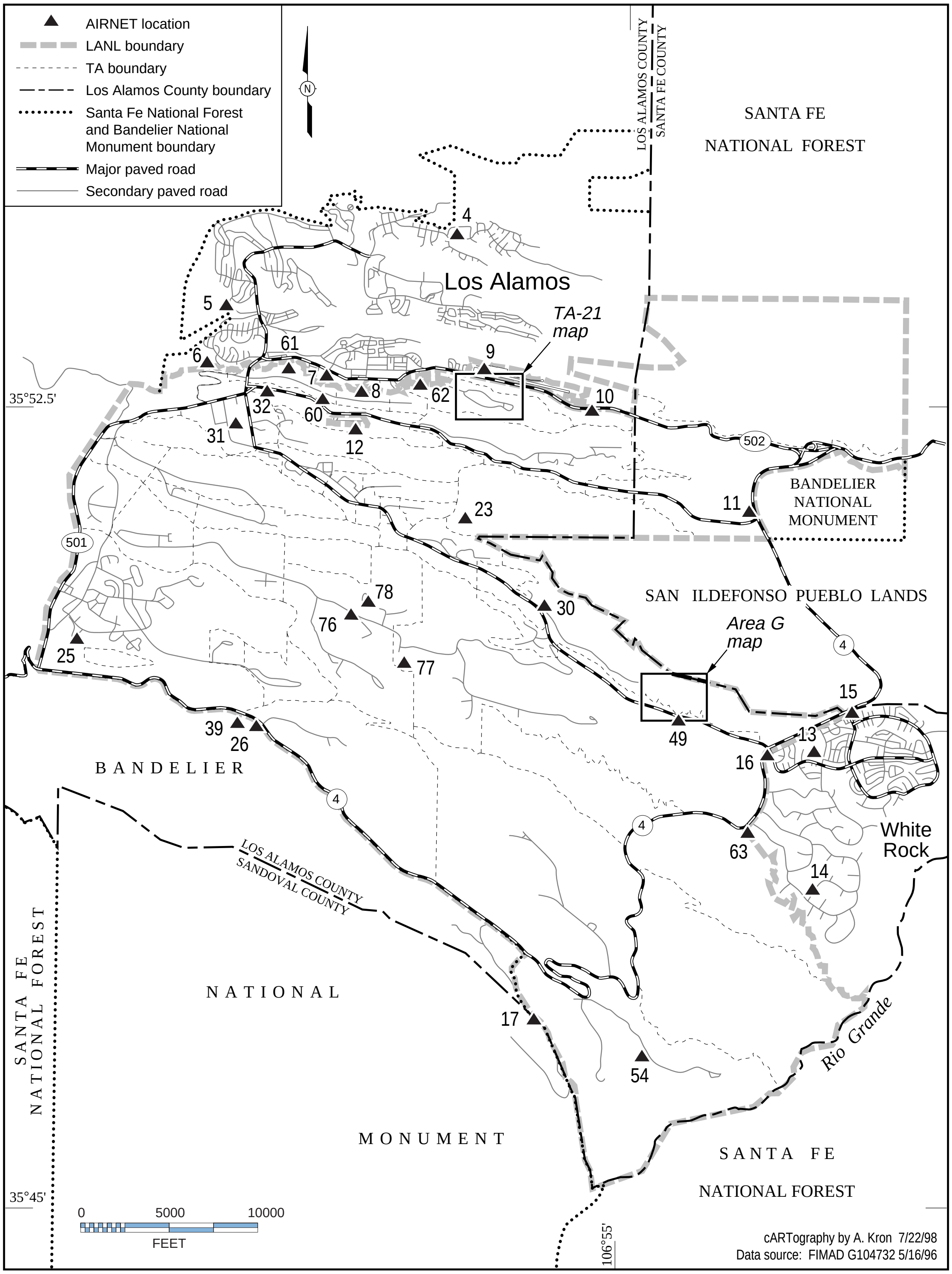

Figure 4-1. Off-site perimeter and on-site Laboratory AIRNET locations.

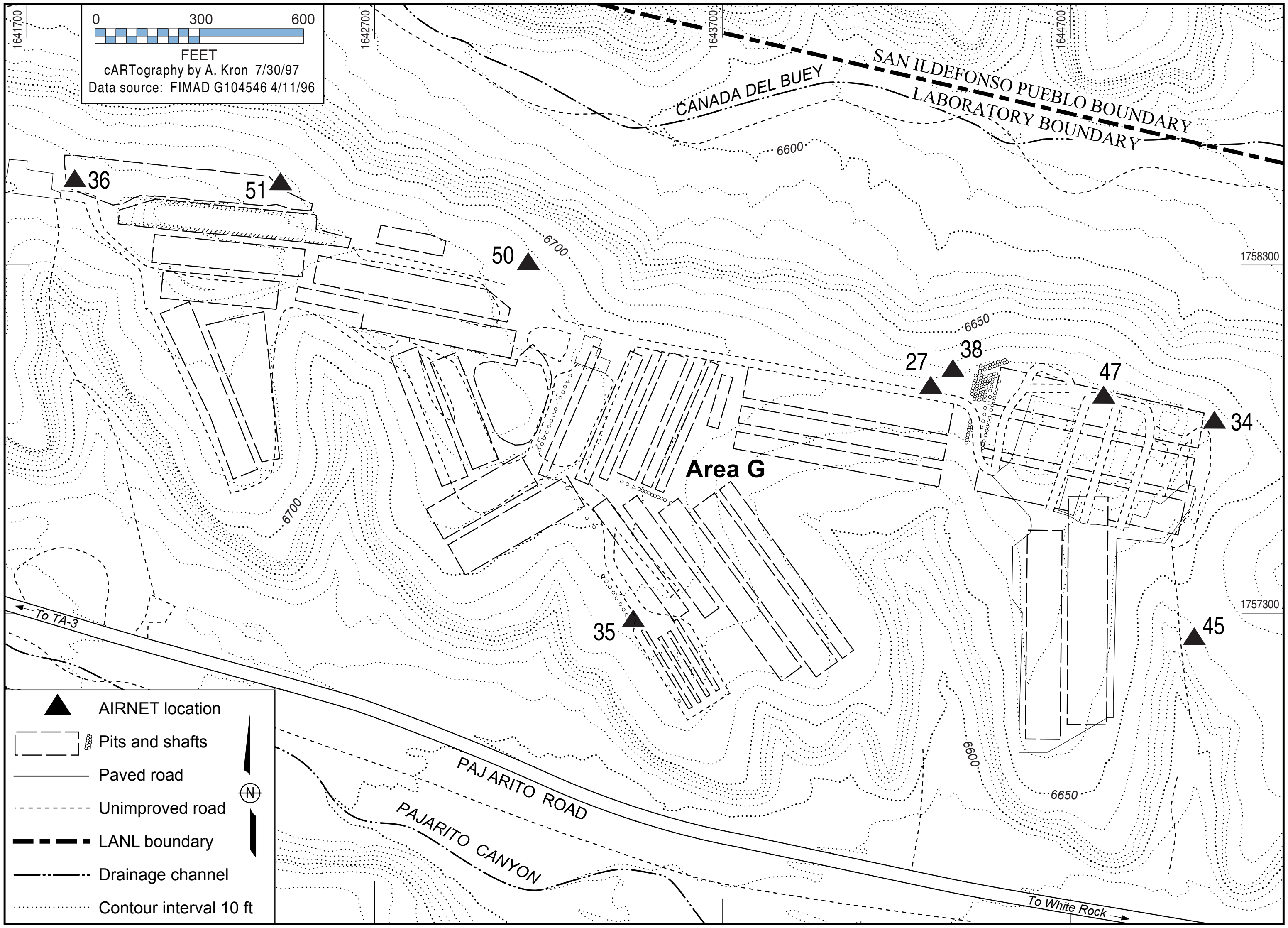

Figure 4-2. Technical Area 54, Area G, map of AIRNET locations.

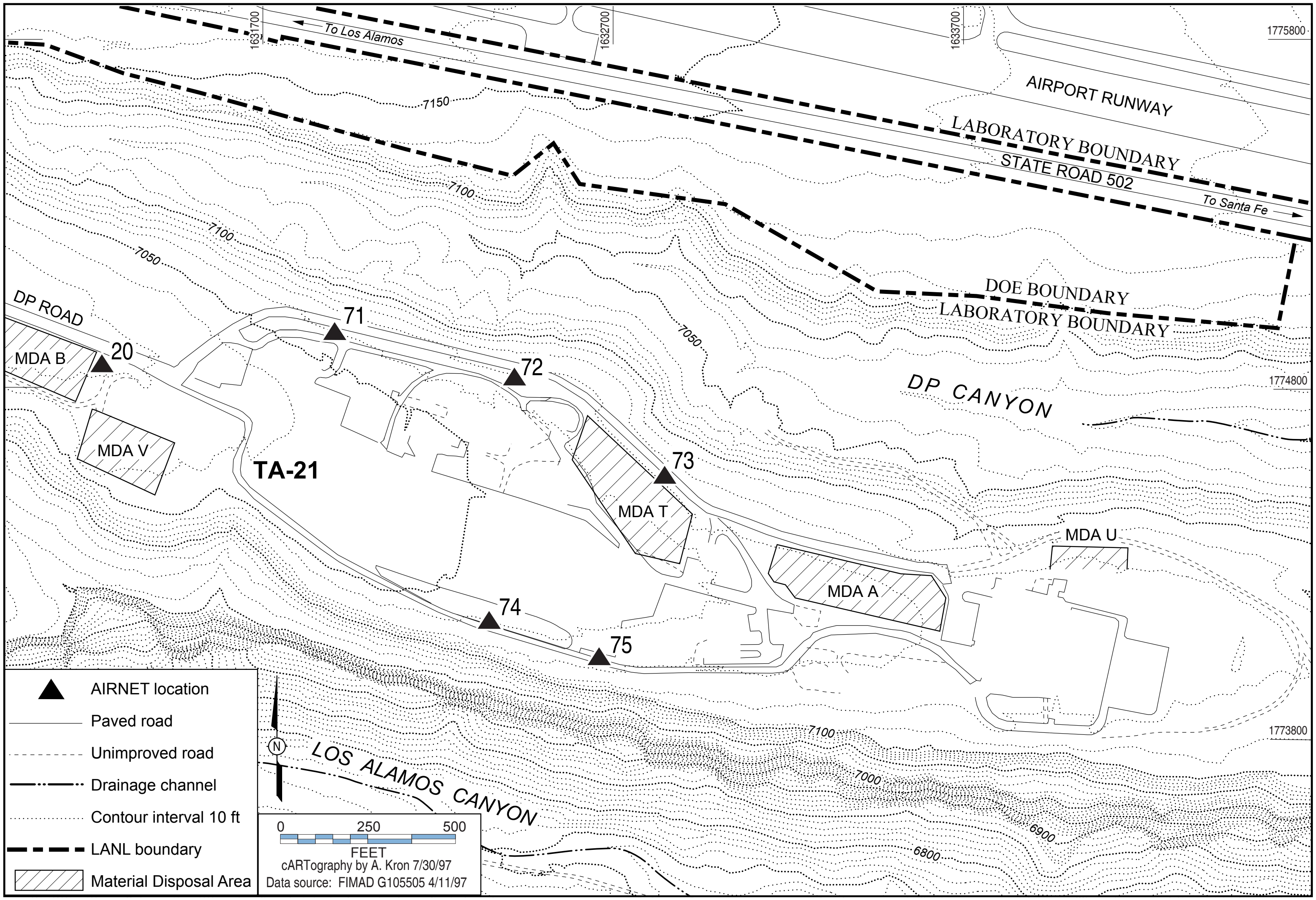

Figure 4-3. Technical Area 21 map of AIRNET locations.

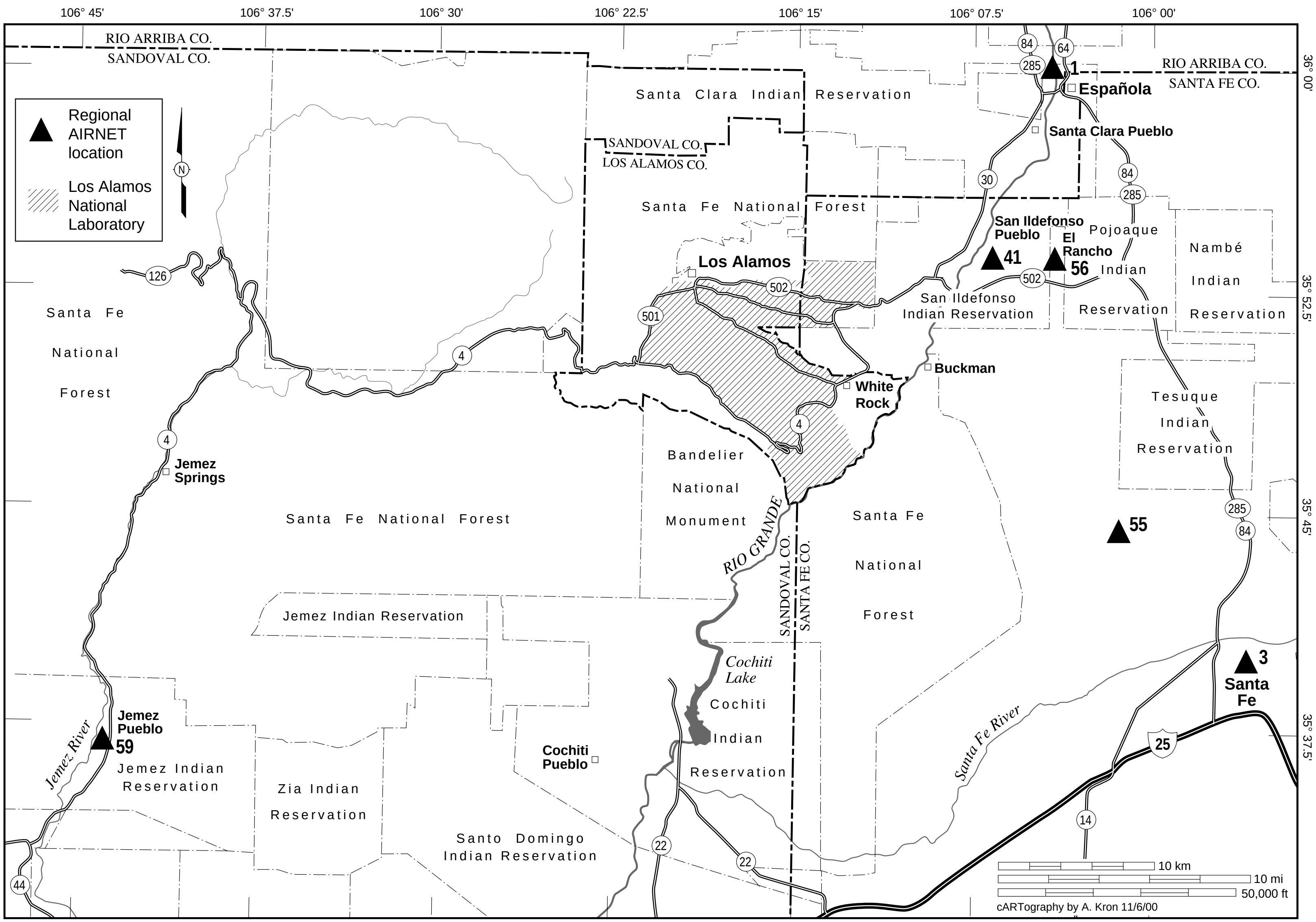

Figure 4-4. Regional and pueblo AIRNET locations.

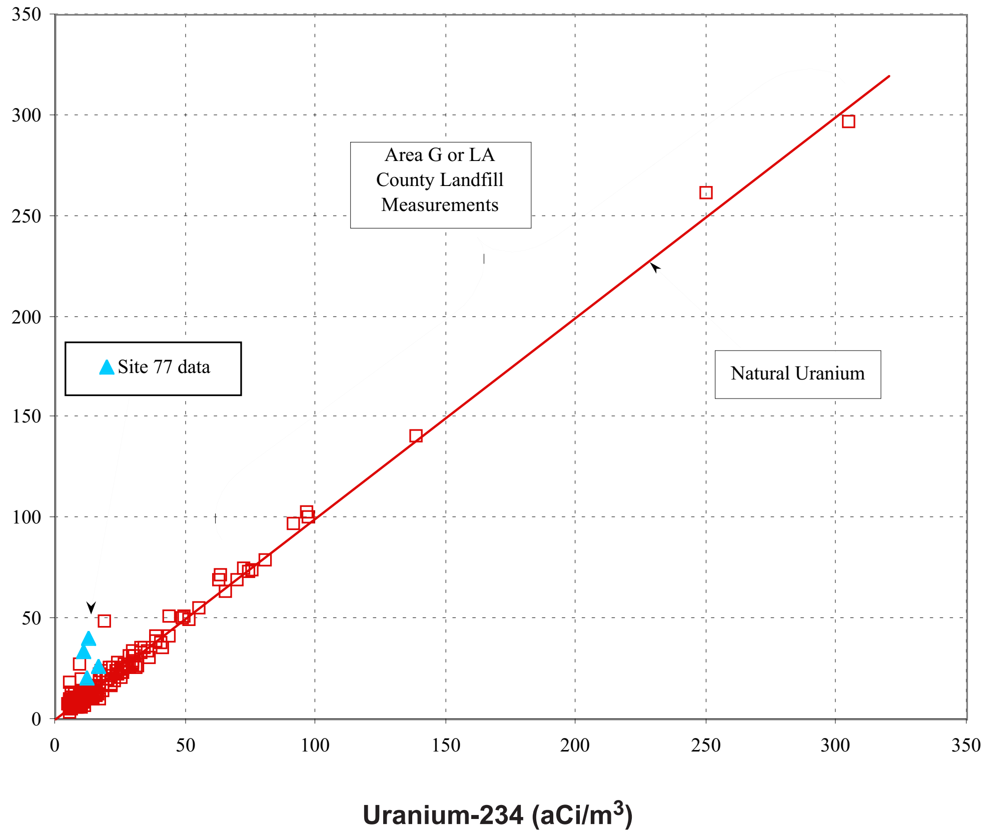

Figure 4-5. AIRNET uranium concentrations for 1999.

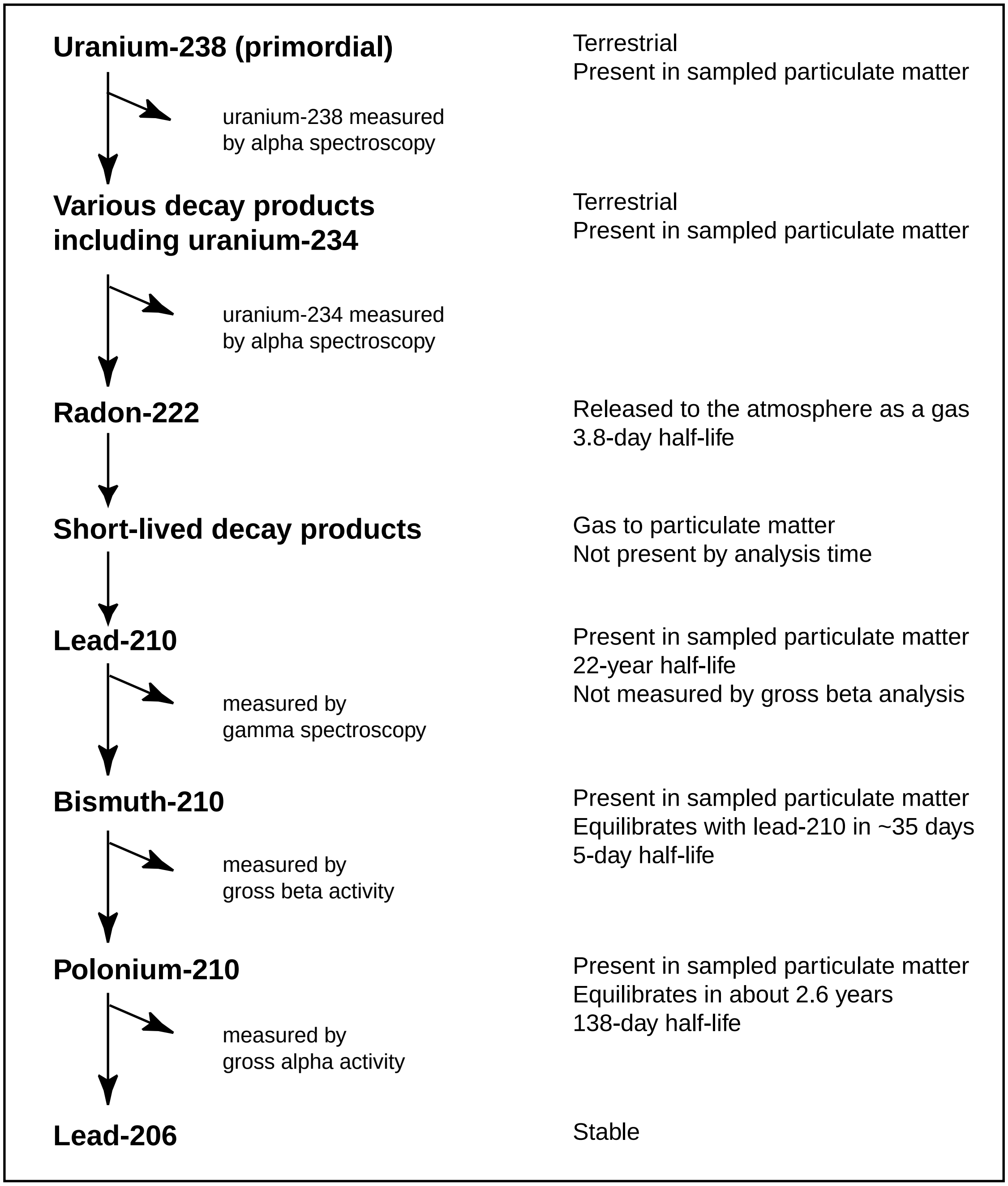

Figure 4-6. Uranium-238 decay series.

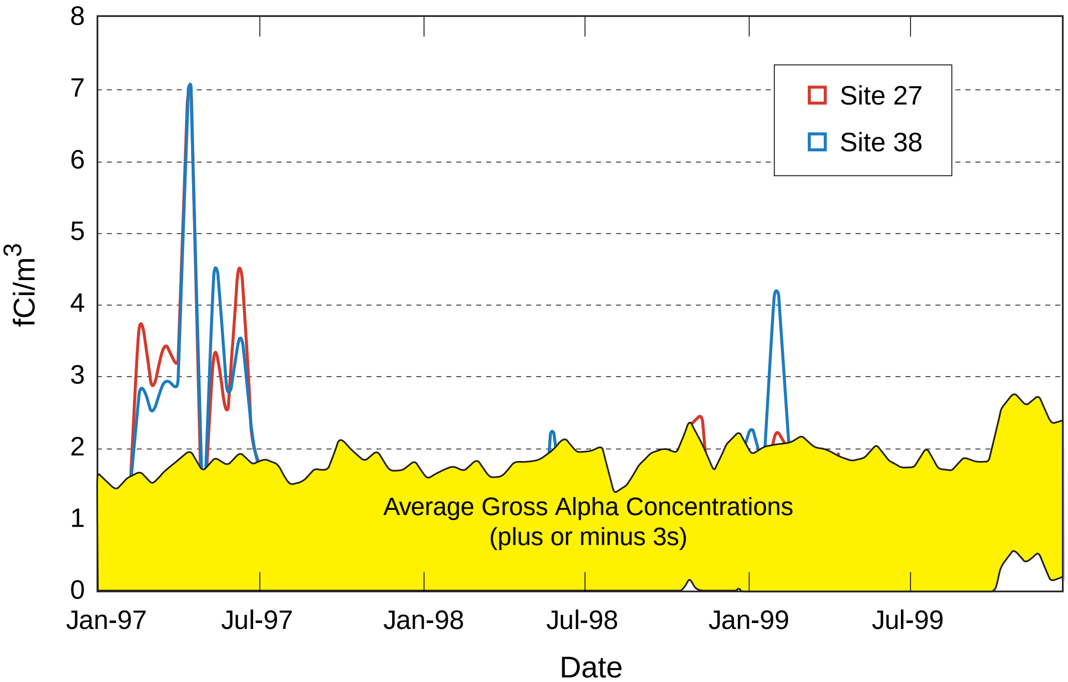

Figure 4-7. Biweekly gross alpha concentrations above the 3s control limits for sites with elevated americium and plutonium.

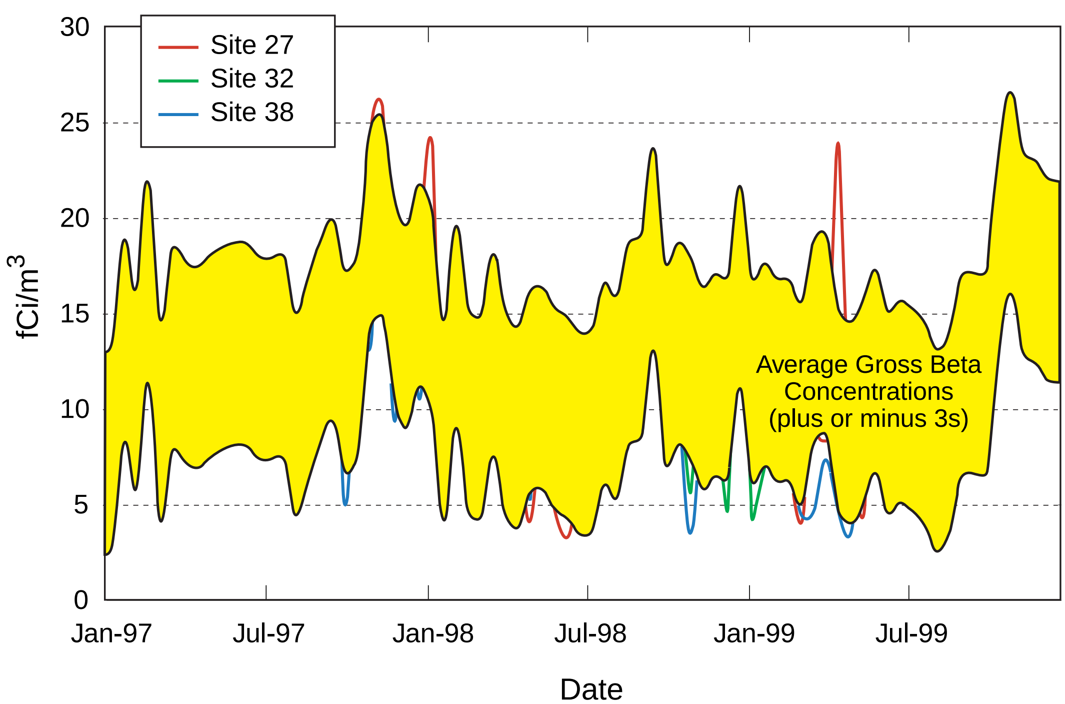

Figure 4-8. Biweekly gross beta concentrations outside the 3s control limits for sites with high levels of particulate matter.

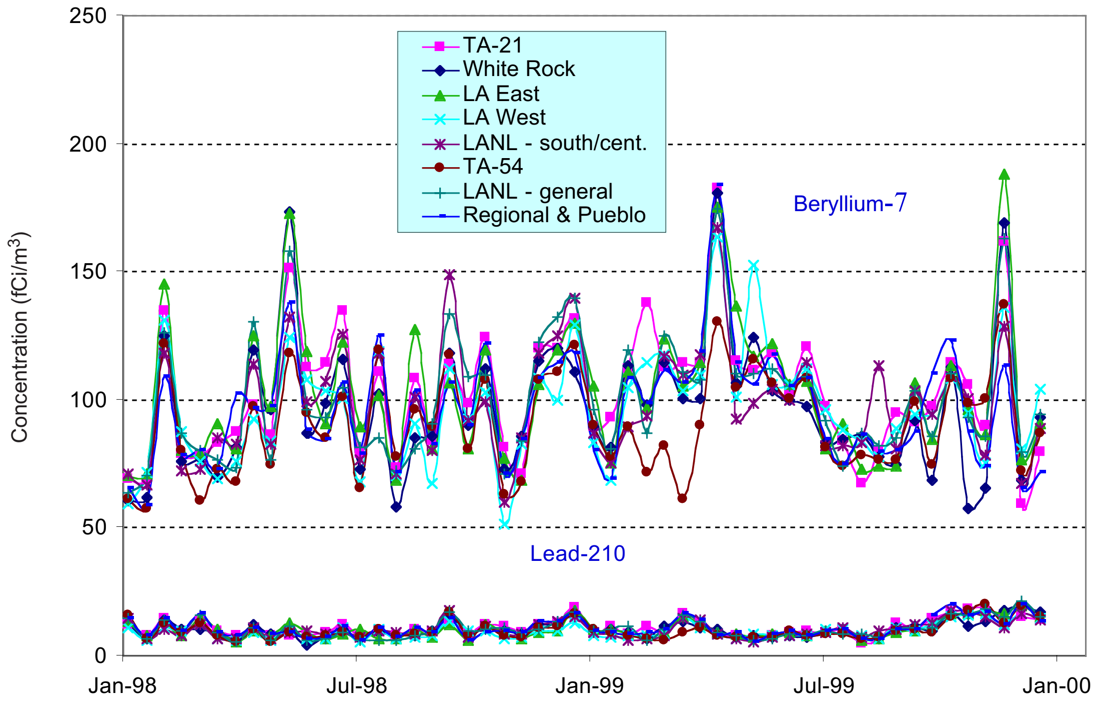

Figure 4-9. Gamma spectroscopy measurements grouped by general location.

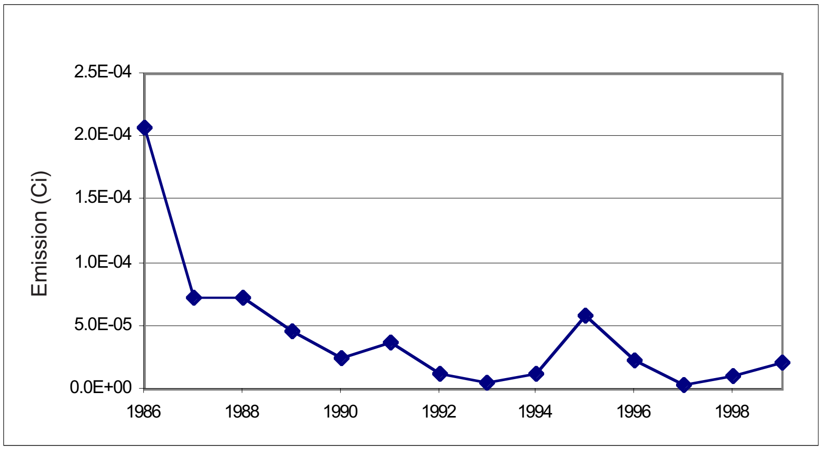

Figure 4-10. Plutonium emissions from sampled Laboratory stacks since 1986.

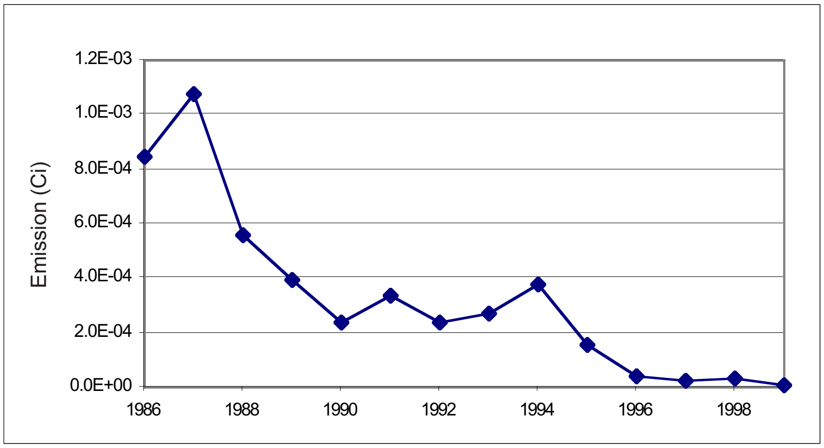

Figure 4-11. Uranium emissions from sampled Laboratory stacks since 1986.

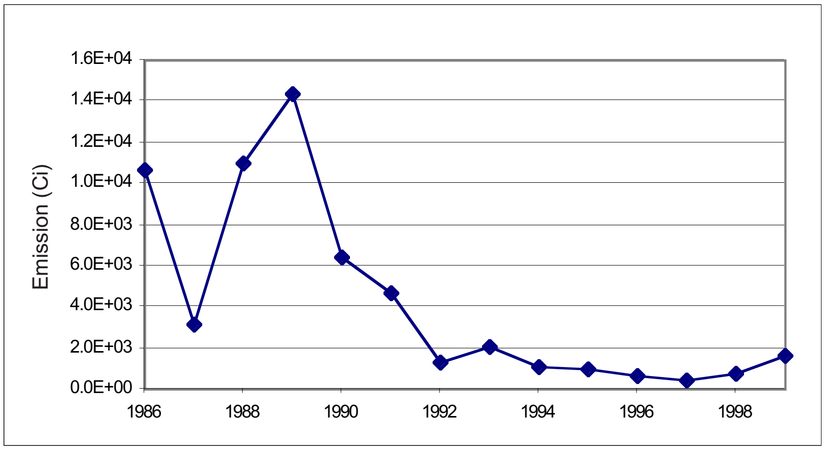

Figure 4-12. Tritium emissions from sampled Laboratory stacks since 1986.

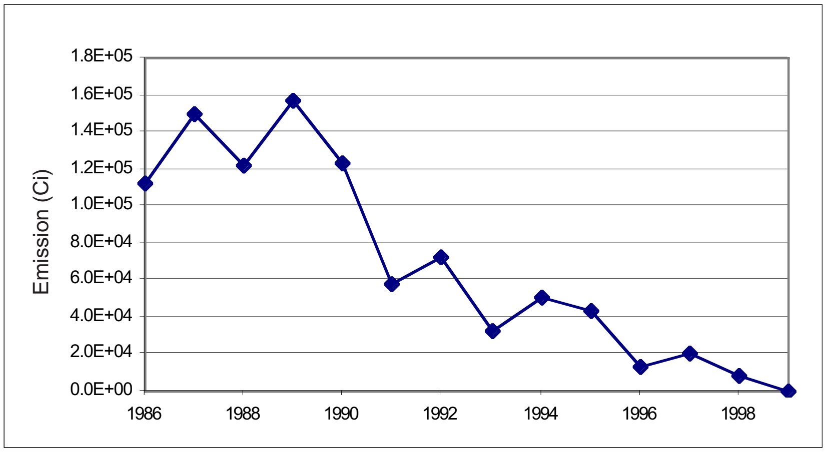

Figure 4-13. G/MAP emissions from sampled Laboratory stacks since 1986.

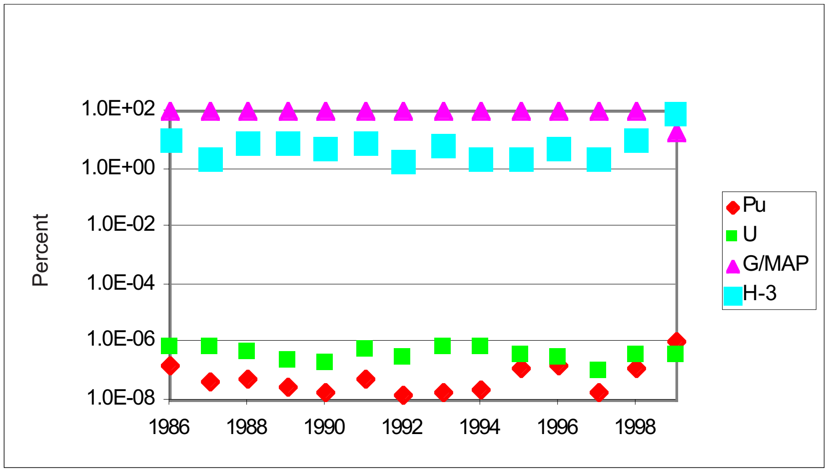

Figure 4-14. Percent of total emissions resulting from plutonium, uranium, tritium, and G/MAP.

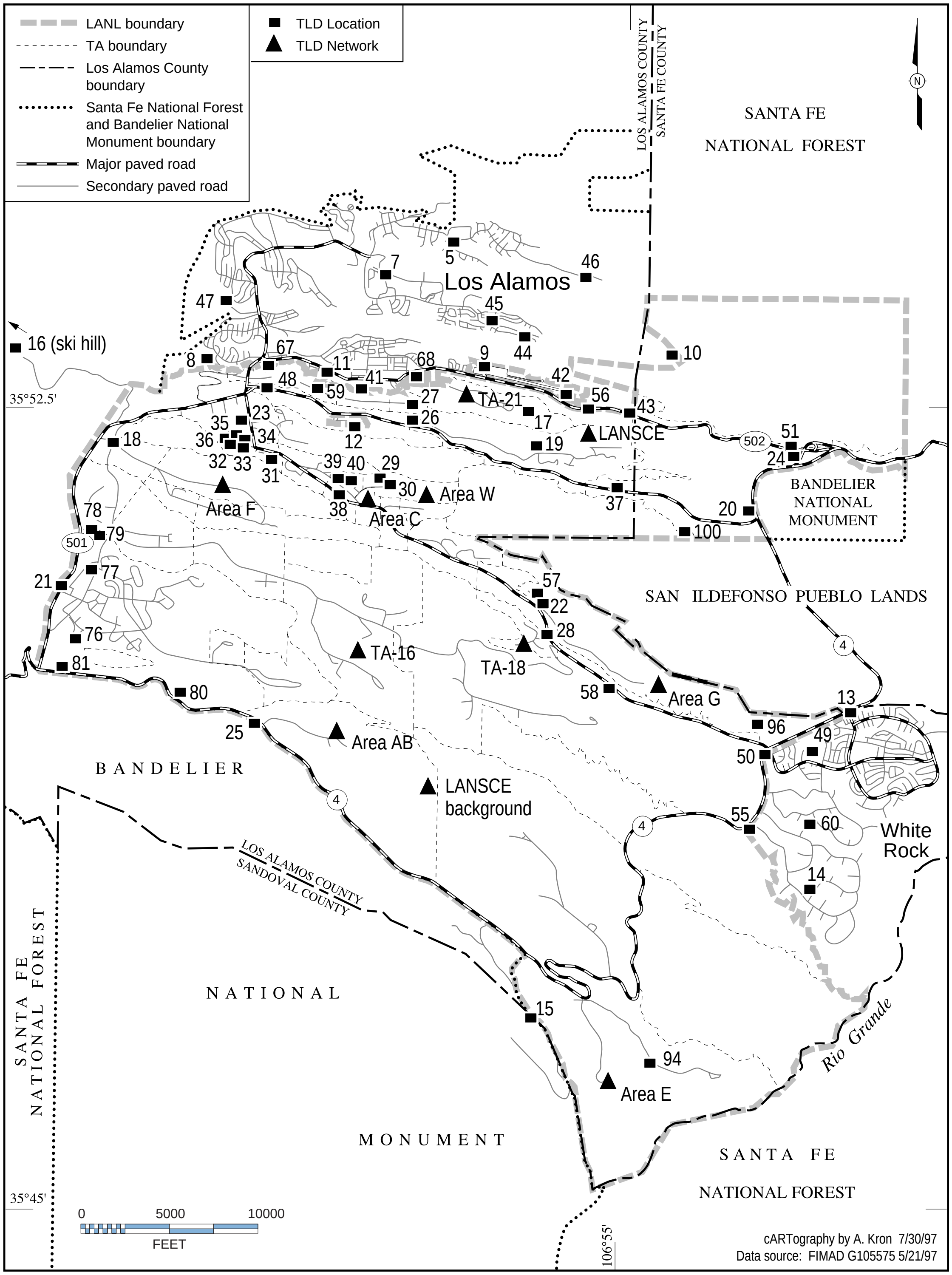

Figure 4-15. Off-site perimeter and on-site Laboratory TLD locations.

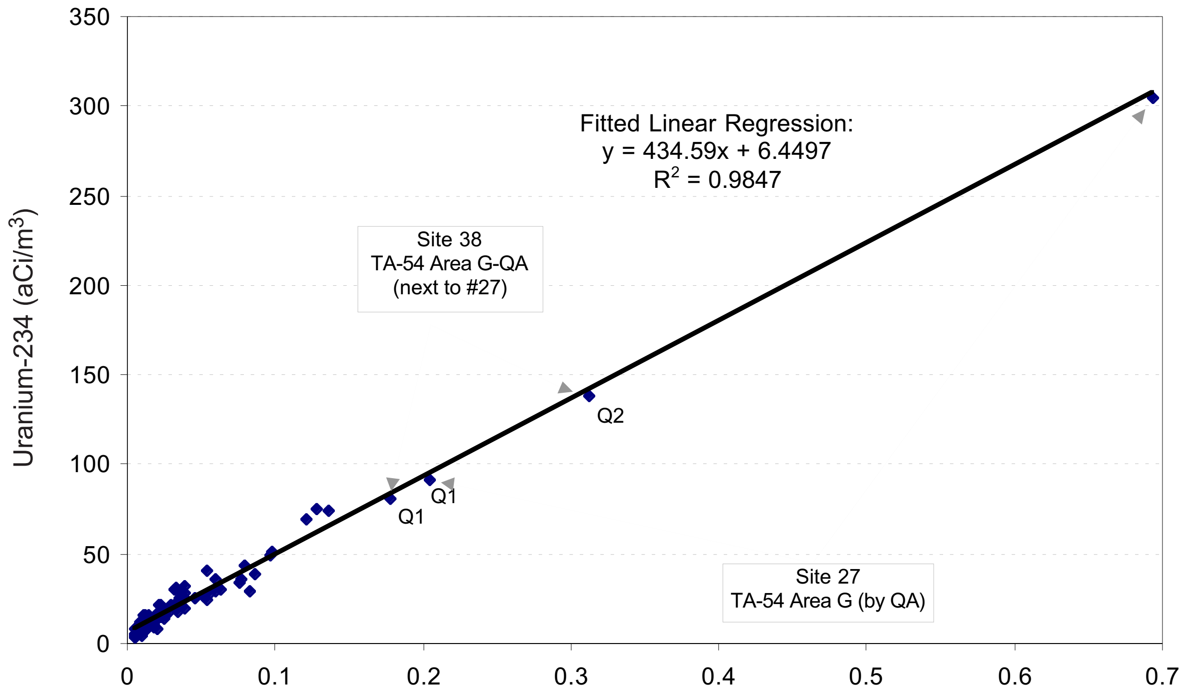

Figure 4-16. Quarterly beryllium and uranium-234 concentrations for 1999.

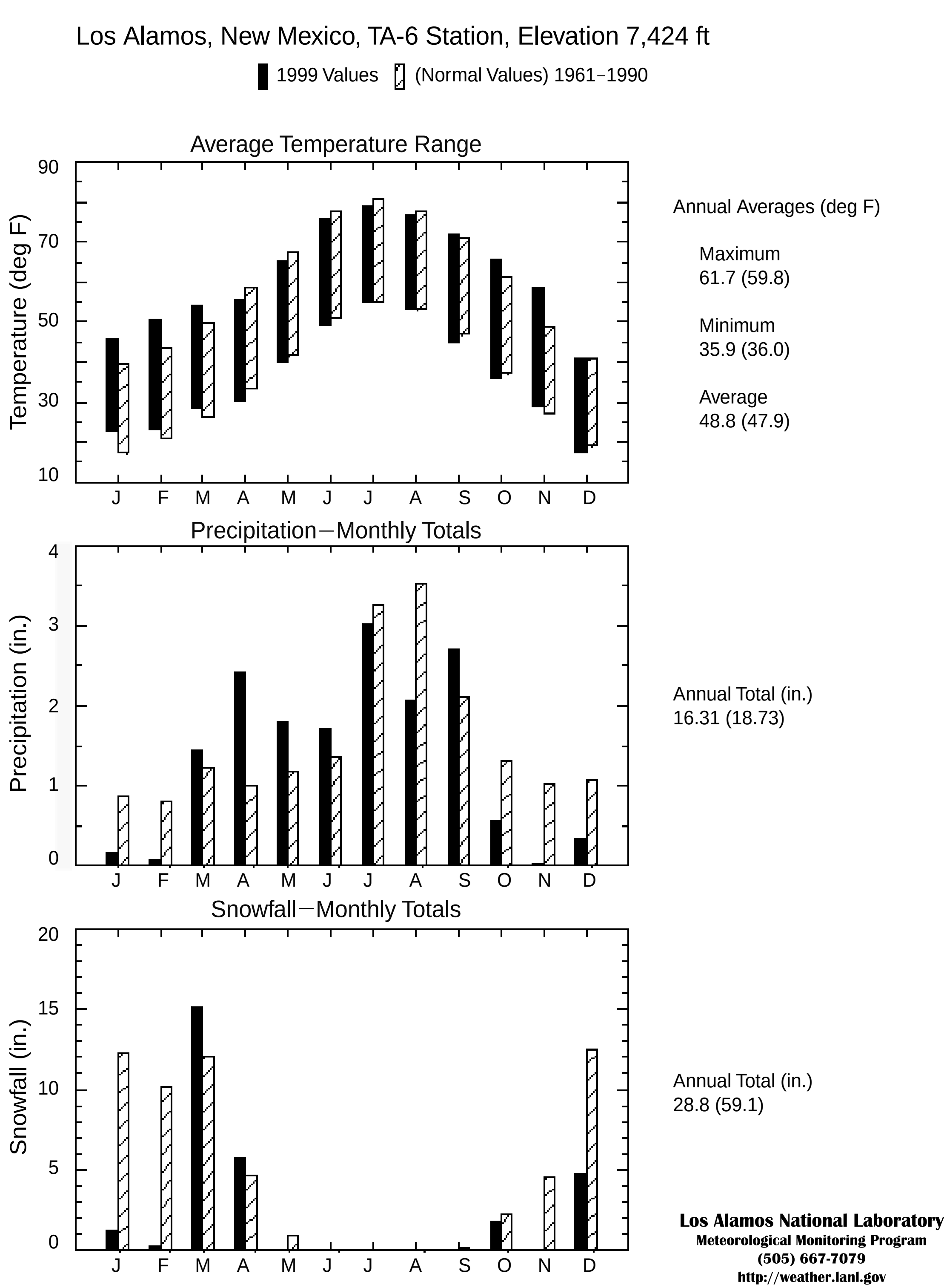

Figure 4-17. 1999 weather summary for Los Alamos.

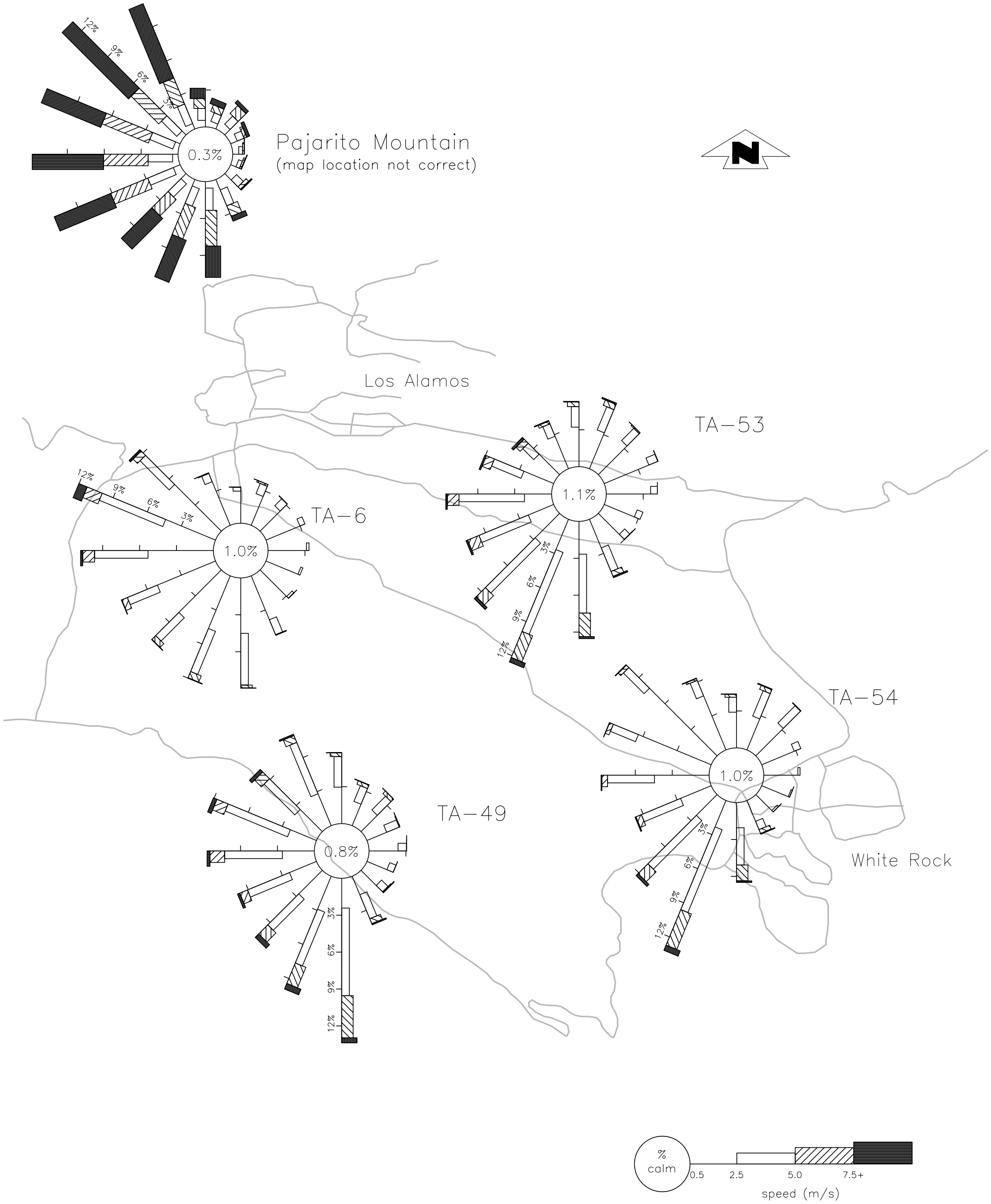

Figure 4-18. Total wind roses.

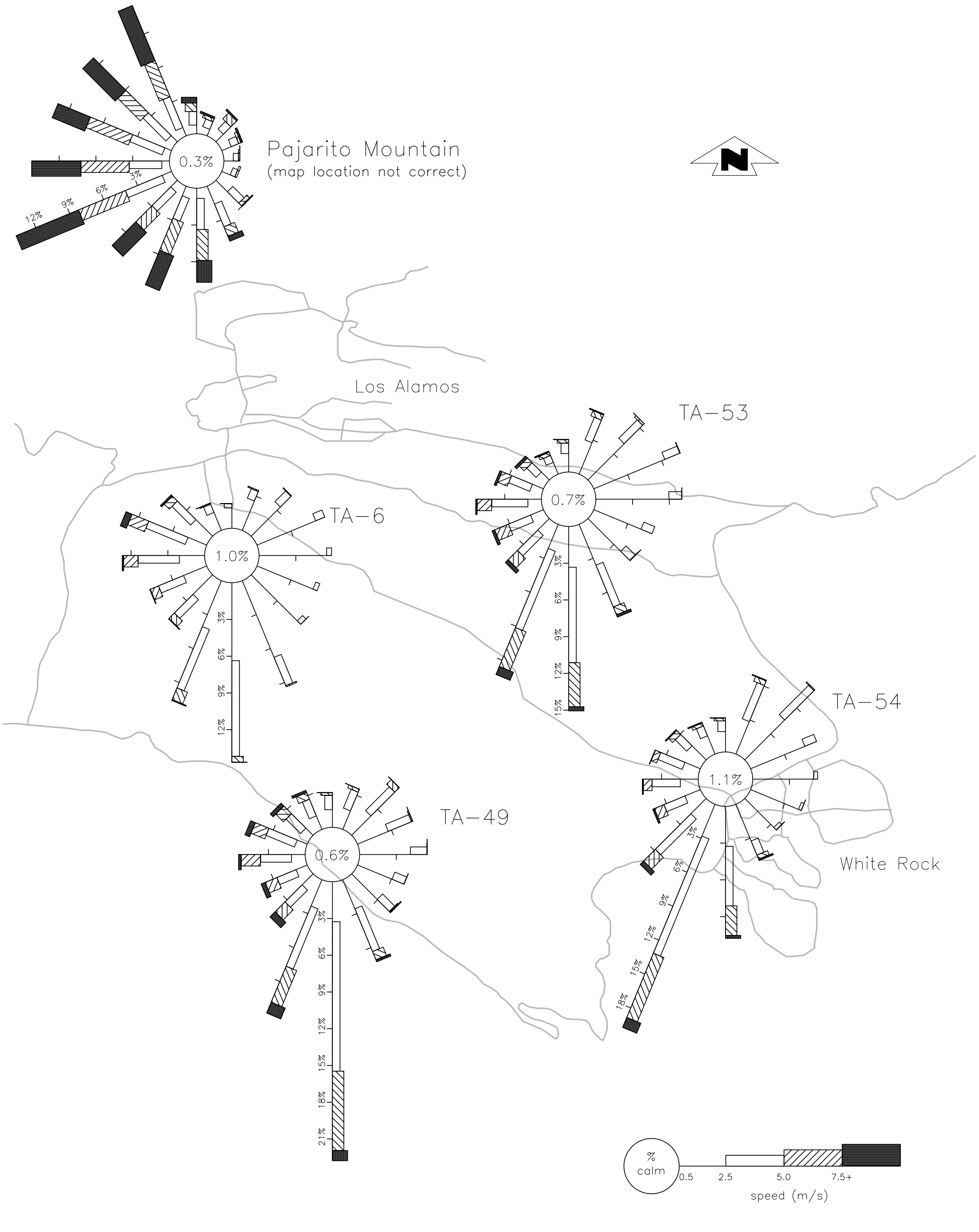

Figure 4-19. Daytime wind roses.

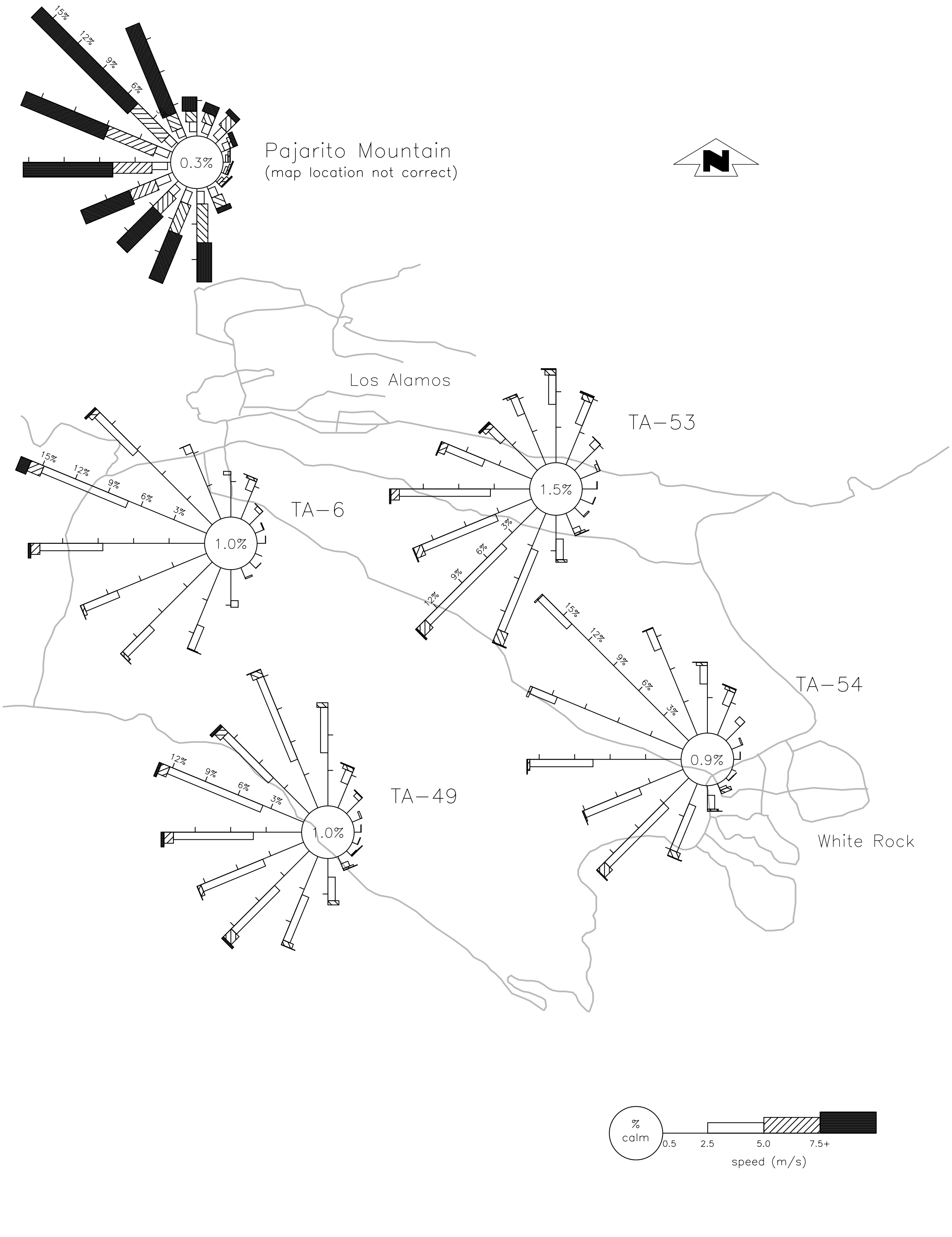

Figure 4-20. Nighttime wind roses.

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5. Surface Water, Groundwater, and Sediments

5. Surface Water, Groundwater, and Sediments

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Abstract

The 1999 surface water and runoff analysis results are generally consistent with past findings. We collected runoff samples using automated samplers; the samplers are actuated when a significant precipitation event causes flow in a drainage crossing the boundaries of Los Alamos National Laboratory (LANL or the Laboratory). Sixteen gross alpha measurements and one gross beta measurement exceeded the Department of Energy (DOE) derived concentration guides (DCG) for public dose in runoff samples in 1999. These samples came from Cañada del Buey, Ancho and Los Alamos Canyons and from around Area G, the Laboratory's low-level radioactive waste disposal facility. We use DCGs to screen runoff samples for cases of larger contaminant transport rather than to evaluate health risk. The DOE DCGs for public dose are determined assuming that two liters per day of water are consumed each year. Runoff, however, is present only a few days each year, and is not used for drinking water.

In 1998, LANL found high-explosives constituents in the regional aquifer at Technical Area (TA) 16 in the southwest portion of the Laboratory at concentrations above the Environment Protection Agency (EPA) Health Advisory guidance values for drinking water. Continued testing of water supply wells in 1999 showed that these compounds are not present in Los Alamos County drinking water. Other groundwater samples from the regional aquifer were consistent with previous results. Trace levels of tritium are present in the regional aquifer in a few areas where liquid waste discharges occurred, notably beneath Los Alamos, Pueblo, and Mortandad Canyons. The highest tritium level found in a regional aquifer test well is about 2% of the drinking water standard. Nitrate concentrations in a test well beneath Pueblo Canyon remain elevated, but in 1999, they were only about half the drinking water standard. In 1999, we detected no radionuclides other than naturally occurring uranium in Los Alamos County or San Ildefonso Pueblo water supply wells.

Analytical results for alluvial and intermediate depth groundwater are similar to those of past years. Waters near former or present effluent discharge points show the effects of these discharges. No samples exceeded DOE DCGs for public exposure. Alluvial groundwater samples in Los Alamos and Mortandad Canyons exceeded DOE DCGs for a DOE-operated drinking water system. The constituents exceeding drinking water DCGs were gross beta and americium-241. Alluvial groundwater is not used for drinking water.

The 1999 sediment sampling analysis is generally consistent with historical data. Plutonium occurs above fallout levels in Pueblo and Los Alamos Canyons and extends off-site from the Laboratory. Within Mortandad Canyon, the greatest radionuclide levels in sediments are found between the point where Radioactive Liquid Waste Treatment Facility (RLWTF) effluent enters the drainage and the sediment traps, approximately a 3-km distance. Radionuclide levels near or slightly exceeding background levels are found downstream of the sediment traps, extending to the Laboratory/San Ildefonso Pueblo boundary. A number of sediment samples near and downstream of the TA-54 Solid Waste Operations at Area G contained plutonium-238 at activities greater than background. We also found above background levels of plutonium and americium in sediments downstream of Area AB.

No high explosives or other organic compounds were detected at any of the surface water, runoff, sediment, or groundwater stations discussed here.

The 1999 strontium-90 data LANL collected in sediments, surface water, and groundwater are not valid because the analytical laboratory failed to properly apply the analytical technique. The data at every location for 1999 are questionable, and this represents the loss of an entire year's monitoring data for strontium-90. We present the data in this report for documentary purposes only. If taken at face value, the 1999 strontium-90 values would indicate unusually high levels in sediments, surface water, and groundwater. LANL has resolved the analytical laboratory problems and will continue monitoring strontium-90 at all locations in 2000. In 1999, the New

Mexico Environment Department (NMED) collected split samples at many wells where LANL data appeared to show unusually high strontium-90 values. NMED samples show only one detection of strontium-90, supporting our conclusion that the 1999 strontium-90 data are not valid.

A. Description of Monitoring Program

Studies related to development of groundwater supplies began at Los Alamos in 1945 under the direction of the US Geological Survey (USGS). Studies specifically aimed at environmental monitoring and protecting groundwater quality were initiated as joint efforts between the Atomic Energy Commission, the Los Alamos Scientific Laboratory, and the USGS in about 1949. These initial efforts focused on Pueblo and DP/Los Alamos Canyons, which received radioactive industrial waste discharges in the early days of the Laboratory.

The current network of annual sampling stations for surface water and sediment surveillance includes a set of regional (or background) stations and a group of stations near or within the Los Alamos National Laboratory (LANL or the Laboratory) boundary. The regional stations establish the background quantities of radionuclides and radioactivity derived from natural minerals and from fallout affecting northern New Mexico and southern Colorado.

Groundwater samples are taken from wells and springs within or adjacent to the Laboratory and from the nearby San Ildefonso Pueblo. The on-site stations, for the most part, focus on areas of present or former radioactive waste disposal operations, such as canyons (Figure 1-3). To provide context for discussion of monitoring results, the setting and operational history of currently monitored canyons that have received radioactive or other liquid discharges are briefly summarized below.

For a discussion of sampling procedures, analytical procedures, data management, and quality assurance, see Section F below.

1. Acid Canyon, Pueblo Canyon, and Lower Los Alamos Canyon

Acid Canyon, a small tributary of Pueblo Canyon, was the original disposal site for liquid wastes generated by research on nuclear materials for the World War II Manhattan Engineer District atomic bomb project. Acid Canyon received untreated radioactive industrial effluent from 1943 to 1951. The Technical Area (TA) 45 treatment plant was completed in 1951, and from 1951 to 1964 the plant discharged treated effluents that contained residual radionuclides into nearby Acid Canyon. Several decontamination projects have removed contamination from the area, but remaining residual radioactivity from these releases is now associated with the sediments in Pueblo Canyon (ESP 1981).

The inventory of radioactivity remaining in the Pueblo Canyon system is only approximately known. Several studies (ESP 1981, Ferenbaugh et al., 1994) have concluded that the plutonium in this canyon system does not present a health risk to the public. Based on analysis of radiological sediment survey data, the estimated total plutonium inventory in Acid Canyon, Pueblo Canyon, and Lower Los Alamos Canyon ranges from 246 mCi to 630 ± 300 mCi (ESP 1981). The estimated plutonium releases were about 177 mCi, in satisfactory agreement with the measured inventory considering uncertainties in sampling and release estimates. About two-thirds of this total is in the Department of Energy (DOE)-owned portion of lower Pueblo Canyon.

Pueblo Canyon currently receives treated sanitary effluent from the Los Alamos County Bayo Sewage Treatment Plant in the middle reach of Pueblo Canyon. Water occurs seasonally in the alluvium, depending on the volume of surface flow from snowmelt, thunderstorm runoff, and sanitary effluents. Tritium, nitrate, and chloride, apparently derived from these industrial and municipal disposal operations, have infiltrated to the intermediate perched ground water (at depths of 37 to 58 m [120 to 190 ft]) and to the regional aquifer (at a depth of 180 m [590 ft]) beneath the lower reach of Pueblo Canyon. Except for occasional nitrate values, levels of these constituents are a small fraction of the EPA drinking water standards.

Starting in 1990, increased discharge of sanitary effluent from the county treatment plant resulted in nearly continual flow during most months except June and July in the lower reach of Pueblo Canyon and across DOE land into the lower reach of Los Alamos Canyon on San Ildefonso Pueblo land. From mid-June through early August, higher evapotranspiration and the diversion of sanitary effluent for golf course irrigation eliminate flow from Pueblo Canyon into Los Alamos Canyon. Hamilton Bend Spring, which in the past discharged from alluvium in the lower reach of Pueblo Canyon, has been dry since 1990, probably because there was no upstream discharge from the older, abandoned Los Alamos County Pueblo Sewage Treatment Plant. Farther east, the alluvium is continuously saturated, mainly because of infiltration of effluent from the Los Alamos County Bayo Sewage Treatment Plant. Effluent flow from Pueblo Canyon into Los Alamos Canyon generally extends to somewhere between the DOE/San Ildefonso Pueblo boundary and the confluence of Guaje and Los Alamos Canyons.

2. DP Canyon and Los Alamos Canyon

In the past, Los Alamos Canyon received treated and untreated industrial effluents containing some radionuclides. The upper reach of Los Alamos Canyon experienced releases of treated and untreated radioactive effluents during the earliest Manhattan Project operations at TA-1 (1942–1945) and some release of water and radionuclides from the research reactors at TA-2. An industrial liquid waste treatment plant that served the old plutonium processing facility at TA-21 discharged effluent containing radionuclides into DP Canyon, a tributary to Los Alamos Canyon, from 1952 to 1986. Los Alamos Canyon also received discharges containing radionuclides from the sanitary sewage lagoon system at the Los Alamos Neutron Science Center (LANSCE) at TA-53. The low-level radioactive waste stream was separated from the sanitary system at TA-53 in 1989 and directed into a total retention evaporation lagoon.

The reach of Los Alamos Canyon within the Laboratory boundary presently carries flow from the Los Alamos Reservoir (west of the Laboratory) as well as National Pollutant Discharge Elimination System (NPDES)-permitted effluents from TA-53 and TA-21. Infiltration of effluents and natural runoff from the stream channel maintains a shallow body of groundwater in the alluvium of Los Alamos Canyon within the Laboratory boundary west of State Road 4. Groundwater levels are highest in late spring from snowmelt runoff and in late summer from thundershowers. Water levels decline during the winter and early summer when runoff is at a minimum. Groundwater also occurs within alluvium in the lower portion of Los Alamos Canyon on San Ildefonso Pueblo lands.

3. Sandia Canyon

Sandia Canyon has a small drainage area that heads at TA-3. The canyon receives water from the cooling tower at the TA-3 power plant. Treated effluents from the TA-46 Sanitary Wastewater Systems (SWS) Facility are rerouted to Sandia Canyon. These effluents support a continuous flow in a short reach of the upper part of the canyon. Only during summer thundershowers does stream flow approach the Laboratory boundary at State Road 4, and only during periods of heavy thunderstorms or snowmelt does surface flow extend beyond the Laboratory boundary.

4. Mortandad Canyon

Mortandad Canyon has a small drainage area that heads at TA-3. Its drainage area receives inflow from natural precipitation and a number of NPDES outfalls, including one from the RLWTF at TA-50. The TA-50 facility began operations in 1963. The effluents infiltrate into the stream channel and maintain a saturated zone in the alluvium extending about 3.5 km (2.2 mi) downstream from the outfall. The easternmost extent of saturation remains on-site, ending about 1.6 km (1 mi) west of the Laboratory boundary with San Ildefonso Pueblo. Over the period of operation, the radionuclides in the Radioactive Liquid Waste Treatment Facility (RLWTF) effluent have often exceeded the DOE DCGs for public dose. The effluent also contains nitrate that has caused alluvial groundwater concentrations to exceed the New Mexico groundwater standard of 10 mg/L (nitrate as nitrogen). In 1999, the new reverse osmosis and ultrafiltration system at the RLWTF began operation. This system removes additional radionuclides and nitrate from the effluent, and discharges from the plant now meet the DOE public dose DCGs and the New Mexico groundwater standard for nitrate.

Continuous surface flow across the drainage has not reached the San Ildefonso Pueblo boundary since observations began in the early 1960s (Stoker et al., 1991). Three sediment traps located about 3 km (2 mi) downstream from the effluent discharge in Mortandad Canyon dissipate the energy of major thunderstorm runoff events and settle out transported sediments. From the sediment traps, it is approximately 2.3 km (1.4 mi) downstream to the Laboratory boundary with San Ildefonso Pueblo.

The alluvium is less than 1.5 m thick in the upper reach of Mortandad Canyon and thickens to about 23 m at the easternmost extent of saturation. The saturated portion of the alluvium is perched on weathered and unweathered tuff, generally with no more than 3 m of saturation. There is considerable seasonal variation in saturated thickness, depending on the amount of runoff experienced in any given year (Stoker et al., 1991). Velocity of water movement in the alluvium ranges from 18 m/day in the upper reach to about 2 m/day in the lower reach of the canyon (Purtymun 1974; Purtymun et al., 1983). The high turnover rate for water in the alluvial groundwater prevents accumulation of chemicals from the RLWTF effluent (Purtymun et al., 1977). The top of the regional aquifer is about 290 m below the alluvial groundwater.

5. Pajarito Canyon

In Pajarito Canyon, water in the alluvium is perched on the underlying tuff and is recharged mainly through snowmelt and thunderstorm runoff. Saturated alluvium does not extend beyond the facility boundary. Three shallow observation wells were constructed in 1985 as part of a compliance agreement with the State of New Mexico to determine whether technical areas in the canyon or solid waste disposal activities on the adjacent mesa were affecting the quality of shallow groundwater. No effects were observed; the alluvial groundwater is contained in the canyon bottom and does not extend under the mesa (Devaurs 1985).

6. Cañada del Buey

Cañada del Buey contains a shallow alluvial groundwater system of limited extent. The thickness of the alluvium ranges from 1.2 to 5 m, but the underlying weathered tuff ranges in thickness from 3.7 to 12 m. In 1992, saturation was found within only a 0.8-km-long segment, and only two observation wells have ever contained water (ESP 1994). Because treated effluent from the Laboratory's SWS Facility may at some time be discharged into the Cañada del Buey drainage system, a network of five shallow groundwater monitoring wells and two moisture monitoring holes was installed during the early summer of 1992 within the upper and middle reaches of the drainage (ESP 1994). Construction of the SWS Facility was completed in late 1992.

B. Surface Water Sampling

1. Introduction

The Laboratory monitors surface waters from regional and Pajarito Plateau stations to evaluate the environmental effects of its operations. No perennial surface water flows extend completely across the Laboratory in any canyon. Periodic natural surface runoff occurs in two modes: (1) spring snowmelt runoff that occurs over days to weeks at a low discharge rate and sediment load and (2) summer runoff from thunderstorms that occurs over hours at a high discharge rate and sediment load. The surface water within the Laboratory is not a source of municipal, industrial, or irrigation water, though wildlife does use the waters. Activities of radionuclides in surface water samples may be compared to either the DOE Derived Concentration Guides (DCGs) or the New Mexico Water Quality Control Commission (NMWQCC) stream standards, which in turn reference the New Mexico Environment Department's (NMED's) New Mexico Radiation Protection Regulations (Part 4, Appendix A). However, New Mexico radiation protection activity levels are in general two orders of magnitude greater than the DOE DCGs for public dose, so we will discuss only the DCGs here. The concentrations of nonradioactive constituents may be compared with the NMWQCC General, Livestock Watering, and Wildlife Habitat standards. The NMWQCC groundwater standards can also be applied in cases where groundwater outflow may affect stream water quality. Appendix A presents information on these standards.

2. Monitoring Network

We collect surface water samples from Pajarito Plateau stations near the Laboratory and from regional stations. We take surface water grab samples annually from locations where effluent discharges or natural runoff maintains stream flow. Runoff samples have historically been collected as grab samples from usually dry portions of drainages during or shortly after runoff events. As of 1996, we collect runoff samples using stream gaging stations, some with automated samplers (Shaull et al., 1996). Samples are collected when a significant rainfall event causes flow in a monitored portion of a drainage. Many runoff stations are located where drainages cross the Laboratory's boundaries.

We collect regional surface water samples (Figure 5-1) from stations on the Rio Grande, Rio Chama, and Jemez River. These waters provide background data from areas beyond the Laboratory boundary.

Figures 5-2, 5-3, and 5-4 show surface water monitoring stations located on the Pajarito Plateau. We use samples from the stations to monitor water quality effects of potential contaminant sources such as industrial outfalls or soil contamination sites.

3. Radiochemical Analytical Results

Table 5-1 lists the results of radiochemical analyses for surface water and runoff samples for 1999. As discussed in Section 5.F, the analytical laboratory had data quality problems with analysis of strontium-90 for 1999. Therefore, the strontium-90 data appear in a separate table, Table 5-2. To emphasize values that are detections, Tables 5-3 and 5-4 list radionuclides detected in surface water and runoff samples. Detections are defined as values exceeding both the analytical method detection limit and three times the individual measurement uncertainty. The analytical laboratory determined analysis-specific detection limits for many radiochemical measurements in 1999; see Tables 5-3 and 5-4. Individual detection limits were not provided for gross alpha, gross beta, or uranium. Because uranium, gross alpha, and gross beta are almost always detected, we indicate in Table 5-3 only occurrences of these measurements above threshold values. The specific levels are 5 μg/L for uranium, 5 pCi/L for gross alpha, and 20 pCi/L for gross beta and are lower than the Environmental Protection Agency (EPA) maximum contaminant levels (MCLs) or screening levels.

The righthand columns of Tables 5-3 and 5-4 indicate radiochemical detections that are greater than 1/25 of the DOE DCGs for public dose for ingestion of environmental water (1/25 of the DOE DCG for public dose is the DOE drinking water system DCG). The EPA drinking water limits for gross alpha and gross beta values are higher than 1/25 of the DOE public dose DCG (that is, greater than the DOE drinking water system DCGs), so we use the EPA values to screen gross alpha and gross beta values. The DOE public dose DCG value for gross beta is actually the strontium-90 DCG, and the DCG for gross alpha is the plutonium-239, -240 DCG. We chose DCGs because the isotopes represented had the lowest DCGs for alpha and beta emitters. Bear in mind that surface waters on the Laboratory are not used for drinking water.

Runoff samples have high turbidity and present special analysis and interpretation problems. Drinking water is generally low in turbidity, so measurements reflect mainly dissolved constituents, rather than those associated with sediments. We use the DOE DCGs for public dose to screen runoff samples for cases of larger contaminant transport rather than to evaluate health risk. The DCGs are determined assuming that 2 liters of water per day are consumed each year. Runoff, however, is present only a few days each year, and is not used for drinking water. Runoff samples frequently contain high levels of suspended solids (exceeding 25,000 mg/L). The analytical uncertainties associated with measurement of gross alpha and beta levels in samples with high suspended solids are probably greater than reported on the accompanying tables. Because of these large uncertainties, the high gross alpha and beta values may have low precision. The higher than reported uncertainties are results of the analytical process. Gross alpha and beta counting uses a small portion of the sample so the counted sample does not shield alpha or beta emissions from reaching the detector. In samples with high suspended solids, very little sample volume is used. The measured concentration is then extrapolated to a 1-liter volume. Because the sample is not homogeneous, it is unlikely that a small portion of a runoff sample will represent the concentration of constituents in the total sample.

Sixteen gross alpha measurements and one gross beta measurement exceeded the DOE public dose DCG values in runoff samples in 1999. We have not been able to tie these measurements to particular radionuclides; the radionuclides measured in the samples do not account for the gross alpha and gross beta measurements. Other radionuclides present, such as naturally occurring potassium-40, may account for a significant portion of the gross alpha and beta measurements, for example. The gross alpha samples were from Area G stations G-SWMS-2, G-SWMS-3, G-SWMS-4, G-SWMS-5, and G-SWMS-6 and Cañada del Buey at White Rock, DP Canyon near Los Alamos, and Los Alamos Canyon near Los Alamos. Gross beta exceeded the DCG at Ancho Canyon at TA-39. Stations with values greater than half the DCG were gross alpha from the surface water sample at Mortandad Canyon at GS-1 and runoff samples from G-SWMS-4, Sandia Canyon below the Power Plant, Sandia Canyon at Roads and Grounds, and Los Alamos Canyon near Los Alamos. Gross beta measurements more than half the DCG occurred at Ancho Canyon near Bandelier and G-SWMS-3, whereas plutonium-239, -240 at Los Alamos Canyon near Los Alamos and americium-241 at G-SWMS-4 were greater than half the DCG.

Except for strontium-90, most of the measurements at or above detection limits are from locations with previously known contamination: the perimeter of Area G, Acid/Pueblo Canyon, DP/Los Alamos Canyon, and Mortandad Canyon. A few of the measurements at or above detection limits were from locations that do not typically show detectable activity. Detections from locations outside the known contaminated areas near TA-54, Area G, and in Pueblo, DP/Los Alamos, and Mortandad Canyons are discussed below.

a. Radiochemical Analytical Results for Surface Water. Several regional and perimeter stations had detections of radiochemical parameters with no apparent source. Rio Chama at Chamita showed two detections of americium-241. Numerous other surface water, runoff, and groundwater samples had detections of americium-241 at about these levels, as did two de-ionized water (DI) blanks. The Jemez River also showed a detection of americium-241. See Section 5.F.3 for a discussion of radiochemical quality control (QC) results. Several stations showed detections of gross gamma: two samples from the Rio Grande at Otowi (the upper station is outside the influence of runoff from LANL), Frijoles at Rio Grande, and the Jemez River station.

Station SCS-3 in Sandia Canyon showed a detection of plutonium-238. No apparent source exists in Sandia Canyon for this radioactivity.

Three surface water stations (Pueblo 1, Mortandad at GS-1, and Los Alamos Canyon Reservoir) exceeded the EPA MCL of 8 pCi/L for strontium-90 in drinking water. Only Mortandad at GS-1 has shown values of this size previously, so the other two values likely reflect analytical problems.

b. Radiochemical Analytical Results for Runoff. Automated samplers collected runoff samples whenever rainfall events caused significant runoff at these stations. See Section 5.F.1 for a description of the runoff samplers and sampling protocols.

The radionuclides we measured in our analyses did not account for the high gross alpha and gross beta readings from runoff samples, suggesting that additional radionuclides may be present. Alternatively, the methodology for measuring gross alpha and beta may have problems as discussed above.

At station Los Alamos Canyon near Los Alamos (LA), runoff contained cesium-137, americium-241, plutonium-239, -240, plutonium-238, gross alpha and beta, and uranium. LA Canyon below TA-2 had americium-241, plutonium-239, -240, and plutonium-238. DP Canyon near LA had cesium-137, americium-241, plutonium-239, -240, plutonium-238, and gross alpha, beta, and gamma. For Los Alamos Canyon near Los Alamos, values were similar to those seen in 1997 and 1998, though uranium and plutonium values are somewhat higher. DP Canyon near LA and Los Alamos Canyon near Los Alamos had several strontium-90 values above the drinking water MCL. The strontium-90 values are similar to prior runoff, surface water, and alluvial groundwater values in Los Alamos and DP Canyons.

In the four runoff samples collected at Cañada del Buey at White Rock, we detected all radiochemical parameters that we measure, except tritium, in at least one runoff sample. High suspended sediment levels in the samples are probably the source of the radioactivity. Samples collected in 1997 and 1998 showed similar levels of radioactivity, although in 1999 gross beta was lower than earlier samples, plutonium-238 was about five times higher, plutonium-239, -240 was lower, and uranium was about twice earlier values.

The Cañada del Buey at White Rock runoff samples had strontium-90 values ranging from five to seven times the drinking water MCL. These values are more than three times prior values and could reflect analytical laboratory problems.

Sources for the radioactivity seen at station Cañada del Buey at White Rock may include Area G at TA-54 or other Laboratory facilities along Cañada del Buey. Runoff samples from stations G-SWMS-4 and G-SWMS-6 on the east and north of Area G showed radioactivity comparable to the Cañada del Buey at White Rock runoff samples in 1998 and 1999.

Levels of radioactivity similar to those in the 1998 Cañada del Buey at White Rock runoff samples have not been seen in the past at the nearby sediment station. Another surface water station and two alluvial wells (CDBO-6 and CDBO-7) located upstream of Area G in Cañada del Buey have also not shown such high levels of radioactivity. However, the wells have had fairly large gross alpha and gross beta values; the gross alpha value at CDBO-6 also exceeded the DOE public dose DCG in 1998.

For runoff samples at TA-54, Area G, all radiochemical parameters measured except tritium were detected in at least one runoff sample. We have previously detected these radionuclides in sediment and runoff samples collected around Area G, and these results indicate that a small amount of radioactivity leaves the area because of surface erosion and runoff. The highest previous strontium-90 value for an Area G runoff station was 11.5 pCi/L in 1997; thirteen 1999 values exceed this level, and they range up to 101 pCi/L. These values could be a result of analytical laboratory problems.

Three stations in Ancho Canyon (North Fork Ancho Canyon at TA-39, Ancho Canyon at TA-39, and Ancho Canyon near Bandelier) showed several radiological constituents including cesium-137; americium-241; plutonium-239, -240; plutonium-238; gross beta and gamma; and uranium. The only recent sample from these stations was from Ancho Canyon near Bandelier in 1996; the sample had no significant radioactivity. Strontium-90 at these stations ranged from below to nine times (73.7 pCi/L) the EPA drinking water MCL. No recent runoff, surface water, or spring samples in Ancho Canyon have shown such high values of strontium-90, so the values could reflect analytical laboratory problems.

Pajarito Canyon above SR-4 had detections of cesium-137; americium-241; plutonium-239, -240; and plutonium-238. Pajarito Canyon above Threemile Canyon showed cesium-137 and plutonium-239, -240. These stations have not been sampled in the last few years; surface water samples have not shown such levels of radionuclides. One strontium-90 value at Pajarito Canyon above SR-4 exceeded the EPA drinking water MCL; such values have not been seen previously and may be the result of analytical laboratory problems.

Potrillo Canyon near White Rock showed the presence of cesium-137; americium-241; plutonium-239, -240; and gross gamma. Except for gross gamma, levels were similar to a 1997 sample. A strontium-90 value was about six times the 1997 level and may be the result of analytical laboratory problems.

Three stations in Sandia Canyon (Sandia Canyon below the Power Plant, Sandia Canyon below Wetlands, and Sandia Canyon near Roads & Grounds at TA-3) collectively showed the presence of americium-241; plutonium-238; plutonium-239, -240; and gross alpha, beta, and gamma. Prior runoff samples are not available for these stations, and the levels are higher than usually seen at surface water stations in Sandia Canyon. SCS-3 did have a lower, though unusual, detection of plutonium-238 in 1999. The three runoff stations had strontium-90 values at about half the EPA drinking water MCL. The values are higher than earlier surface water values in Sandia Canyon so may be the result of analytical laboratory problems.

c. Technical Area 50 Discharges. The cumulative discharge of radionuclides from the RLWTF into Mortandad Canyon between 1963 and 1977 and yearly discharge data for 1997 through 1999 appear in Table 5-5. In addition to total annual activity released for 1997 through 1999, Table 5-5 also shows mean annual activities in effluent for each radionuclide and the ratio of this activity to the DOE DCG for public dose. In 1999, americium-241, plutonium-238, and plutonium-239, -240 again exceeded the DCG. As mentioned above, the new reverse osmosis and ultrafiltration system began operation at the RLWTF in 1999. This system is designed to remove additional radionuclides from the effluent, and the discharges will meet the DOE public dose DCGs.

In response to a letter of noncompliance from the NMED, in March 1999 the RLWTF instituted a program to restrict the discharge of nitrogenous wastes into facility's collection system. As a result, the nitrate (nitrate as nitrogen) concentration of all effluent discharge from the RLWTF after March 21, 1999, was less than 10 mg/L. The average 1999 effluent nitrate concentration (value of 24.2 mg/L, nitrate as nitrogen) exceeded the New Mexico groundwater standard of 10 mg/L but was much lower than the values for the previous two years.

The fluoride concentration in the discharge also has declined over the last three years. The 1999 effluent fluoride concentration (average value of

1.12 mg/L) was below the New Mexico groundwater standard of 1.6 mg/L. The 1997 average effluent fluoride concentration exceeded the New Mexico groundwater standard by 25%, and in 1998 it was approximately equal to the standard.

4. Nonradiochemical Analytical Results

a. Major Chemical Constituents. Table 5-6 lists the results of analyses for major chemical constituents in surface water and runoff samples for 1999. The results are generally consistent with those observed in previous years, with some variability. The measurements in waters from areas receiving effluents show the effect of these effluents. None of the results were outside the ranges for standards with the following exception. The total dissolved solids (TDS) value at SCS-2 exceeded the EPA secondary drinking water standard. Several other TDS values (at SCS-1, SCS-3, Mortandad at Rio Grande, and Pueblo 3) exceeded half the EPA secondary drinking water standard, and sulfate at SCS-2 exceeded half the EPA secondary drinking water standard. The nitrate value for Mortandad at Rio Grande was about 51% of the NMWQCC Groundwater Standard. These stations are all downstream from sanitary sewage discharges.

b. Trace Metals. Table 5-7 lists the results of trace metal analyses on surface water and runoff samples for 1999. Samples collected for trace metal analysis (with the exception of unfiltered runoff samples) were filtered so that they could be compared to the NMWQCC standards that apply to dissolved constituents. Samples collected for mercury and selenium analysis were unfiltered, as the NMWQCC standards for these analytes apply to total metal content. The levels of trace metals in samples for 1999 are generally consistent with previous observations.

As in 1998, several surface water, runoff, and groundwater samples showed detections of selenium in 1999. Typically, selenium has not been detected in surface water or groundwater on the Pajarito Plateau. The analytical detection limit for selenium in 1999 samples was 3 µg/L, higher than in previous years and higher than the New Mexico Wildlife Habitat Standard of 2 µg/L. New Mexico changed this value to 5 µg/L in February 2000. Numerous selenium results reported as 3 µg/L do not appear to be detections (having three sigma uncertainties equal to the reported value), raising the question of whether these values indicate the presence of selenium. Selenium was present in runoff samples at Cañada del Buey near White Rock, three samples at Los Alamos Canyon near Los Alamos, Ancho Canyon at TA-39, North Fork Ancho Canyon at TA-39, Potrillo Canyon near White Rock, and G-SWMS-6.

The analytical detection limit for mercury (0.1 µg/L) is not adequate to determine whether it is present in excess of the New Mexico Wildlife Habitat stream standard of 0.012 µg/L. New Mexico changed this value to 0.77 µg/L in February 2000. In 1998, we did not detect mercury at any location with the exception of a runoff sample at Cañada del Buey at White Rock. For 1999, we detected mercury at Sandia Canyon Truck Route, Pajarito Canyon above Threemile Canyon, Los Alamos Canyon near Los Alamos, Los Alamos Canyon below TA-2, DP Canyon near Los Alamos, G-SWM-3, North Fork Ancho Canyon, Ancho Canyon near Bandelier, Ancho Canyon at TA-39, and Cañada del Buey at White Rock.

Runoff samples we collected at Los Alamos Canyon near Los Alamos again had lead levels exceeding NM Groundwater and Livestock Watering standards and showed the presence of beryllium, cadmium, and cobalt. Barium exceeded the New Mexico Groundwater limit. This station is upstream of State Road 4 in Los Alamos Canyon. Los Alamos Canyon below TA-2 also showed the presence of barium, beryllium, cobalt, and lead. DP Canyon near Los Alamos had beryllium, lead, and chromium.

Stations in Sandia Canyon had beryllium, lead, and chromium.

In addition to high levels of radioactivity as described earlier, runoff samples from Cañada del Buey at White Rock contained levels of barium, beryllium, cadmium, cobalt, nickel, and selenium near or exceeding regulatory standards. Note that some of these regulatory standards apply to groundwater or drinking water rather than expressly to surface water and are used for purposes of comparison.

Pajarito Canyon above Threemile Canyon had beryllium and cadmium. Pajarito Canyon above SR-4 showed beryllium and antimony. Potrillo Canyon near White Rock had barium, beryllium, cadmium, cobalt, and vanadium near or above regulatory limits. None of these stations have prior samples.

Stations in Ancho Canyon (North Fork Ancho Canyon at TA-39, Ancho Canyon at TA-39, and Ancho Canyon near Bandelier) had barium, beryllium, cadmium, cobalt, chromium, mercury, nickel, lead, selenium, and vanadium near or above regulatory standards. None of these stations have prior samples, except for Ancho Canyon near Bandelier on 6/29/96.

None of the metals that exceeded a standard in 1999 did so in the 1996 sample.

The Area G runoff stations showed the presence of barium, beryllium, cadmium, cobalt, chromium, mercury, nickel, lead, selenium, and vanadium near or above regulatory standards.

Aluminum, iron, and manganese concentrations exceed EPA secondary drinking water standards in surface water and runoff samples at many locations. These results reflect the presence of suspended solids in the water samples. Some of these cases occur with filtered samples. The results are due to naturally occurring constituents (e.g., aluminum, iron, and manganese) of minerals in the suspended solids.

c. Organic Constituents in Surface Water and Runoff. Table 5-8 summarizes the locations where we collected organic samples in 1999. (See Section 5.F.2.c. for analytical methods and analytes.) We analyzed samples for volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), and polychlorinated biphenyls (PCBs). Some samples were also analyzed for high-explosive (HE) constituents. No HE or other organic compounds were detected above the analytical laboratory's reporting level at any stations in 1999.

5. Long-Term Trends

Long-term trends for surface water are discussed in Section 5.D with groundwater trends.

C. Sediment Sampling

1. Introduction

Sediment transport associated with surface water runoff is a significant mechanism for contaminant movement. Contaminants originating from airborne deposition, effluent discharges, or unplanned releases can become attached to soils or sediments by adsorption or ion exchange.

There are no federal or state regulatory standards for soil or sediment contaminants that we can use for comparison with the Laboratory's environmental surveillance data. Instead, contaminant levels in sediments may be interpreted in terms of toxicity as a result of ingestion, inhalation, or direct exposure. The Laboratory's Environmental Restoration Project uses screening action levels (SALs) to identify contaminants at concentrations or activities of concern. SALs are screening levels selected to be less than levels that would constitute a human health risk. SAL values are derived from toxicity values and exposure parameters using data from the EPA.

We can also compare the data with activities of radionuclides resulting from atmospheric fallout or from naturally occurring radionuclides. We used radionuclide analyses of sediment samples collected from regional stations for the period 1974 to 1986 to establish background activities from atmospheric fallout of radionuclides and to determine the background concentrations of naturally occurring uranium (Purtymun et al., 1987). McLin et al. (in preparation) developed provisional background levels for data from the period 1974 to 1996. We use the average activity of each of the radionuclides in the regional station samples, plus twice its standard deviation, as an estimate of the upper limit of background values. This approach assumes that the regional station values are normally distributed and that about 95% of the regional station samples will fall within two standard deviations of the mean. If the activity of an individual sediment sample is greater than the estimated background value, we consider the Laboratory as a possible source of contamination. Tables summarizing analytical results list both background and SAL values for sediments.

2. Monitoring Network

Sediments are sampled in all major canyons that cross the Laboratory, including those with either perennial or ephemeral flows. We also sample sediments from regional reservoirs and stream channels annually.

Regional sediment sampling stations (Figure 5-1) are located within northern New Mexico and southern Colorado at distances up to 200 km from the Laboratory. Samples from regional stations provide a basis for estimating background activities of radionuclides resulting from atmospheric fallout or from naturally occurring radionuclides. We obtained regional sediment samples from reservoirs on the Rio Grande and the Rio Chama and at stations on the Rio Grande and Jemez River.

Stations on the Pajarito Plateau (Figure 5-5) are located within about 4 km of the Laboratory boundary, with the majority located within the Laboratory boundary. The information gathered from these stations documents conditions in areas potentially affected by Laboratory operations. Many of the sediment sampling stations on the Pajarito Plateau are located within canyons to monitor sediment contamination related to past and/or present effluent release sites. We sampled three major canyons (Pueblo, Los Alamos, and Mortandad Canyons) that have experienced past or present liquid radioactive releases from upstream of the Laboratory to their confluence with the Rio Grande.

We also collected sediments from drainages downstream of two material disposal areas. Area G at TA-54 is an active waste storage and disposal area. Nine sampling stations were established outside its perimeter fence in 1982 (Figure 5-4) to monitor possible transport of radionuclides from the area. The surface drainage changed, and we dropped two sampling stations in 1998 and added four others. G-4 R-1 and G-4 R-2 replaced station G-4. G-6 was located in a channel that received runoff that was not entirely from Area G. G-6R replaced G-6 and is located in a stream channel that receives runoff only from Area G. Station G-0 was added on the north side of Area G in a drainage that flows to Cañada del Buey. We collected special samples in 1999 at the Transuranic Waste Inspectable Storage Project (TWISP) Dome at Silt Fence and G3-01 and G3-02.

Area AB at TA-49 was the site of underground nuclear weapons testing from 1959 to 1961 (Purtymun and Stoker 1987, ESP 1988). The tests involved high explosives and fissionable material insufficient to produce a nuclear reaction. We established 11 stations in 1972 to monitor surface sediments in drainages adjacent to Area AB (Figure 5-6). We added another station (AB-4A) in 1981 as the surface drainage changed.

Two special sediment sampling events occurred in 1999. In response to high values of gross alpha and gross beta in runoff samples collected at Cañada del Buey at White Rock, we collected sediment samples at five sites along Cañada del Buey in White Rock (Figure 5-7). At each location, we collected several samples from different depths. Table 5-9 provides the information on sediment sample depths. In December, the EPA conducted special sampling of sediments in Ancho, Bayo, Cañada del Buey, Mortandad, Pajarito, and Sandia Canyons. LANL collected split samples at these locations; most of the samples came from outside of the Laboratory boundary (Figure 5-8). See Table 5-9 for information on sediment sample depths.

3. Radiochemical Analytical Results for Sediments

Table 5-10 shows the results of radiochemical analysis of sediment samples collected in 1999. The sample size for most sediment samples is 100 g. Reservoir sample sizes for plutonium-238 and plutonium-239, -240 are 1,000 g, resulting in limits of detection of 0.0001 pCi/g. As discussed in Section 5.F, the analytical laboratory had data quality problems with analysis of strontium-90 for 1999. Therefore, the strontium-90 data appear in a separate table, Table 5-11. To emphasize values that are detections, Tables 5-12 and 5-13 list radiochemical detections for values that are higher than background levels and also identify values that are near or above SALs. Tritium has no established background value for sediments, so Table 5-12 shows all tritium detections. Detections are defined as values exceeding both the analytical method detection limit and three times the individual measurement uncertainty. The analytical laboratory determined analysis-specific detection limits for many radiochemical measurements in 1999, which are listed in Tables 5-3 and 5-4. Individual detection limits were not provided for gross alpha, gross beta, or uranium. Because of analytical laboratory delays, many sediment stations did not have results completed for plutonium-238, plutonium-239, -240, and americium-241 in time for this report; these data will appear in the next report. Except for strontium-90, results from the 1999 sediment sample analysis are generally consistent with historical data.

Strontium-90 was above fallout levels in all 105 sediment samples where it was detected in samples from the Pajarito Plateau and at regional stations in 1999. These high values resulted from problems with a new strontium-90 laboratory technique. Strontium-90 has previously been detected infrequently at most stations.

For 1999, samples from the upper and lower stations in Rio Grande Reservoir (Colorado) had cesium-137 at activities from 20 to 50% above background. In 1998, sediment samples from all three stations in the reservoir contained cesium-137 at activities up to 70% above background. Cesium-137 activity in sediments analyzed from that reservoir in 1996 and 1997 was 20 to 30% greater than background. We detected tritium in two samples at Abiquiu Reservoir at levels from 15 to 30% of the EPA drinking water MCL. Guaje Reservoir sediments contained above background values of gross alpha, gross beta, cesium-137, and uranium. These values were a few percent above background except for uranium, which was about 250% of background. The levels of tritium, strontium-90, plutonium-238, plutonium-239, -240, americium-241, gross beta, and gross gamma in all other reservoirs were below background values.

A sediment sample collected from station Rio Grande at Bernalillo yielded a plutonium-238 value nearly 70% above background. The sample from the Jemez River had a plutonium-238 value slightly above background.

Many 1999 sediment samples from the known radioactive effluent release areas in Acid/Pueblo, DP/Los Alamos, and Mortandad Canyons exceeded background levels for tritium, cesium-137, plutonium-238, plutonium-239, -240, americium-241, gross alpha, gross beta, and gross gamma activities. These levels are consistent with historical data.

Within both Los Alamos and Pueblo Canyon sediments, above-background levels of plutonium are evident for distances greater than 16 km downstream from the sources in Acid and DP Canyons. The contamination extends off-site across San Ildefonso Pueblo lands and reaches the Rio Grande near the Otowi Bridge. Plutonium-238 and plutonium-239, -240 activities downstream of historical release sites in those canyons have remained relatively constant during the past. These patterns have been documented for several decades in Laboratory reports (ESP 1981).

At station DPS-4 in DP Canyon, activities of cesium-137, plutonium-238, and plutonium-239, -240 were about four times background in 1999, consistent with historical data.

At Acid Weir (at the confluence of Acid Canyon and Pueblo Canyon), plutonium-238 was five times background, and plutonium-239, -240 activity was nearly 300 times background (and about one-fourth of the SAL). Americium-241 was five times background. These values are all consistent with historical data.

Plutonium-239, -240 was 42 times background at Pueblo 2, 8 times background at Pueblo 3, and was 47 times greater than background at Pueblo State Road 502. The activities of radionuclides at other sediment stations in Acid/Pueblo Canyons and DP/Los Alamos Canyons in 1999 were near background.

Within Mortandad Canyon, the greatest radionuclide levels in sediments are found between the point where the TA-50 RLWTF effluent enters the drainage (station GS-1) and the sediment traps (MCO-7), approximately a 3-km distance. Radionuclide levels decrease in the downstream direction from TA-50 to the sediment traps. Radionuclide levels near, or slightly exceeding, background levels are found downstream of the sediment traps, extending to the Laboratory/San Ildefonso Pueblo boundary station A-6. Based on mass spectrometry analysis, Gallaher concluded that off-site plutonium contamination at levels near fallout values might extend two miles beyond the Laboratory boundary (Gallaher et al., 1997).

In 1999, sediment samples from GS-1, MCO-5, and MCO-7 in Mortandad Canyon showed cesium-137 concentrations that were up to five times greater than the SAL value. Median values since 1980 for cesium-137 at these stations range up to six times greater than the SAL value. Cesium-137 levels at these stations have declined by factors of five to 35 since the early 1980s because of lower cesium-137 discharges from the RLWTF. The plutonium-239, -240 activity at MCO-5 was over three times the SAL, and plutonium-238 activity was just over the SAL. The validity of these plutonium values is uncertain: duplicate plutonium analyses for this sample from MCO-5 gave results for both plutonium-238 and plutonium-239, -240 that were exactly one-tenth of these unusually high values, and the gross alpha values for the samples do not support the higher plutonium results. During 1999, no other sediment samples in Mortandad Canyon showed any values that exceeded SAL values.

Downstream of the sediment traps at stations MCO-9 and MCO-13 in Mortandad Canyon, plutonium-238 and cesium-137 activities and uranium concentrations were below background values. This result is consistent with data from the last 15 years.

A number of sediment samples in the vicinity and downstream of Area G contained plutonium-238 at activities greater than background. Plutonium-238 was 60 times background at G-9 and more than 20 times background at G-7. G-7, G-9, and G-6R had plutonium-239, -240 activities more than 10 times background. Tritium was also found at G-4 R-1, G-4 R-2, G-7, and TWISP Dome at Silt Fence. The station Pajarito at State Road 4, which is located more than one km downstream of Area G, had cesium-137 and plutonium-239, -240 at levels greater than background and plutonium-238 at nearly 70 times background.

We found plutonium-238 and plutonium-239, -240 at activities greater than background in a number of sediment samples collected at Area AB. Station AB-3 is located immediately downstream of a known surface-contamination area dating to 1960 (Purtymun and Stoker, 1987). At AB-3, plutonium-239, -240 was again nearly 50 times background, and plutonium-238 was three times background activity. These values are consistent with past results.

At Ancho at SR-4, tritium was detected. Chaquehui at Rio Grande and Fence at SR-4 both had detections of cesium-137 and plutonium-239, -240 slightly above background.

We collected sediment samples in White Rock at five sites along Cañada del Buey (Figure 5-7). At site #5 in Overlook Park, we found plutonium-239, -240 at over 30 times background levels. At site #2 on Rover near the stream channel, plutonium-239, -240 was found at twice background.

In December, the EPA conducted special sampling of sediments in Ancho, Bayo, Cañada del Buey, Mortandad, Pajarito, and Sandia Canyons. LANL collected split samples at each station. Sandia Canyon 3 showed a detection of tritium. Bayo Canyon 1 and Sandia Canyon 5 had cesium-137 slightly above background.

The remainder of sediment samples collected at locations at the Laboratory in 1999 were near background levels.

4. Nonradiochemical Analytical Results

a. Trace Metals. Beginning in 1992, we have analyzed sediments for trace metals. Table 5-14 presents trace metal results for the sediment samples collected in 1999.

Several trace metal values for sediments appear to be up to about 1,000 times larger than prior values for the station or values found at nearby stations. The large values could be due to analytical laboratory errors, but no errors were found upon reexamining data packages. At Cochiti Lower, a selenium value of 440 mg/kg contrasts with nondetects at nearby stations and prior measurements of either nondetection or of 0.6 mg/kg. Acid Weir had a lead value of 150 mg/kg, compared with five prior measurements ranging from 15 to 32 mg/kg. The manganese value at Pueblo at SR-4 was reported as 18,563 mg/kg, while six prior values ranged from 200 to 650 mg/kg.

Since 1990, trace metals analysis has indicated the presence of mercury at near detection limit concentrations (0.025 mg/kg) in nearly 200 sediment samples. The largest numbers of those historic samples (from 1990–1998) were from Los Alamos Canyon (22 samples), followed by Mortandad Canyon (21 samples since 1992), Area AB (19 samples), and Area G (15 samples since 1994). In 1999, we did not find mercury in sediments in Los Alamos Canyon, Area G, or Area AB. Mortandad Canyon stations Mortandad West of GS-1, Mortandad at GS-1, and Mortandad at MCO-5 had low levels of mercury, far below the SAL of 23 mg/kg. During the special EPA sampling, mercury was detected in Ancho, Bayo, Cañada del Buey, Mortandad, Pajarito, and Sandia Canyons. The highest value, at Ancho Canyon 1, was 1% of the SAL.

The SAL for arsenic is 19 mg/kg. Several stations show arsenic in sediments at levels larger than about half the SAL, including Heron (7 to 14 mg/kg) and Abiquiu Reservoirs (4 to 11 mg/kg), Pueblo at SR-502 (7.5 mg/kg), and Pajarito at SR-4 (9 mg/kg). Previously, seven arsenic results for Heron Reservoir stations show a mean and maximum of 10.8 and 34 mg/kg; seven samples for Abiquiu Reservoir show a mean and maximum of 4.1 and 8 mg/kg. The three earlier arsenic results for Pueblo at SR-502 have a mean and maximum of 1.4 and 3 mg/kg; seven samples for Pajarito at SR-4 show a mean and maximum of 0.7 and 1.1 mg/kg.

Chromium was found above or near the hexavalent chromium SAL of 30 mg/kg (the total chromium SAL is 210 mg/kg) at Heron, Abiquiu, Cochiti, and Guaje Reservoirs and also during the special EPA sampling in Pajarito and Sandia Canyons. Previously seven chromium results for Heron Reservoir stations show a mean and maximum of 14.6 and 18.1 mg/kg; seven samples for Abiquiu Reservoir show a mean and maximum of 10.7 and 22 mg/kg. Seven earlier chromium results for Cochiti Reservoir stations show a mean and maximum of 14.7 and 22 mg/kg. The three earlier chromium results for Pueblo at SR-502 have a mean and maximum of 7 and 14 mg/kg; seven samples for Pajarito at SR-4 show a mean and maximum of 6.2 and 13 mg/kg.

b. Organic Analysis. Beginning in 1993, we have analyzed sediments for PCB and SVOCs. Some sediment samples have been analyzed for HE constituents since 1995. We analyze samples from only a portion of the sediment stations each year. Table 5-15 lists these samples. The analytical results showed no PCB, SVOCs, or HE constituents detected above the analytical laboratory's reporting limit in any of the sediment samples collected during 1999.

5. Long-Term Trends

For the plots discussed in this section, we show only detections of a particular radionuclide in sediments; samples without such detections are not shown.

Figure 5-9a depicts plutonium-238 activities at five stations in Mortandad Canyon from 1976 to 1999. GS-1, MCO-5, and MCO-7 are located downstream of the

RLWTF discharge point and upstream of the sediment traps. Plutonium-238 activity at GS-1 has decreased by a factor of about 10 during that time period and, except for a 1999 sample at MCO-5, has not exceeded the SAL since 1985. MCO-9 and MCO-13 are located downstream of the sediment traps. Plutonium-238 is infrequently above background at those stations and is not regularly detected.

Figure 5-9b shows plutonium-239, -240 levels on Laboratory lands in Mortandad Canyon. Plutonium-239, -240 levels upstream of the sediment traps have declined by approximately a factor of ten since the 1980s, presumably because of decreased radioactivity in the RLWTF discharges and the dispersion of previously contaminated sediments. Downstream of the sediment traps, plutonium activities have remained relatively constant; the activities are two orders of magnitude less than upstream of the sediment traps and are near background activities.

Figure 5-9c shows that cesium-137 has been present in Mortandad Canyon since the 1970s. Between TA-50 and the sediment traps, cesium-137 levels have often exceeded the SAL but have decreased over the last 25 years. Cesium-137 levels below the sediment traps have gradually declined to near background levels.

D. Groundwater Sampling

1. Introduction

Groundwater resource management and protection efforts at the Laboratory are focused on the regional aquifer underlying the region (see Section 1.A.3) but also consider groundwater found within canyon alluvium and perched at intermediate depths above the regional aquifer. The Los Alamos public water supply comes from supply wells drawing water from the regional aquifer.

The early groundwater management efforts by the USGS evolved through the growth of the Laboratory's current Groundwater Protection Management Program, required by DOE Order 5400.1 (DOE 1988). This program addresses environmental monitoring, resource management, aquifer protection, and hydrogeologic investigations. The Laboratory issued formal documentation for the program, the "Groundwater Protection Management Program Plan," in April 1990 and revised it in 1995 (LANL 1996a). During 1996, the Laboratory developed and submitted an extended groundwater characterization plan, known as the Hydrogeologic Workplan (LANL 1996b), to the NMED. NMED approved the Hydrogeologic Workplan on March 25, 1998. Investigations under the Hydrogeologic Workplan are described in Chapter 2.

Concentrations of radionuclides in environmental water samples from the regional aquifer, the alluvial groundwater in the canyons, and the intermediate-depth perched systems may be evaluated by comparison with DCGs for ingested water calculated from DOE's public dose limit (see Appendix A for a discussion of standards). The NMWQCC has also established standards for groundwater quality (NMWQCC 1993). Concentrations of radioactivity in drinking water samples from the water supply wells, which draw water from the regional aquifer, are compared with New Mexico Environmental Improvement Board (NMEIB) and EPA MCLs or to the DOE DCGs applicable to radioactivity in DOE drinking water systems, which are more restrictive in a few cases.

The concentrations of nonradioactive chemical quality parameters may be evaluated by comparing them with NMWQCC groundwater standards and with the NMEIB and EPA drinking water standards, although these latter standards are only directly applicable to the public water supply. Although it is not a source of municipal or industrial water, shallow alluvial groundwater is a source of return flow to surface water and springs used by livestock and wildlife and may be compared with the Standards for Groundwater or the Livestock Watering and Wildlife Habitat Stream Standards established by the NMWQCC (NMWQCC 1993, NMWQCC 1995). However, it should be noted that these standards are for the most part based on dissolved concentrations. Many of the results reported here are total concentrations (that is, they include both dissolved and suspended solids concentrations), which may be higher than dissolved concentrations alone.

2. Monitoring Network

Groundwater sampling locations are divided into three principal groups, related to the three modes of groundwater occurrence: the regional aquifer, alluvial groundwater in the canyons, and localized intermediate-depth perched groundwater systems. Figure 5-10 shows the sampling locations for the regional aquifer and the intermediate-depth perched groundwater systems. Figure 5-11 presents the sampling locations for the canyon alluvial groundwater systems. Purtymun (1995) described the springs and wells.

Sampling locations for the regional aquifer include test wells, supply wells, and springs. New wells constructed by the Hydrogeologic Workplan activities are not yet part of the monitoring network.

We routinely sample eight deep test wells, completed within the regional aquifer. The USGS drilled these test wells between 1949 and 1960 using the cable tool method. The Laboratory located these test wells where they might detect infiltration of contaminants from areas of effluent disposal operations. These wells penetrate only a few tens or hundreds of feet into the upper part of the regional aquifer. The casings are not cemented because that would seal off surface infiltration along the boreholes.

We collect samples from 13 deep-water supply wells in three well fields that produce water for the Laboratory and community. The well fields include the off-site Guaje well field and the on-site Pajarito and Otowi well fields. The Guaje well field, located northeast of the Laboratory, now contains five wells. With one exception (G-1A), the older wells were retired in 1999 because of their age. Four new wells were drilled in this field in 1998. Three of the former wells and three of the remaining wells had significant production during 1999. The five wells of the Pajarito well field are located in Sandia and Pajarito Canyons and on mesa tops between those canyons. Two wells make up the Otowi well field, located in Los Alamos and Pueblo Canyons. We took additional regional aquifer samples from wells located on San Ildefonso Pueblo.

We sample numerous springs near the Rio Grande because they represent natural discharge from the regional aquifer (Purtymun et al., 1980). As such, the springs serve to detect possible discharge of contaminated groundwater from beneath the Laboratory into the Rio Grande. Based on their chemistry, the springs in White Rock Canyon are divided into four groups, three of which have similar, regional aquifer-related chemical quality. The chemical quality of springs in a fourth group reflects local conditions in the aquifer, probably related to discharge through faults or from volcanics. Sacred Spring is west of the river in lower Los Alamos Canyon.

We sample approximately half of the White Rock Canyon springs each year. Larger springs and springs on San Ildefonso Pueblo lands are sampled annually, with the remainder scheduled for alternate years.

We sample the alluvial groundwater in five canyons (Pueblo, Los Alamos, Mortandad, and Pajarito Canyons, and Cañada del Buey) with shallow observation wells to determine the impact of NPDES discharges and past industrial discharges on water quality. In any given year, some of these alluvial observation wells may be dry, and thus we cannot obtain water samples. Observation wells in Water, Fence, and Sandia Canyons have been mostly dry since their installation in 1989. All but two of the wells in Cañada del Buey are generally dry.

Intermediate-depth perched groundwater of limited extent occurs in conglomerates and basalt at depths of several hundred feet beneath the alluvium in portions of Pueblo, Los Alamos, and Sandia Canyons. We obtain samples from two test wells and one spring. The well and spring locations allow us to monitor possible infiltration of effluents beneath Pueblo and Los Alamos Canyons.

Some perched water occurs in volcanics on the flanks of the Jemez Mountains to the west of the Laboratory. This water discharges at several springs (Armstead and American) and yields a significant flow from a gallery in Water Canyon, where this perched water is sampled. During the winter of 1996–97, a falling tree broke the connecting pipe, and the water now flows down Water Canyon. We now sample the gallery at the point where the pipe broke. Additional perched water extends eastward from the Jemez Mountains beneath TA-16 in the southwestern portion of the Laboratory. The drilling of Hydrogeologic Workplan well R-25 confirmed the existence of this perched water, at a depth of about 750 ft below the mesa top in 1998. The water was found to contain high-explosives compounds resulting from past Laboratory discharges. We are conducting further work to characterize this perched zone.

3. Radiochemical Analytical Results for Groundwater

Table 5-16 lists the results of radiochemical analyses of groundwater samples for 1999. As discussed in Section 5.F, the analytical laboratory had data quality problems with analysis of strontium-90 for 1999. Therefore, the strontium-90 data are presented in a separate table, Table 5-17. LANL strontium-90 values fall into two groups—regular and low-level analyses. Where NMED split sample data are available, we have presented them for comparison.

To emphasize values that are detections, Tables 5-18 and 5-19 list radionuclides detected in groundwater samples. Detections are defined as values exceeding both the analytical method detection limit and three times the individual measurement uncertainty. The analytical laboratory determined analysis-specific detection limits for many radiochemical measurements in 1999, which appear in Tables 5-18 and 5-19. They did not provide individual detection limits for gross alpha, gross beta, or uranium. Because uranium, gross alpha, and gross beta are almost always detected, we indicate in Table 5-18 only occurrences of these measurements above threshold values. The specific levels are 5 μg/L for uranium, 5 pCi/L for gross alpha, and 20 pCi/L for gross beta and are lower than the EPA MCLs or screening levels.

The righthand columns of Tables 5-18 and 5-19 indicate radiochemical detections that are greater than 1/25 of the DOE DCGs for public dose for ingestion of environmental water (1/25 of the DOE DCG for public dose is the DOE drinking water system DCG). The EPA drinking water limits for gross alpha and gross beta values are higher than 1/25 of the DOE public dose DCG (that is, greater than the DOE drinking water system DCGs), so we use the EPA values to screen gross alpha and gross beta values. The DCG value for gross beta is actually the strontium-90 DCG, and the DCG for gross alpha is the plutonium-239, -240 DCG. These DCGs were chosen because the isotopes represented had the lowest DCGs for alpha and beta emitters. No groundwater values exceeded half the DOE public dose DCG values in 1999.

Discussion of results will address the regional aquifer, the canyon alluvial groundwater, and the intermediate-depth perched groundwater system.

a. Radiochemical Constituents in the Regional Aquifer. For samples from wells or springs in the regional aquifer, most of the results for radiochemical measurements were below the DOE drinking water DCGs or the EPA or New Mexico standards applicable to a drinking water system. In addition, most of the results were near or below the detection limits of the analytical methods used. The exceptions are discussed below.

The main detected radioactive element was uranium, found in springs and wells on San Ildefonso Pueblo land. See Section 5.E for a discussion of these values.

Supply wells G-6 and PM-1, Test Wells 3 and 4, and Spring 6A showed apparent detections of americium-241 at low levels. Numerous other surface water, runoff, and groundwater samples had detections of americium-241 at low levels, as did two DI blanks.

Analytical laboratory problems caused many apparent detections of strontium-90 where it has not been seen previously. Levels of strontium-90 exceeding the drinking water MCL of 8 pCi/L were apparently detected in Test Wells 1, 3, 4, 8, DT-9, DT-10, and Sanchez House Well at San Ildefonso Pueblo. Strontium-90 was also detected in Los Alamos water supply wells G-1, G-1A, O-1, O-4, and PM-4 and San Ildefonso Pueblo water supply wells LA-5, Don Juan Playhouse Well, Pajarito Well (Pump 1), and Eastside Artesian Well. Sacred Spring and Spring 8B showed strontium-90 detections. LANL believes that none of these detections are valid and that they are due to analytical laboratory problems. The NMED split samples collected at many of the wells, which show no detection of strontium-90, support this conclusion. The NMED data did show a strontium-90 detection at PM-1.

b. Radiochemical Constituents in Alluvial Groundwater. None of the radionuclide activities in alluvial groundwater are above the DOE DCGs for public dose for ingestion of environmental water. Except for gross beta, americium-241, and strontium-90 values from Mortandad and Los Alamos Canyons, none of the radiochemical measurements exceed DOE DCGs applicable to a drinking water system. Levels of tritium; cesium-137; uranium; plutonium-238; plutonium-239, -240; and gross alpha, beta, and gamma are all within the range of values observed in recent years.

In Pueblo Canyon, samples from APCO-1 showed detections of americium-241 and plutonium-239, -240. This well had plutonium-239, -240 above the detection limit in most years since 1994. We have seen similar values in previous years in surface water and alluvial groundwater in Pueblo Canyon, as a consequence of past Laboratory discharges.

The samples of alluvial groundwater in Los Alamos and DP Canyons show residual contamination, as we have seen since the original installation of monitoring wells in the 1960s. In particular, for LAO-1, LAO-2, and LAO-3A, the activity of strontium-90 usually approaches or exceeds the EPA primary drinking water MCL of 8 pCi/L. Strontium-90 was apparently detected in every alluvial well in Los Alamos and DP Canyons in 1999; most values are suspect because of analytical laboratory problems. Plutonium-239, -240 was not detected in LAO-0.7 for the first year since 1993. A number of wells had detections of low values of americium-241, which may be the result of analytical laboratory problems; numerous other wells, springs, surface water samples, and two blanks had detections in the same range. Several wells showed gross beta activities approaching or exceeding the drinking water screening level of 50 pCi/L.

The alluvial groundwater samples from Mortandad Canyon showed activities of radionuclides within the ranges observed previously. Tritium; strontium-90; cesium-137; plutonium-238; plutonium-239, -240; americium-241; and gross alpha, beta, and gamma are usually detected in many of the wells. The radionuclide levels are in general highest nearest to the TA-50 RLWTF outfall at well MCO-3 and decrease down the canyon. The levels of tritium, strontium-90, and gross beta usually exceed EPA drinking water criteria in many of the wells. In some years, the levels (except for tritium) exceed the DOE drinking water system DCGs, but the levels do not exceed the DOE DCGs for public dose for ingestion of environmental water. EPA has no drinking water criteria for plutonium-238; plutonium-239, -240; or americium-241. Except for americium-241 in MCO-3, the DOE Drinking Water System DCGs for these latter radionuclides were not exceeded in Mortandad Canyon alluvial groundwater in 1999 samples.

PCO-1 had unusual detections of plutonium-238 and americium-241 in a sample taken March 26. A second sample on December 9 did not detect plutonium-238; americium-241 was not analyzed in the second sample. In 16 samples taken since 1985, we have never detected plutonium-238 at this well. Americium-241 was detected only once, in 1995, out of five previous samples analyzed.

Two wells in Cañada del Buey contain little water and in the past often yielded very turbid samples. Except for strontium-90, we detected no radiochemical parameters in these wells in 1999. In 1998, Cañada del Buey well CDBO-6 had detections of gross alpha and gross beta. The 1999 strontium-90 detection is likely the result of analytical laboratory problems.

c. Radiochemical Constituents in Intermediate-Depth Perched Groundwater. In the 1950s, based on measurements of water levels and major inorganic ions, the USGS established that contaminated surface water and alluvial groundwater in Pueblo Canyon recharge the intermediate-depth perched zone water that underlies the canyon floor (Weir et al., 1963; Abrahams 1966). Taken over time, the radionuclide activity measurements in samples from TW-1A, TW-2A, and Basalt Spring in Pueblo and Los Alamos Canyons confirm this connection. TW-2A, furthest upstream and closest to the historical discharge area in Acid Canyon, has shown the highest levels. We detected no tritium in TW-2A in 1999; 1997 and 1999 are the only years since 1991 with no tritium detections. Tritium levels in that well averaged at about 2,590 pCi/L from 1992 through 1996. We found no detectable plutonium-239, -240 in Basalt Spring, TW-1A, or TW-2A, in contrast to earlier years. Strontium-90 was detected in Test Well 2A at a very high value and in Basalt Spring. These detections are likely the result of analytical laboratory problems. The sample from the Water Canyon Gallery, which lies southwest of the Laboratory, was consistent with previous results, showing no evidence of radionuclides from Los Alamos operations.

4. Nonradiochemical Analytical Results

Table 5-20 lists the results of general chemical analyses of groundwater samples for 1999, and results of trace metal analyses appear in Table 5-21.

a. Nonradiochemical Constituents in the Regional Aquifer. With the exceptions discussed here, values for all parameters measured for environmental surveillance sampling in the water supply wells are within drinking water limits. Separate samples were collected from the public water supply system to determine regulatory compliance with the Safe Drinking Water Act, and these samples were all in compliance for 1999 (see Section 2.9).

For well G-2, the fluoride level was over half the standard of 1.6 mg/L and was similar to previous measurements. The vanadium values in new wells G-2A, G-3A, and G-5A were about 60% of the EPA health advisory range of 80 to 110 µg/L. This result, along with detection of cobalt in G-5A, may be due to new well construction.

The test wells in the regional aquifer showed levels of several constituents that approach or exceed standards for drinking water distribution systems. However, it should be noted that the test wells are for monitoring purposes only and are not part of the water supply system. TW-1 had a nitrate value of 5.8 mg/L (nitrate as nitrogen), again below the EPA primary drinking water standard of 10 mg/L. This test well has shown nitrate levels in the range of about 5 to 20 mg/L (nitrate as nitrogen) since the early 1980s. The source of the nitrate might be infiltration from sewage treatment effluent released into Pueblo Canyon or residual nitrates from the now decommissioned TA-45 radioactive liquid waste treatment plant that discharged effluents into upper Pueblo Canyon until 1964. Nitrogen isotope analyses the ER Project made during 1998 indicate that the nitrate is from a sewage source (Nylander et al., 1999).

Six groundwater samples and several surface water samples showed an apparent detection of selenium in 1998. Typically, we have not detected selenium in groundwater on the Pajarito Plateau. Selenium was found in Los Alamos Canyon alluvial groundwater and in each of the three DT series test wells at TA-49. We detected no selenium at these sites in 1999, suggesting that the previous year's values, which were close to the detection limit, did not indicate its presence. In 1999, we detected selenium at low levels at Spring 1 and Spring 9.

Test Well 1 had a lead concentration above the EPA action level and a high antimony concentration, similar to past values attributed to metal flaking from hardware in the well. Levels of trace metals that approach water quality standards in some of the test wells are believed to be associated with turbidity of samples and with the more than 40-year-old steel casings and pump columns. In the last few years, iron, manganese, cadmium, nickel, antimony, and zinc have been high in several of the regional aquifer test wells. The lead levels appear to result from flaking of piping installed in the test wells and do not represent lead in solution in the water (ESP 1996a).

La Mesita Spring had a nitrate value of 5.4 mg/L (nitrate as nitrogen), at the upper limit of past values. Samples collected for metals analysis from most of the White Rock Canyon springs were filtered in 1999. Many of the springs have very low flow rates, and we collected samples in small pools in contact with the surrounding soils. Except for selenium, none of the springs showed trace metals at levels of concern in 1999.

b. Nonradiochemical Constituents in Alluvial Groundwater. The canyon bottom alluvial groundwater in Pueblo, Los Alamos, and Mortandad Canyons receives effluents. The groundwater shows the effects of those effluents in that values of some constituents are elevated above natural levels.

The Mortandad Canyon groundwater samples in Table 5-20 exceeded or approached the NMWQCC Groundwater Standards for fluoride and nitrate. The nitrate source is nitric acid from plutonium processing at TA-55 that enters the TA-50 waste stream. In response to a letter of noncompliance from the NMED, in March 1999 the RLWTF instituted a program to restrict the discharge of nitrogenous wastes into the facility's collection system. As shown in Figure 5-12, the nitrate (nitrate as nitrogen) concentration of effluent discharge from the RLWTF after March 21, 1999, was less than 10 mg/L.

Under the Laboratory's groundwater discharge plan application for the RLWTF, we collected separate samples for nitrate, fluoride, and TDS bimonthly from four alluvial monitoring wells in Mortandad Canyon during 1999: MCO-3, MCO-4B, MCO-6, and MCO-7. We reported the analytical results quarterly to the NMED. During 1999, nitrate concentrations in alluvial groundwater wells MCO-3, MCO-4B, and MCO-6 displayed a downward trend, as Figure 5-12 shows. By December 1999, nitrate concentrations at these three wells were below the NMWQCC Groundwater Standard for nitrate of 10 mg/L (nitrate as nitrogen). Beginning in June 1999, fluoride concentrations in discharged effluent and at all four wells were below the NMWQCC Groundwater Standard for fluoride of 1.6 mg/L, as shown in Figure 5-12.

The pH in PCO-1 was again below the EPA secondary drinking water range of 6.8–8.5. The pH of CDBO-6 was reported as 1.7, with a conductance reported as 11,600 µS/cm. Neither of these values is realistic; both probably represent analytical laboratory aberrations. Usual values are pH of 7.3 and conductance of 200 µS/cm.

In 1998, we detected beryllium and barium in Cañada del Buey wells CDBO-6 and CDBO-7. We also found lead at high levels in these wells in 1998. We found none of these constituents in 1999, possibly because the samples were much less turbid as a result of lower pumping rates during sampling.

LAO-3A continued to show levels of molybdenum just below the New Mexico Groundwater Limit. LAO-5 had a detection of beryllium below the EPA drinking water MCL, and MT-3 had a value just above the MCL.

c. Nonradiochemical Constituents in Intermediate-Depth Perched Groundwater. In 1999, the nitrate values for TW-2A and Basalt Spring were well below NMWQCC Groundwater and EPA Drinking Water Standards. These sample locations have occasionally shown higher nitrate values in recent years. The source of the nitrate is infiltration of contaminated surface water and shallow groundwater from Pueblo Canyon.

TW-2A again had levels of iron, lead, manganese, and zinc approaching or exceeding water quality standards. The detection of metals in these test wells probably reflects either suspended sediments or the flaking of metals from pump hardware and the well casing rather than the existence of dissolved metals in the groundwater. Otherwise, the intermediate-depth perched groundwater samples from these stations and the Water Canyon gallery did not show any concentrations of nonradiochemical constituents that are of concern.

d. Organic Constituents in Groundwater. We performed analyses for organic constituents on selected springs and test wells in 1999. The stations sampled appear in Table 5-22. Some samples were analyzed for VOCs, SVOCs, and PCBs. Water supply wells, test wells, and most springs were analyzed for HE constituents. No organic or high-explosive constituents were found above the analytical laboratory's reporting limit in the groundwater samples listed in Table 5-22. We rejected most of the possible organic detections reported by the analytical laboratory because the compounds were either detected in method blanks (that is, they were introduced during laboratory analysis) or detected in trip blanks. Trip blanks go along during sampling to determine if organic constituents come from sample transportation and shipment.

e. Special Water Supply Sampling. In 1998, drilling of characterization well R-25 at TA-16 in the southwest portion of the Laboratory revealed the presence of high-explosive constituents at concentrations above the EPA Health Advisory guidance values for drinking water. As a result, the Laboratory tested all nearby water supply wells for these compounds. None of the analytical laboratories detected any high explosives or their degradation products in any of the water samples from any of the supply wells sampled. In 1999, because of continuing concerns over possible contamination of the regional aquifer, LANL implemented quarterly sampling of some water supply wells for selected constituents. Table 5-23 lists the dates and constituents sampled. PM-2, 4, and 5 are closest to R-25 where HE was found in groundwater in 1998. We did not find HE in any of the water supply well samples in 1999. Samples from PM-1 and O-4 showed strontium-90 and PM-2 and PM-5 showed no perchlorate during 1999. The Analytical Chemistry Sciences Group (CST-9) analyzed these strontium-90 samples.

5. Long-Term Trends

a. Regional Aquifer. The long-term trends of the water quality in the regional aquifer have shown limited impact resulting from Laboratory operations. In 1998, drilling characterization well R-25 at TA-16 in the southwest portion of the Laboratory revealed the presence of high-explosive constituents. No high-explosive constituents have been found in water supply wells. The extent of high explosives in the regional aquifer is presently unknown. The Laboratory is working in cooperation with regulatory agencies to define the extent of the contamination and ensure that drinking water supplies are adequately protected.

Aside from naturally occurring uranium, the only radionuclide we consistently detected in water samples from production wells or test wells within the regional aquifer is tritium, which is found at trace levels. We have found tritium contamination at four locations in Los Alamos and Pueblo Canyons and one location in Mortandad Canyon. The tritium levels measured range from less than 2% to less than 0.01% of current drinking water standards, and all are below levels detectable by the EPA-specified analytical methods normally used to determine compliance with drinking water regulations.

Other measurements of radionuclides above detection limits in the regional aquifer reflect occasional analytical outliers not confirmed by analysis of subsequent samples.

Nitrate concentrations in TW-1 have been near the EPA MCL since 1980. The source of the nitrate might be infiltration of sewage-effluent-contaminated shallow groundwater and surface water in Pueblo Canyon or residual nitrates from the now decommissioned TA-45 radioactive liquid waste treatment plant that discharged effluents into upper Pueblo Canyon until 1964.

b. Surface Water and Alluvial Groundwater in Mortandad Canyon. Figure 5-13 depicts long-term trends of radionuclide concentrations in surface water and shallow alluvial groundwater in Mortandad Canyon downstream from the outfall for the RLWTF at TA-50. Because of strong adsorption to sediments, cesium-137 is not detected in groundwater samples. The figure only shows radionuclide detections. If more than one sample was collected in a year, the average value for the year is plotted. The surface water samples are from the station Mortandad at GS-1, a short distance downstream of the TA-50 effluent discharge. Radioactivity levels at this station vary daily depending on whether individual samples are collected shortly after a release from the RLWTF. These samples also vary in response to changes in amount of runoff from other sources in the drainage. The groundwater samples are from observation well MCO-5 in the middle reach of the canyon. Groundwater radioactivity at MCO-5 is more stable than at Mortandad at GS-1 because groundwater responds more slowly to variations in runoff water quality.

Chemical reactions such as adsorption do not delay tritium transport, and high tritium activities are found throughout the groundwater within the Mortandad Canyon alluvium. The tritium level in MCO-5 in 1999 was above the EPA MCL of 20,000 pCi/L. The surface water tritium activity at Mortandad at GS-1 reflects diluted values of effluent from TA-50 as the effluent mixes with other stream water. The tritium activity at MCO-5 has fluctuated almost in direct response (with a time lag of about one year) to the average annual activity of tritium in the TA-50 outfall effluent. Tritium values at both stations have decreased since the mid-1980s because of decreased tritium content of the TA-50 effluent.

The americium-241 activity of RLWTF discharges has exceeded the DOE DCG for public dose of 30 pCi/L for all but four years since 1973. Americium-241 activity has not been measured regularly at monitoring stations in Mortandad Canyon. Under many environmental conditions, americium is less strongly adsorbed than cesium or strontium and moves more readily in groundwater. The americium-241 activity in the observation wells was below the DOE drinking water DCG of 1.2 pCi/L. Data for the last four years at Mortandad at GS-1 show an increase in americium-241 activity to near the DOE DCG for public dose, but the value decreased in 1999. At MCO-5, the americium-241 activity shows only a slight increase over the past few years.

We detected plutonium isotopes at Mortandad at GS-1, MCO-3, and MCO-7.5 in 1999 but at no other alluvial observation wells. Both isotopes have been detected at Mortandad at GS-1 and MCO-3 at levels near the DOE public dose DCGs (30 pCi/L for plutonium-239, -240 and 40 pCi/L for plutonium-238) over the past few years. Values at other alluvial observation wells except for MCO-4 and MCO-7.5 have been near the detection limit in the 1990s. Plutonium has in general been detected in all alluvial observation wells in Mortandad Canyon but appears to be decreasing in activity at downstream locations. We last detected plutonium-238 in MCO-8 in 1976 and in MCO-7 and MCO-7.5 in 1985. Plutonium-239, -240 was last detected in MCO-8 in 1969, MCO-7.5 in 1987, and MCO-7 and MCO-7A in 1995.

E. Groundwater and Sediment Sampling at San Ildefonso Pueblo

To document the potential impact of Laboratory operations on lands belonging to San Ildefonso Pueblo, DOE entered into a Memorandum of Understanding (MOU) with the Pueblo and the Bureau of Indian Affairs in 1987 to conduct environmental sampling on pueblo land. This section deals with hydrologic and sediment sampling. Figures 5-14 and 5-15 show the groundwater, surface water, and sediment stations sampled on San Ildefonso Pueblo. Aside from stations shown on those figures, the MOU also specifies collection and analysis of additional water and sediment samples from sites that have long been included in the Laboratory's Environmental Surveillance Program, as well as special sampling of storm runoff in Los Alamos Canyon. These locations appear in Figures 5-1, 5-2, 5-3, 5-5, and 5-10. We discuss the results of these analyses in previous sections. Some sediment samples were collected in 1999 during sampling with the EPA in December. The locations of these samples are shown in Figure 5-8, and we discuss the results in Section 5.C.

1. Groundwater

Table 5-16 lists the results of radiochemical analyses of groundwater samples for 1999. As discussed in Section 5.F, the analytical laboratory had data quality problems with analysis of strontium-90 for 1999. Therefore, the strontium-90 data are presented in a separate table, Table 5-17. LANL strontium-90 values fall into two groups—regular and low-level analyses. Where NMED split sample data are available, we present them for comparison.

To emphasize values that are detections, Tables 5-18 and 5-19 list radionuclides detected in groundwater samples. Detections are defined as values exceeding both the analytical method detection limit and three times the individual measurement uncertainty. The analytical laboratory determined analysis-specific detection limits for many radiochemical measurements in 1999, which are listed in Tables 5-18 and 5-19. They did not provide individual detection limits for gross alpha, gross beta, or uranium. Because uranium, gross alpha, and gross beta are almost always detected, we indicate in Table 5-18 only occurrences of these measurements above threshold values. The specific levels are 5 µg/L for uranium, 5 pCi/L for gross alpha, and 20 pCi/L for gross beta and are lower than the EPA MCLs or screening levels.

The righthand columns of Tables 5-18 and 5-19 indicate radiochemical detections that are greater than 1/25 of the DOE DCGs for public dose for ingestion of environmental water (1/25 of the DOE DCG for Public Dose is the DOE drinking water system DCG).

The EPA drinking water limits for gross alpha and gross beta values are higher than 1/25 of the DOE public dose DCG (that is, greater than the DOE drinking water system DCGs), so we use the EPA values to screen gross alpha and gross beta values. The DCG value for gross beta is actually the strontium-90 DCG, and the DCG for gross alpha is the plutonium-239, -240 DCG. These DCGs were chosen because the isotopes represented had the lowest DCGs for alpha and beta emitters. No groundwater values exceeded half the DOE public dose DCG values in 1999.

See Section 5.D for a discussion of most of the groundwater stations (wells and springs) listed in the MOU. The present section focuses on the San Ildefonso Pueblo water supply wells.

As in previous years, the groundwater data for San Ildefonso Pueblo indicate the widespread presence of naturally occurring uranium at levels approaching or in excess of proposed EPA drinking water limits. Naturally occurring uranium concentrations near or even much greater than the proposed MCL of 20 μg/L are prevalent in well water throughout the Pojoaque area and San Ildefonso Pueblo. The high gross alpha readings for these wells are related to uranium occurrence.

In 1999, we did not detect radionuclides other than uranium in San Ildefonso Pueblo water supply wells. In previous years, San Ildefonso Pueblo water supply well data have suggested the occasional detection of trace levels of plutonium and americium. In most cases, these values are near the detection limit of the analytical method so that it is uncertain whether detection has occurred. At such measurement levels, precise quantification of the amount detected is not possible.

New Community Well again had a uranium concentration exceeding the proposed EPA primary drinking water standard of 20 μg/L. Uranium concentrations at the Don Juan Playhouse and Sanchez House Wells were more than half of the proposed EPA standard. Pajarito Pump 1 has had similar values but because of a high analytical uncertainty, the 1999 uranium value was not a detection. These measurements are consistent with the levels in previous samples and with the relatively high levels of naturally occurring uranium in other wells and springs in the area.

The gross alpha levels in these wells are attributable to the presence of uranium. The gross alpha values in the wells were above the EPA primary drinking water standard of 15 pCi/L but were not detections because of high analytical uncertainties. This standard applies to gross alpha from radionuclides other than radon and uranium.

Analytical laboratory problems caused many apparent detections of strontium-90 where it has not been seen previously. A value of strontium-90 exceeding the drinking water MCL of 8 pCi/L was apparently detected in Sanchez House Well. Strontium-90 was also detected in San Ildefonso Pueblo water supply wells LA-5, Don Juan Playhouse Well, Pajarito Well (Pump 1), and Eastside Artesian Well. LANL believes that none of these detections are valid, and that they are due to analytical laboratory problems. The NMED split samples collected at LA-5 and Sanchez House Well, which show no detection of strontium-90, support this conclusion.

The chemical quality of the groundwater, shown in Table 5-20, is consistent with previous observations. The sample from the Pajarito Pump 1 Well exceeded the drinking water standard for total dissolved solids; this level is similar to those previously measured. This well also has a chloride concentration at 70% of the New Mexico Groundwater Limit.

The fluoride values for some wells (Eastside Artesian and Sanchez House) are near the NMWQCC Groundwater Standard of 1.6 mg/L, similar to previous values. Several of the wells (Eastside Artesian and Don Juan Playhouse) have alkaline pH values above the EPA secondary standard range of 6.8 to 8.5; these values do not represent a change from those previously observed in the area.

Many of the wells have sodium values significantly above the EPA health advisory limit of 20 mg/L. The values from Pajarito Pump 1, Sanchez House, and Eastside Artesian Wells are especially high.

Table 5-21 shows trace metal analyses. The boron value in Pajarito Pump 1 was nearly twice the NMWQCC Groundwater Limit of 750 μg/L. This value was similar to those of past years.

2. Sediments

We collected sediments from San Ildefonso Pueblo lands in Mortandad Canyon in 1999 from several stations. The results of radiochemical analysis of sediment samples collected in 1999 appear in Table 5-10. As discussed in Section 5.F, the analytical laboratory had data quality problems with analysis of strontium-90 for 1999. Therefore, the strontium-90 data are presented in a separate table, Table 5-11. To emphasize values that are detections, Tables 5-12 and

5-13 list radiochemical detections for values that are higher than background levels and also identify values that are near or above SALs. Tritium has no established background value for sediments, so all tritium detections are shown in Table 5-12. Detections are defined as values exceeding both the analytical method detection limit and three times the individual measurement uncertainty. The analytical laboratory determined analysis-specific detection limits for many radiochemical measurements in 1999, which are listed in Tables 5-3 and 5-4. They did not provide individual detection limits for gross alpha, gross beta, or uranium. Because of analytical laboratory delays, many sediment stations did not have results completed for plutonium-238; plutonium-239, -240; and americium-241 in time for this report. Section 5.C presents related information. Results are comparable to sediment data collected from these same stations in previous years; exceptions are discussed below.

All sediment stations in Mortandad Canyon on San Ildefonso Pueblo lands showed only background activities of radionuclides. Sediments from the sampling station located on San Ildefonso Pueblo lands at Los Alamos at Otowi again showed the activity of plutonium-239, -240 as nearly twice background. This activity is slightly less than typical sediment samples previously collected at that station.

F. Sampling Procedures, Analytical Procedures, Data Management, and Quality Assurance

1. Sampling

The Draft Quality Assurance Project Plan (ESH-18 1996) is the basic document covering sampling procedures and quality assurance (QA). The formal procedures developed to address sampling for each sample matrix (Mullen and Naranjo 1996, 1997) provide more focused guidance. All sampling is conducted using strict chain-of-custody procedures, as described in Gallaher (1993). The completed chain-of-custody form serves as an analytical request form and includes the requester or owner, sample barcode number, program code, date and time of sample collection, total number of bottles, the list of analytes to be measured, and the bottle sizes and preservatives for each analysis required. We send the samples to the Chemical Science and Technology (CST) Division or to other analytical laboratories. Detailed analytical methods are published in Gautier (1995). We submit samples using blind sample numbers to prevent possible bias that might occur if the analyst knows the sampled location.

We filtered in the field samples collected for radionuclide and metals analysis at the White Rock Canyon Springs to minimize the effects of surface soils and to represent groundwater surfacing at the springs. The "F/UF" column on the tables of analytical results shows a "UF" for unfiltered samples and an "F" for samples filtered through a 0.45-micron filter.

We filtered in the field surface water samples collected for metals analysis. This procedure allows for comparison of analytical results with the NMWQCC standards. These standards are mainly for dissolved concentrations, except mercury and selenium, for which standards are based on total concentrations. Mercury and selenium were not filtered in the field and were analyzed to determine total concentration.

Automated samplers located at recently installed gaging stations (Shaull et al., 1999) collected runoff. The contents of bottles collected by the automated sampler were first transferred to a churn splitter, which agitates the samples to ensure that they are well mixed and that the sediments are suspended. If the automated sampler collected adequate water, we submitted two sets of samples to the analytical laboratory. One set was unfiltered and preserved for total concentration analysis, whereas the other set was submitted unfiltered and unpreserved. The analytical laboratory filtered the latter samples, preserved them, and routed them to the appropriate analyst. If insufficient water was available, only unfiltered samples were analyzed to determine total concentrations.

2. Analytical Procedures

a. Metals and Major Chemical Constituents. Metals and major chemical constituents are analyzed using EPA SW-846 methods. Filtering in the analytical laboratory and digestion methods (breaking down the solids by acid) have changed over time. Before 1993, water samples were preserved in the field and filtered in the laboratory before digestion. From 1993 forward, the analytical laboratory has not filtered water samples submitted for metals analyses, with the exception of runoff samples as mentioned above.

b. Radionuclides. Radiochemical analysis is performed using the methods as updated in Gautier (1995). Sediment samples are screened through a number 12 US standard testing sieve before digestion. The sieve meets ASTM E-11 specifications and screens out materials larger than 1.7 mm. Ten-g samples are analyzed from stream channels; larger 1,000-g samples are analyzed from reservoirs for plutonium-238 and plutonium-239, -240. Larger 1,000-g samples give a 10-fold improvement in detection limits of plutonium-238 and plutonium-239, -240 for reservoir samples.

We preserve water samples for radiochemical analyses with nitric acid in the field to a pH of 2 or less. Before 1996, the analytical laboratory filtered water samples before digesting. Samples collected in 1996 and after are preserved in the field as before but the analytical laboratory does not filter them. At the analytical laboratory, both water and sediment samples are completely digested in a mixture of nitric and hydrofluoric acids. We collect a separate, unpreserved sample for tritium analysis.

When especially precise trace-level tritium analyses are required, we ship samples to the University of Miami Tritium Laboratory. These samples are collected and analyzed according to procedures described in Tritium Laboratory (1996).

Negative values are reported for some radiological measurements. Negative numbers occur because measurements of radiochemical samples require that analytical or instrumental backgrounds be subtracted to obtain net values. Consequently, individual measurement values can result in positive or negative numbers. Although negative values do not represent a physical reality, we report them as they are received from the analytical laboratory. Valid long-term averages can be obtained only if negative values are included in the analytical results.

c. Organics. Organics are analyzed using SW-846 methods as shown on Table A-9. This table shows the number of analytes included in each analytical suite. Tables A-10 through A-13 list the specific compounds that are analyzed in each suite. All organic samples are collected in brown glass bottles, and the VOC samples are preserved with hydrochloric acid. A trip blank, or field blank, always accompanies the VOC sample. A trip blank is a sample of de-ionized water that accompanies the field samples and is submitted for analysis like any other sample. The analytical laboratory prepares method blanks and also analyzes them with samples. If trip or method blanks contain organic compounds, they were introduced during sampling or analytical procedures. Certain organic compounds used in analytical laboratories are frequently detected in the method blanks. These compounds include acetone, methylene chloride, toluene, 2-butanone, di-n-butyl phthalate, di-n-octyl phthalate, and bis (2-ethylhexyl) phthalate (Fetter 1993).

3. Data Management and Quality Assurance

a. Data Management. CST transfers analytical results to the Water Quality and Hydrology Group (ESH-18) both electronically and as a hard copy. Samples submitted to CST go through the SQL Laboratory Information Management System. A data retrieval query generates a table of ESH-18 data every week. The data set is downloaded to ESH-18 computers every week. The sample location name, the sample number, and the field data are stored in a separate table, providing the link for associating a blind sample number with a location name.

b. Strontium-90 Data for 1999. Because of concern about possible presence of strontium-90 in water samples from the regional aquifer, in 1998 ESH-18 requested CST-9 to find a new analytical technique with a lower detection limit. They instituted a new technique for 1999 strontium-90 samples. Once 1999 analytical results became available, ESH-18 determined that numerous analytical values for strontium-90 were probably significantly in error. Based on comparison with previous data for particular stations, comparison with data obtained by the NMED Oversight Bureau, and review of analytical laboratory results and procedures, ESH-18 concluded that the entire strontium-90 data set for surface water, runoff, groundwater, and sediments for 1999 is not valid.

The data at every location for 1999 are questionable, and this represents the loss of an entire year's monitoring data. We present the data in this report for documentary purposes only. Taken at face value, the 1999 strontium-90 values would indicate unusually high levels in sediments, surface water, and groundwater. LANL has resolved the analytical laboratory problems and will continue monitoring strontium-90 in 2000.

Results in Table 5-24 show a high analytical bias for strontium-90. Ideally, the values for the blanks should be zero; strontium-90 was detected in several of the blanks. Table 5-24 also shows the reported concentrations of strontium-90 in the spiked samples. The reported concentrations range from about 15% to 90% of the actual spiked concentration.

ESH-18 questioned the analytical results that indicated the presence of strontium-90 in a number of water samples. The levels of strontium-90 could not be confirmed with reanalysis of a portion of those same samples. A Corrective Action Request (CAR) was initiated so that a thorough investigation could examine potential problems associated with the data sets in question. CST-9 wrote the draft CAR and dated it August 10, 2000. The CAR concludes that the analytical method, which employs selective extraction resins, may not be adequate for analysis of strontium-90 in the samples submitted for analysis.

A review of the analytical laboratory's data packages and standard operating procedures by the DOE Analytical Management Program, dated August 6, 2000, indicated several problems with the analyses that "very likely…result in erroneously high strontium-90 results." The DOE review points out operating procedures involving the extraction efficiencies of the resins that could lead to deleterious effects on resulting strontium-90 data. That review also outlined several other reasons for erroneous strontium-90 results.

c. Quality Assurance. Each analytical batch of water samples (20 samples or less) contains at least one blank, one matrix spike, and a duplicate as dictated by SW-846 protocols. CST provides these quality control samples and submits them along with environmental surveillance samples. ESH-18 also submits blanks, spikes, and duplicate water samples. Tables 5-25 and 5-26 present the analytical results of the blanks and spikes. The analytical results for the duplicates are presented on the analytical result tables. No quality control samples were submitted for sediment analysis.

ESH-18 submits DI trip blanks and spiked samples as regular samples, without any indication that they are QC samples. They go through the same analytical process as the regular field samples. The DI blanks and spiked samples are measured with the same background contributions from reagents and biases as the regular samples and give an estimate of background and systematic analytical errors.

We also submit trip blanks to detect if any organics are inadvertently introduced during the sampling or analytical laboratory procedures.

Results in Table 5-25 show a high analytical bias of several analytes. Ideally, the values for all analytes in the blanks should be zero. A high bias of 20% of the detection limit is apparent in the uranium DI blank results. A high bias of 25% and 35%, respectively, is apparent in the plutonium-238 and plutonium-239 DI blank results, and a high bias of 50% is observed in the americium-241 DI blanks during the analysis procedure. The likely causes for the unaccounted for concentrations for americium-241 are the plutonium-242 and americium-247 tracers that are added to each sample. Both of those tracers contain americium-241.

The concentrations reported in Table 5-25 for the spiked samples are the concentrations after subtraction of the average blank values. For plutonium-238 the agreement is good, relative to their respective detection limits, between the analytical results and the spiked concentrations after blank correction. The indicated activity of plutonium-239 in the DI blanks was nearly 20% more than the actual spiked concentration, and americium-241 was 30% greater.

Taylor (1987) suggests a method for evaluating detection limits based on the analytical results for spiked samples. The standard deviation of the average spiked sample result can be used as a measure of the one sigma analytical uncertainty. Results of this analysis are presented in the last two lines on Table 5-25. Detection limits calculated using this method are nearly identical to the values the analytical laboratory reported for cesium-137, plutonium-238, and plutonium-239. The calculated detection limit for americium-241 is nearly twice as high as the laboratory detection limit.

Analytical concentrations for DI blanks submitted for trace metals were generally reported as less-than-detection limits. Spiked samples for metals analyses contained four metals: silver, barium, mercury, and lead. The agreement between the spiked concentration of barium and the analytical results was generally good. The spiked concentrations of mercury and silver were, respectively, 21% and 28% less than their spiked concentrations. Standard deviations associated with the average values of barium and mercury for the DI blanks and spiked samples were significantly less than the reported concentrations, suggesting relatively precise measurements for those analytes.

QA samples were spiked with lead at a concentration of 7.5 μg/L. The analytical laboratory, however, did not report lead concentrations of less than 60 μg/L.

4. Determination of Radiochemical Detections

CST has determined detection limits for each analytical method. Radiological detection limits are based on Currie's formula (Currie 1968). Detection limits appear at the bottom of the tables summarizing the radiochemical analytical results. In deriving the detection limits, CST included the average uncertainties associated with the entire analytical method. Sources of error considered include average counting uncertainties, sample preparation effects, digestion, dilutions, gravimetric and pipetting uncertainties, and spike recoveries.

While these method detection limits determined by CST or other analytical laboratories give an idea of the average limit of detection for a particular measurement technique, the detection limits do not apply to each individual sample measurement. Instead, the question of whether or not an individual measurement is a detection is evaluated in light of its individual measurement uncertainty. For radiochemical analytical results, the analytical uncertainties are reported in the tables. These uncertainties represent a one standard deviation (one sigma) propagated uncertainty. “It is virtually unanimously accepted that an analyte should be reported as present when it is measured at a concentration three-sigma or more above the corresponding method blank.” (Keith 1991) Our reported values are corrected by blank subtraction to eliminate the effects of positive or negative analytical laboratory biases. Therefore, we report radiochemical detections as values greater than three times the reported uncertainty. For sediments, the values reported as detections in the table are also above background levels determined for fallout (or natural background levels in the case of uranium).

The limit of quantification or LOQ is the level where the concentration of an analyte can be quantified with confidence. “When the analyte signal is 10 or more times larger than the standard deviation of the measurements, there is a 99% probability that the true concentration of the analyte is ±30% of the calculated concentration.” (Keith 1991) Thus, measured values near the detection limit or less than 10 times the analytical uncertainty do not provide a reliable indication of the amount present. The importance of this number is demonstrated when analytical results are compared against standards; the analytical result should be greater than 10 times the analytical uncertainty for the comparison to be meaningful.

G. Unplanned Releases

ESH-18 investigated all unplanned releases of nonradioactive liquid. Upon cleanup, personnel from NMED-DOE/OB (Oversight Bureau) inspected the unplanned release site to ensure adequate cleanup. NMED-DOE/OB recommended administrative closure of five of the six unplanned releases that occurred in 1999. It is anticipated that the other unplanned release investigation will be closed when NMED-DOE/OB personnel become available for inspections.

1. Radioactive Liquid Materials

No unplanned radioactive liquid releases occurred in 1999.

2. Nonradioactive Liquid Materials

There were six unplanned releases of nonradioactive liquid in 1999. The following is a summary of these discharges.

- Three unplanned releases of potable water that impacted a solid waste management unit or potential release site.
- Two unplanned releases of sanitary sewage from the Laboratory’s TA-46, SWS Facility’s collection system.
- One unplanned release of steam condensate to a solid waste management unit or potential release site.

H. Special Studies

Surface water discharge data were collected from approximately 50 stream-gaging stations that cover most of the Laboratory. Gaging stations with discharge rating data published in the report “Surface Water Data at Los Alamos National Laboratory: 1999 Water Year” (Shaull et al., 2000), show less runoff than do data for the 1998 water year. Water chemistry data from storm events occurring at some stations are also published in the Laboratory’s annual environmental surveillance report, not in the Surface Water Data report.

The annual water data report from LANL contains flow data. The data collection focused on the Laboratory’s downstream boundary, close to State Road 4; the upstream boundary is approximated by State Road 501 and stations located within the Laboratory. Station data is only published for gages that have been rated. Group ESH-18, along with the USGS Water Resources Division, developed and installed the initial nine-station stream-gaging network and designed and installed the necessary data collection structures. This network has grown to 61 stations and is operated and maintained by the Storm Water Team of ESH-18.

Table 5-1. Radiochemical Analysis of Surface Water and Runoff Samples for 1999 (pCi/L[a])

Station Name	Date	Matrix[b]	Code[c]	F/UF[d]	^{3}H		^{137}Cs		U (μg/L)		^{238}Pu		^{239,240}Pu		^{241}Am		Gross Alpha		Gross Beta		Gross Gamma	
Regional Stations																						
Rio Chama at Chamita	06/16	SW	1	UF	–20	590	0.28	0.68	1.21	0.05	0.008	0.007	0.003	0.010	0.063	0.015	2.6	2.1	3.4	2.4	66	51
Rio Chama at Chamita	06/16	SW	1D	UF					1.10	0.11												
Rio Chama at Chamita	06/16	SW	2	UF	170	610	0.92	0.86	1.17	0.07	0.015	0.007	0.014	0.008	0.036	0.010	2.2	2.0	3.2	2.3	70	51
Rio Chama at Chamita	06/16	SW	2D	UF					1.07	0.11												
Rio Grande at Embudo	10/05	SW	1	UF	0	600	0.42	0.70	1.50	0.30	0.002	0.010	0.017	0.010	0.009	0.005	2.1	1.4	3.9	2.8	39	49
Rio Grande at Otowi Upper (bank)	08/03	SW	1	UF	–20	610	0.57	1.05	2.24	0.22	0.025	0.018	0.008	0.010	–0.024	0.075	19.2	8.6	32.7	13.9	154	51
Rio Grande at Otowi Upper (bank)	08/03	SW	1D	UF					2.60	0.30												
Rio Grande at Otowi (bank)	08/03	SW	1	UF	–130	610	2.51	1.99	2.54	0.25	0.007	0.008	0.016	0.010	–0.004	0.003	12.9	5.3	20.1	7.9	184	51
Rio Grande at Otowi (bank)	08/03	SW	1D	UF					3.00	0.20												
Rio Grande at Frijoles (bank)	09/22	SW	1	UF	–10	610	0.00	7.29	2.00	0.20	–0.003	0.008	0.010	0.008	0.021	0.008	3.9	2.0	6.4	3.2	45	49
Rio Grande at Frijoles (bank)	09/22	SW	2	UF	320	630	0.00	10.00	1.70	0.10	0.001	0.010	0.005	0.007	–0.012	0.008	5.7	3.3	7.5	5.5	34	48
Rio Grande at Cochiti	09/23	SW	1	UF	160	620	–0.92	7.37	2.10	0.10	0.004	0.006	0.003	0.012	0.005	0.003	6.0	3.4	9.2	5.7	39	49
Jemez River	08/02	SW	1	UF	–50	610	1.81	1.36	1.53	0.15	0.021	0.013	0.033	0.014	0.001	0.002	12.6	5.2	18.0	7.5	154	51
Jemez River	08/02	SW	1D	UF					1.50	0.20												
Jemez River	08/02	SW	2	UF	50	620	0.00	7.41	1.34	0.13	–0.017	0.021	0.006	0.015	0.039	0.011	14.5	6.6	16.0	9.0	90	51
Jemez River	08/02	SW	2D	UF					1.40	0.30												
Pajarito Plateau																						
Guaje Canyon:																						
Guaje Canyon	11/16	SW	1	UF	–50	580	–0.60	2.90	–0.14	0.05	0.004	0.013	0.013	0.010	0.007	0.004	0.3	2.2	1.6	1.5	6	49
Acid/Pueblo Canyon:																						
Acid Weir	06/23	SW	1	UF	220	610	0.00	7.91	0.20	0.70	0.003	0.015	0.528	0.045	0.033	0.009	1.3	1.3	19.9	5.8	111	52
Pueblo 1	06/23	SW	1	UF	230	610	1.36	1.26	–0.02	0.70	0.018	0.014	0.035	0.015	–0.008	0.006	7.3	3.0	16.6	5.1	133	52
Pueblo 3	05/20	SW	1	UF	20	590	1.46	1.21	0.30	0.05	0.004	0.017	0.037	0.016	–0.010	0.030	1.6	2.8	11.6	6.7	63	51
Pueblo 3	05/20	SW	1D	UF					0.51	0.05												
Pueblo at SR-502	08/03	SW	1	UF					0.04	0.05												
Pueblo at SR-502	08/04	SW	1	UF	150	630	2.38	1.51	0.34	0.03	0.011	0.009	0.129	0.020	0.015	0.006	1.1	1.2	16.2	9.0	175	51
Pueblo at SR-502	08/04	SW	1D	UF					0.05	0.05												
Pueblo at SR-502	12/01	SW	1	UF	–130	590	–0.95	5.67	0.20	0.10	0.007	0.010	0.006	0.014	0.016	0.006	0.7	8.6	13.6	6.5	25	49
DP/Los Alamos Canyon:																						
Los Alamos Canyon Reservoir	06/23	SW	1	UF	30	600	–0.22	4.97	0.05	0.70	0.010	0.011	–0.004	0.005	0.010	0.004	0.9	1.1	6.4	3.0	150	52
Los Alamos at Upper Gaging Station	05/26	SW	1	UF	–50	590	0.00	5.88	0.24	0.02	0.001	0.005	0.051	0.015	0.026	0.010	1.3	1.8	3.7	2.6	145	51
Los Alamos at Upper Gaging Station	05/26	SW	1D	UF					0.10	0.05												

Table 5-1. Radiochemical Analysis of Surface Water and Runoff Samples for 1999 (pCi/L[a]) (Cont.)

Station Name	Date	Matrix[b]	Code[c]	F/UF[d]	^{3}H		^{137}Cs		U (μg/L)		^{238}Pu		$^{239, 240}$Pu		^{241}Am		Gross Alpha		Gross Beta		Gross Gamma	
Pajarito Plateau (Cont.)																						
Sandia Canyon:																						
SCS-1	05/27	SW	1	UF	140	600	–1.14	3.71	0.80	0.10	0.004	0.007	0.023	0.011	0.024	0.014	2.6	4.3	20.7	9.2	30	50
SCS-2	05/19	SW	1	UF	90	600	0.36	0.25	0.90	0.30	0.003	0.007	0.002	0.007	0.036	0.013	0.4	7.3	17.6	9.6	195	51
SCS-2	05/19	SW	1D	UF					0.83	0.08												
SCS-3	06/16	SW	1	UF	340	620	0.00	7.14	0.56	0.08	0.208	0.034	0.022	0.012	0.032	0.011	2.4	3.8	10.5	6.1	86	51
SCS-3	06/16	SW	1D	UF					0.43	0.04												
Mortandad Canyon:																						
Mortandad at Gaging Station 1	05/27	SW	1	UF	2,480	760	28.63	3.54	1.21	0.12	8.108	0.250	3.757	0.140	4.438	0.154	27.5	9.1	81.6	19.9	133	51
Mortandad at Gaging Station 1	05/27	SW	1D	UF					1.40	0.60												
Mortandad at Rio Grande (A-11)	09/20	SW	1	UF	–20	610																
Mortandad at Rio Grande (A-11)	09/21	SW	1	UF			–1.50	6.98			–0.001	0.008	0.005	0.006	–0.001	0.002	0.6	0.9	13.8	6.6	19	48
Pajarito Canyon:																						
Pajarito at Rio Grande	09/21	SW	1	UF	150	620	0.00	7.65	1.00	0.10	0.008	0.012	0.037	0.014	0.030	0.010	1.6	1.2	5.3	3.0	9	48
Water Canyon:																						
Water Canyon at Beta	11/17	SW	1	UF	–60	580	0.11	1.00	–0.09	0.05	–0.002	0.004	–0.001	0.007	0.017	0.006	0.3	3.2	2.8	1.6	44	49
Ancho Canyon:																						
Ancho at Rio Grande	09/21	SW	1	UF	0	610	0.00	5.59	0.30	0.10	0.022	0.010	0.009	0.007	0.020	0.007	0.7	0.7	3.3	2.7	77	49
Frijoles Canyon:																						
Frijoles at Monument Headquarters	12/22	SW	1	UF	–60	580	1.38	1.25	1.90	0.40	0.012	0.011	0.001	0.006	–0.005	0.004	–0.3	0.7	1.1	1.4	72	49
Frijoles at Rio Grande	12/22	SW	1	UF	50	590	0.00	4.70	2.60	0.40	0.012	0.008	0.016	0.011	0.012	0.005	0.4	0.5	1.7	1.5	286	50
Runoff Stations																						
Perimeter:																						
LA Canyon near Los Alamos	04/30	RO/D	1	F			0.93	0.18	0.16	0.05	0.016	0.009	0.033	0.009	0.083	0.026	1.5	1.1	10.7	2.3	80	51
LA Canyon near Los Alamos	04/30	RO/TOT	1	UF	100	640	4.02	0.40			0.106	0.028	1.787	0.101	9.466	0.411	81.8	17.1	85.2	10.1	84	51
LA Canyon near Los Alamos	05/03	RO/D	1	F			–0.17	1.92			0.004	0.011	0.038	0.019	0.045	0.016	1.4	1.0	8.5	2.2	130	52
LA Canyon near Los Alamos	05/03	RO/TOT	1	UF	120	620	1.81	0.36	1.40	0.10	0.184	0.038	1.568	0.116	0.939	0.086	18.1	4.3	14.9	3.7	58	51
LA Canyon near Los Alamos	07/08	RO/D	1	F			1.02	0.83			–0.014	0.020	0.047	0.025	0.025	0.010	1.0	1.2	12.6	4.1	74	52
LA Canyon near Los Alamos	07/08	RO/TOT	1	UF			42.27	5.04			1.531	0.122	15.778	0.638	7.393	0.240	160.0	48.7	191.0	55.1	130	52
LA Canyon near Los Alamos	07/13	RO/D	1	F					–0.10	0.70												
LA Canyon near Los Alamos	07/13	RO/TOT	1	UF					8.20	0.70												
LA Canyon near Los Alamos	08/09	RO/D	1	F			0.00	6.20	2.02	0.20	0.052	0.022	0.028	0.016	0.003	0.002	1.4	1.3	9.3	3.6	54	50
LA Canyon near Los Alamos	08/09	RO/D	1D	F					0.14	0.06												
LA Canyon near Los Alamos	08/09	RO/TOT	1	UF	–220	600	10.32	2.53	7.33	0.73	0.222	0.040	2.471	0.149	2.921	0.187	507.0	181.0	536.0	196.0	142	51
LA Canyon near Los Alamos	08/09	RO/TOT	1D	UF					4.10	0.70												

Table 5-1. Radiochemical Analysis of Surface Water and Runoff Samples for 1999 (pCi/L[a]) (Cont.)

Station Name	Date	Matrix[b]	Code[c]	F/UF[d]	^{3}H		^{137}Cs		U (µg/L)		^{238}Pu		$^{239, 240}Pu$		^{241}Am		Gross Alpha		Gross Beta		Gross Gamma	
Runoff Stations (Cont.)																						
Perimeter: (Cont.)																						
LA Canyon near Los Alamos	08/10	RO/D	1	F			–0.56	8.49			0.023	0.015	0.112	0.023	0.069	0.019	2.5	1.7	12.3	4.2	107	51
LA Canyon near Los Alamos	08/10	RO/TOT	3	UF			7.23	1.48	3.50	0.70	0.220	0.040	5.291	0.235	3.038	0.148	70.2	28.8	90.6	34.5	103	51
LA Canyon below TA-2	09/16	RO/D	1	F			–1.74	7.62	0.00	0.06	0.007	0.007	0.040	0.017	0.082	0.047	–0.1	0.5	1.2	1.5	53	48
LA Canyon below TA-2	09/16	RO/TOT	1	UF			1.00	1.10	4.30	0.30	0.173	0.036	6.298	0.289	0.220	0.037	111.0	40.8	77.9	34.9	145	49
DP Canyon near Los Alamos	06/23	RO/D	1	F			1.09	0.83	–0.20	0.70	0.009	0.009	0.030	0.013	0.043	0.011	1.0	1.3	18.2	5.3	21	51
DP Canyon near Los Alamos	06/23	RO/TOT	1	UF	80	600	22.01	2.87	3.00	1.00	0.645	0.085	2.928	0.201	7.362	0.336	165.0	49.9	282.0	73.3	130	52
DP Canyon near Los Alamos	08/14	RO/TOT	1	UF			5.36	1.39	1.19	0.12	0.062	0.019	0.962	0.076	2.576	0.180	31.3	18.4	81.6	32.5	12	50
DP Canyon near Los Alamos	08/14	RO/TOT	1D	UF					1.11	0.09												
DP Canyon near Los Alamos	09/16	RO/TOT	1	UF			16.17	2.26	2.50	0.30	0.027	0.015	1.835	0.126	4.443	0.201	172.0	60.1	324.0	93.5	221	49
Sandia Canyon below Power Plant	05/28	RO/TOT	1	UF			–0.14	1.53	1.50	0.10	0.006	0.016	0.021	0.014	0.064	0.026	24.3	5.8	30.2	5.4	47	50
Sandia Canyon below Wetlands	07/12	RO/TOT	1	UF			1.28	0.91	1.60	0.70	1.183	0.079	0.018	0.011	0.017	0.013	29.6	10.6	36.0	12.0	34	52
Sandia Canyon below Wetlands	08/10	RO/TOT	1	UF			0.32	0.84	0.60	0.70	0.002	0.011	0.042	0.014	0.030	0.012	6.5	2.8	9.7	3.6	101	51
Sandia Canyon near Roads & Grounds at TA-3	05/28	RO/TOT	1	UF			–0.09	1.82	1.10	0.20	0.000	0.000	0.013	0.024	–0.003	0.003	19.6	4.9	25.8	4.9	66	51
Sandia Canyon near Roads & Grounds at TA-3	07/14	RO/TOT	1	UF			0.54	0.62	0.70	0.70	0.018	0.009	0.018	0.010	0.045	0.011	7.5	3.0	12.5	4.1	25	51
Sandia Canyon near Roads & Grounds at TA-3	08/10	RO/TOT	1	UF			0.56	1.20	1.20	0.70	0.008	0.015	0.044	0.017	–0.019	0.021	33.9	15.5	47.5	19.5	67	51
Sandia Canyon Truck Route	09/14	RO/TOT	1	UF			0.67	1.60	2.40	0.30	0.040	0.019	0.039	0.017	0.028	0.013	106.0	39.6	85.7	36.7	85	49
Cañada del Buey at White Rock	06/17	RO/D	1	F			0.00	8.58	0.17	0.02	0.009	0.010	0.019	0.012	0.074	0.019	0.1	25.3	1.8	20.0	106	51
Cañada del Buey at White Rock	06/17	RO/D	1D	F					0.10	0.70												
Cañada del Buey at White Rock	06/17	RO/TOT	1	UF	170	620	2.46	1.47	6.47	0.65	0.578	0.054	2.044	0.110	0.488	0.062	208.0	55.6	160.0	46.5	134	51
Cañada del Buey at White Rock	06/17	RO/TOT	1D	UF					0.90	0.70												
Cañada del Buey at White Rock	08/06	RO/TOT	1	UF			2.00	0.92	5.43	0.54	0.119	0.038	0.147	0.043	0.137	0.033	328.0	138.0	365.0	153.0	201	52
Cañada del Buey at White Rock	08/06	RO/TOT	1D	UF					11.50	0.50												
Cañada del Buey at White Rock	08/23	RO/TOT	3	UF			3.67	0.90	7.41	0.74	0.136	0.037	0.288	0.055	0.319	0.049	121.0	81.0	219.0	118.0	179	51
Cañada del Buey at White Rock	08/23	RO/TOT	3D	UF					14.00	1.00												
Cañada del Buey at White Rock	09/16	RO/TOT	1	UF			1.54	1.12	3.60	0.40	0.161	0.037	1.305	0.107	0.235	0.039	282.0	124.0	269.0	129.0	230	50
Pajarito Canyon above Threemile Canyon	09/16	RO/D	1	F			29.43	8.43	0.03	0.05	0.003	0.009	0.013	0.008	–0.033	0.204	1.1	1.0	2.1	1.7	74	48
Pajarito Canyon above Threemile Canyon	09/16	RO/TOT	1	UF			0.00	9.80	3.00	0.50	0.043	0.021	0.088	0.027	0.043	0.015	52.1	21.9	38.1	19.9	59	48
Pajarito Canyon above SR-4	06/17	RO/D	1	F			0.31	0.90	0.32	0.03	0.014	0.009	0.444	0.041	0.003	0.000	3.6	4.2	10.2	9.2	84	51
Pajarito Canyon above SR-4	06/17	RO/D	1D	F					0.10	0.70												
Pajarito Canyon above SR-4	06/17	RO/TOT	1	UF	140	620	1.24	1.55	1.45	0.15	0.100	0.031	1.565	0.109	7.853	0.238	56.2	19.1	31.2	14.1	83	51
Pajarito Canyon above SR-4	06/17	RO/TOT	1D	UF					1.30	0.70												
Potrillo Canyon near White Rock	08/31	RO/D	1	F			0.96	0.99	0.15	0.02	0.001	0.010	0.009	0.008	–0.001	0.006	0.7	0.8	3.0	2.0	119	49
Potrillo Canyon near White Rock	08/31	RO/D	1D	F					0.01	0.05												

Table 5-1. Radiochemical Analysis of Surface Water and Runoff Samples for 1999 (pCi/L[a]) (Cont.)

Station Name	Date	Matrix[b]	Code[c]	F/UF[d]	^{3}H		^{137}Cs		U (μg/L)		^{238}Pu		$^{239, 240}Pu$		^{241}Am		Gross Alpha		Gross Beta		Gross Gamma	
Runoff Stations (Cont.)																						
Perimeter: (Cont.)																						
Potrillo Canyon near White Rock	08/31	RO/TOT	1	UF	90	610	3.85	1.22	4.76	0.48	0.047	0.031	0.431	0.067	0.085	0.023	9.6	3.4	16.4	5.0	470	51
Potrillo Canyon near White Rock	08/31	RO/TOT	1D	UF					2.30	0.40												
Potrillo Canyon near White Rock	09/16	RO/TOT	1	UF			3.67	2.41	3.90	0.40	0.006	0.012	0.091	0.033	0.055	0.017	109.0	45.1	102.0	46.1	147	49
North Fork Ancho Canyon at TA-39	09/16	RO/TOT	1	UF			1.64	1.48	8.80	0.90	0.050	0.015	0.137	0.025	0.196	0.033	241.0	113.0	267.0	129.0	159	49
Ancho Canyon at TA-39	07/27	RO/TOT	1	UF			6.51	1.64	4.60	0.50	0.060	0.021	0.207	0.040	0.308	0.210	247.0	114.0	257.0	127.0	83	50
Ancho Canyon at TA-39	08/04	RO/TOT	1	UF			5.57	1.83	14.00	1.00	0.037	0.033	0.314	0.061	0.314	0.076	505.0	175.0	1010.0	297.0	207	52
Ancho Canyon at TA-39	08/04	RO/TOT	1D	UF					6.30	0.63												
Ancho Canyon at TA-39	08/10	RO/TOT	3	UF			5.77	1.61	5.16	0.52	0.238	0.046	0.774	0.084	0.167	0.030	303.0	132.0	320.0	143.0	149	51
Ancho Canyon at TA-39	08/10	RO/TOT	3D	UF					12.60	0.40												
Ancho Canyon near Bandelier	06/18	RO/TOT	1	UF			5.59	1.03	170.00	20.00	0.075	0.043	0.775	0.102	0.399	0.058	504.0	181.0	829.0	251.0	162	52
Ancho Canyon near Bandelier	07/08	RO/D	1	F			0.24	1.11	–0.30	0.70	0.029	0.012	0.016	0.010	–0.004	0.003	0.8	1.1	3.8	2.4	89	52
Ancho Canyon near Bandelier	07/08	RO/TOT	1	UF	70	640	2.80	0.92	12.00	1.00	0.096	0.044	0.285	0.063	0.020	0.181	8.9	3.3	9.5	3.7	154	52
Ancho Canyon near Bandelier	07/27	RO/TOT	3	UF			12.49	2.27			0.000	0.000	0.000	0.000	0.000	0.000	465.0	166.0	596.0	215.0	315	52
Ancho Canyon near Bandelier	08/03	RO/TOT	1	UF					5.30	0.50												
Ancho Canyon near Bandelier	08/04	RO/TOT	3	UF					9.00	1.00												
Mesa Top:																						
TA-55	08/14	RO/D	1	F			–1.01	4.65	0.05	0.01	0.008	0.011	0.008	0.014	0.041	0.013	0.4	0.9	1.1	1.6	36	51
TA-55	08/14	RO/TOT	1	UF			0.00	5.45	0.07	0.01	0.015	0.016	0.024	0.020	0.045	0.015	2.0	1.5	4.2	2.3	25	51
TA-55	08/14	RO/TOT	1D	UF					–0.02	0.05												
Area L	08/14	RO/TOT	1	UF			3.67	0.90	0.07	0.01	–0.005	0.012	0.024	0.012	0.008	0.006	1.6	1.3	3.0	2.0	128	51
Area L	08/14	RO/TOT	1D	UF					–0.05	0.20												
Area G:																						
G-SWMS-1	07/29	RO/D	1	F			0.00	9.85	0.36	0.04	0.013	0.008	0.039	0.012	–0.009	0.005	0.4	1.1	5.8	2.9	49	51
G-SWMS-1	07/29	RO/D	1D	F					0.13	0.05												
G-SWMS-1	07/29	RO/TOT	1	UF	920	670	3.57	1.80	5.52	0.55	1.016	0.072	0.410	0.044	0.287	0.202	236.0	86.6	421.0	129.0	180	51
G-SWMS-1	07/29	RO/TOT	1D	UF					5.00	0.60												
G-SWMS-2	05/24	RO/TOT	1	UF	–30	610	1.54	0.35	4.40	0.90	0.107	0.027	1.284	0.096	0.220	0.046	256.0	51.4	195.0	22.6	52	51
G-SWMS-2	07/08	RO/TOT	1	UF			1.80	1.05	4.80	0.70	0.060	0.022	0.270	0.044	0.060	0.012	161.0	46.2	194.0	52.9	70	52
G-SWMS-2	07/29	RO/TOT	3	UF	1,120	680	26.64	4.29	2.30	0.40	0.088	0.021	0.302	0.038	0.721	0.216	128.0	41.0	129.0	44.9	199	52
G-SWMS-3	05/28	RO/TOT	1	UF			–0.17	1.76	9.00	1.00	0.370	0.047	1.930	0.116	1.001	0.085	72.1	15.1	59.7	7.6	199	52
G-SWMS-3	06/17	RO/TOT	1	UF			2.55	1.42			0.427	0.070	2.155	0.157	0.391	0.041	278.0	83.5	383.0	105.0	222	53
G-SWMS-3	07/15	RO/TOT	1	UF	290	610	2.10	0.92	9.00	1.00	0.976	0.124	3.064	0.243	1.060	0.113	429.0	128.0	504.0	143.0	191	53
G-SWMS-3	07/29	RO/D	1	F			1.28	1.17	0.60	0.10	–0.004	0.004	0.013	0.006	0.029	0.010	1.7	1.4	6.1	2.9	23	50

Table 5-1. Radiochemical Analysis of Surface Water and Runoff Samples for 1999 (pCi/L[a]) (Cont.)

Station Name	Date	Matrix[b]	Code[c]	F/UF[d]	^{3}H		^{137}Cs		U (μg/L)		^{238}Pu		^{239,240}Pu		^{241}Am		Gross Alpha		Gross Beta		Gross Gamma	
Runoff Stations (Cont.)																						
Area G: (Cont.)																						
G-SWMS-3	07/29	RO/TOT	3	UF	190	620	2.09	0.95	12.40	0.70	0.658	0.073	3.076	0.180	1.613	0.160	607.0	203.0	438.0	175.0	160	51
G-SWMS-4	05/22	RO/TOT	1	UF	880	680	0.29	1.34			0.093	0.024	0.395	0.047	2.485	0.179	20.0	4.9	29.0	4.8	28	50
G-SWMS-4	05/24	RO/TOT	1	UF					2.30	0.10												
G-SWMS-4	06/21	RO/TOT	1	UF			1.56	0.93	0.20	0.70	0.009	0.013	0.940	0.065	15.168	0.665	36.1	9.4	26.6	7.5	26	51
G-SWMS-4	07/15	RO/TOT	1	UF	580	630	0.00	7.01	–0.10	0.70	0.119	0.029	1.227	0.098	10.608	0.861	24.3	7.1	22.9	6.8	238	53
G-SWMS-5	06/17	RO/TOT	1	UF	530	630	2.68	1.45	2.10	0.70	0.084	0.024	1.236	0.093	0.235	0.040	93.4	27.0	92.3	27.1	107	51
G-SWMS-5	07/08	RO/TOT	1	UF	860	650	2.16	1.16	1.70	0.70	0.075	0.018	0.182	0.025	0.020	0.011	60.2	17.0	71.6	19.3	51	52
G-SWMS-5	09/17	RO/TOT	1	UF	1,030	680	–1.02	5.85	0.27	0.05	0.073	0.025	0.065	0.029	0.125	0.036	21.7	7.4	29.1	9.2	41	48
G-SWMS-6	05/24	RO/TOT	1	UF	250	630	1.64	0.86	1.60	0.07	0.644	0.058	6.878	0.260	0.255	0.190	45.2	9.9	46.5	6.7	110	51
G-SWMS-6	06/13	RO/TOT	1	UF	430	630	1.00	0.69	3.16	0.32	0.195	0.049	1.557	0.142	0.421	0.047	323.0	106.0	402.0	123.0	68	51
G-SWMS-6	06/13	RO/TOT	1D	UF					4.70	0.70												
G-SWMS-6	07/08	RO/TOT	1	UF			3.23	1.19	4.70	0.70	0.393	0.064	0.764	0.088	0.619	0.083	234.0	74.4	260.0	79.7	166	52
G-SWMS-6	07/20	RO/TOT	5	UF					6.60	0.90												
G-SWMS-6	07/29	RO/TOT	1	UF			2.76	1.35			0.167	0.033	0.577	0.062	0.469	0.053	462.0	171.0	409.0	169.0	216	52
G-SWMS-6	08/14	RO/D	1	F			1.43	1.00	0.17	0.02	0.017	0.011	0.025	0.013	–0.005	0.004	0.8	1.0	2.6	1.9	90	51
G-SWMS-6	08/14	RO/D	1D	F					0.03	0.05												
G-SWMS-6	08/14	RO/TOT	1	UF			–1.02	3.85	1.18	0.12	0.033	0.017	0.160	0.029	0.086	0.023	33.6	19.1	38.2	22.2	55	51
G-SWMS-6	08/14	RO/TOT	1D	UF					1.20	0.10												
G-SWMS-6	08/31	RO/D	1	F			0.00	5.52	0.24	0.02	–0.006	0.008	0.010	0.008	0.030	0.020	0.4	0.6	1.6	1.6	499	51
G-SWMS-6	08/31	RO/D	1D	F					0.26	0.08												
G-SWMS-6	08/31	RO/TOT	3	UF	420	630	0.65	1.03	5.66	0.57	0.127	0.033	0.669	0.071	0.517	0.072	9.8	3.5	10.3	3.7	623	62
G-SWMS-6	08/31	RO/TOT	3D	UF					4.30	0.40												
Detection Limits					700		4		0.1		0.04		0.04		0.04		3		3		120	
Water Quality Standards[e]																						
DOE DCG for Public Dose					2,000,000		3,000		800		40		30		30		30		1,000			
DOE Drinking Water System DCG					80,000		120		30		1.6		1.2		1.2		1.2		40			
EPA Primary Drinking Water Standard					20,000				20								15					
EPA Screening Level																			50			
NMWQCC Groundwater Limit									5,000													

[a] Except where noted. Two columns are listed: the first is the analytical result, and the second is the radioactive counting uncertainty (1 std dev). Radioactivity counting uncertainties may be less than the analytical method uncertainties.
[b] Matrix: SW–surface water; RO–runoff; D–dissolved; TOT–total.
[c] Codes: 1–primary analysis; 2–secondary analysis; R–lab replicate; D–lab duplicate.
[d] F/UF: F–filtered; UF–unfiltered.
[e] Standards given here for comparison only; see Appendix A.

Table 5-2. Strontium-90 in Surface Water and Runoff for 1999
(LANL's 1999 strontium-90 data are not valid because of analytical laboratory problems; the data appear in this report for documentary purposes only.)

Station Name	Date	Matrix[a]	Code[b]	F/UF[c]	Analyte	Value	Uncertainity	Detection Limit	Units	Detect?
Rio Chama at Chamita	06/16	SW	1	UF	^{90}Sr	0.66	0.19	0.36	pCi/L	Detect
Rio Chama at Chamita	06/16	SW	1	UF	^{90}Sr	0.70	0.18	0.34	pCi/L	Detect
Rio Grande at Embudo	10/05	SW	1	UF	^{90}Sr	–0.94	0.38	0.78	pCi/L	ND[d]
Rio Grande at Otowi Upper (bank)	08/03	SW	1	UF	^{90}Sr	1.00	0.40	0.78	pCi/L	ND
Rio Grande at Otowi (bank)	08/03	SW	1	UF	^{90}Sr	1.76	0.46	0.82	pCi/L	Detect
Rio Grande at Frijoles (bank)	09/22	SW	1	UF	^{90}Sr	0.08	0.40	0.91	pCi/L	ND
Rio Grande at Frijoles (bank)	09/22	SW	1	UF	^{90}Sr	–0.31	0.43	0.95	pCi/L	ND
Rio Grande at Cochiti	09/23	SW	1	UF	^{90}Sr	0.04	0.38	0.88	pCi/L	ND
Jemez River	08/02	SW	1	UF	^{90}Sr	–0.07	0.34	0.75	pCi/L	ND
Jemez River	08/02	SW	1	UF	^{90}Sr	0.41	0.44	0.93	pCi/L	ND
Guaje Canyon	11/16	SW	1	UF	^{90}Sr	–0.85	0.34	0.69	pCi/L	ND
Acid Weir	06/23	SW	1	UF	^{90}Sr	1.33	0.21	0.33	pCi/L	Detect
Pueblo 1	06/23	SW	1	UF	^{90}Sr	21.36	1.19	0.27	pCi/L	Detect
Pueblo 3	05/20	SW	1	UF	^{90}Sr	0.31	0.21	0.42	pCi/L	ND
Pueblo at SR–502	08/04	SW	1	UF	^{90}Sr	–0.15	0.45	1.00	pCi/L	ND
Pueblo at SR–502	12/01	SW	1	UF	^{90}Sr	–0.32	0.38	0.83	pCi/L	ND
Los Alamos Canyon Reservoir	06/23	SW	1	UF	^{90}Sr	8.66	0.57	0.31	pCi/L	Detect
Los Alamos at Upper GS	05/26	SW	1	UF	^{90}Sr	2.85	0.27	0.30	pCi/L	Detect
SCS–1	05/27	SW	1	UF	^{90}Sr	3.57	0.34	0.37	pCi/L	Detect
SCS–2	05/19	SW	1	UF	^{90}Sr	0.33	0.20	0.40	pCi/L	ND
SCS–3	06/16	SW	1	UF	^{90}Sr	0.67	0.18	0.35	pCi/L	Detect
Mortandad at GS–1	05/27	SW	1	UF	^{90}Sr	16.45	0.96	0.31	pCi/L	Detect
Mortandad at Rio Grande (A–11)	09/21	SW	1	UF	^{90}Sr	–1.46	0.89	1.92	pCi/L	ND
Pajarito at Rio Grande	09/21	SW	1	UF	^{90}Sr	–0.28	0.72	1.64	pCi/L	ND
Water Canyon at Beta	11/17	SW	1	UF	^{90}Sr	–0.01	0.29	0.65	pCi/L	ND
Ancho at Rio Grande	09/21	SW	1	UF	^{90}Sr	0.00	0.37	0.86	pCi/L	ND
Frijoles at Monument HQ	12/22	SW	1	UF	^{90}Sr	–0.94	0.42	0.87	pCi/L	ND
Frijoles at Rio Grande	12/22	SW	1	UF	^{90}Sr	–0.25	0.36	0.81	pCi/L	ND
LA Canyon near LA	04/30	RO/D	1	F	^{90}Sr	5.47	0.42	0.32	pCi/L	Detect
LA Canyon near LA	05/03	RO/D	1	F	^{90}Sr	3.31	0.30	0.31	pCi/L	Detect
LA Canyon near LA	07/08	RO/D	1	F	^{90}Sr	5.15	0.41	0.35	pCi/L	Detect
LA Canyon near LA	08/09	RO/D	1	F	^{90}Sr	2.31	0.31	0.42	pCi/L	Detect
LA Canyon near LA	08/10	RO/D	1	F	^{90}Sr	3.22	0.81	1.47	pCi/L	Detect
LA Canyon near LA	04/30	RO/TOT	1	UF	^{90}Sr	32.06	1.74	0.30	pCi/L	Detect
LA Canyon near LA	05/03	RO/TOT	1	UF	^{90}Sr	4.28	0.37	0.35	pCi/L	Detect
LA Canyon near LA	07/08	RO/TOT	1	UF	^{90}Sr	32.91	1.75	0.26	pCi/L	Detect

Table 5-2. Strontium-90 in Surface Water and Runoff for 1999 (Cont.)
(LANL's 1999 strontium-90 data are not valid because of analytical laboratory problems; the data appear in this report for documentary purposes only.)

Station Name	Date	Matrix[a]	Code[b]	F/UF[c]	Analyte	Value	Uncertainity	Detection Limit	Units	Detect?
LA Canyon near LA	08/09	RO/TOT	1	UF	^{90}Sr	29.80	1.67	0.39	pCi/L	Detect
LA Canyon near LA	08/10	RO/TOT	1	UF	^{90}Sr	36.76	2.29	0.84	pCi/L	Detect
DP Canyon near Los Alamos	06/23	RO/D	1	F	^{90}Sr	10.05	0.66	0.35	pCi/L	Detect
DP Canyon near Los Alamos	06/23	RO/TOT	1	UF	^{90}Sr	32.25	1.73	0.29	pCi/L	Detect
DP Canyon near Los Alamos	08/14	RO/TOT	1	UF	^{90}Sr	14.17	1.11	0.82	pCi/L	Detect
Sandia Canyon below Power Plant	05/28	RO/TOT	1	UF	^{90}Sr	6.95	0.47	0.26	pCi/L	Detect
Sandia Canyon below Wetlands	07/12	RO/TOT	1	UF	^{90}Sr	3.94	0.34	0.32	pCi/L	Detect
Sandia Canyon below Wetlands	08/10	RO/TOT	1	UF	^{90}Sr	2.10	0.83	1.64	pCi/L	ND
Sandia Canyon near Roads & Grounds at TA–3	05/28	RO/TOT	1	UF	^{90}Sr	5.56	0.39	0.25	pCi/L	Detect
Sandia Canyon near Roads & Grounds at TA–3	07/14	RO/TOT	1	UF	^{90}Sr	1.57	0.22	0.32	pCi/L	Detect
Sandia Canyon near Roads & Grounds at TA–3	08/10	RO/TOT	1	UF	^{90}Sr	4.33	0.81	1.33	pCi/L	Detect
Cañada del Buey at WR	06/17	RO/D	1	F	^{90}Sr	0.30	0.15	0.29	pCi/L	ND
Cañada del Buey at WR	06/17	RO/TOT	1	UF	^{90}Sr	58.82	3.05	0.29	pCi/L	Detect
Cañada del Buey at WR	08/06	RO/TOT	1	UF	^{90}Sr	36.37	2.22	0.74	pCi/L	Detect
Cañada del Buey at WR	08/23	RO/TOT	1	UF	^{90}Sr	55.07	3.18	0.75	pCi/L	Detect
Pajarito Canyon above SR–4	06/17	RO/D	1	F	^{90}Sr	0.46	0.14	0.27	pCi/L	Detect
Pajarito Canyon above SR–4	06/17	RO/TOT	1	UF	^{90}Sr	10.26	0.64	0.27	pCi/L	Detect
Potrillo Canyon near WR	08/31	RO/D	1	F	^{90}Sr	0.74	0.56	1.15	pCi/L	ND
Potrillo Canyon near WR	08/31	RO/TOT	1	UF	^{90}Sr	14.17	0.96	0.49	pCi/L	Detect
Ancho Canyon at TA–39	07/27	RO/TOT	1	UF	^{90}Sr	0.46	0.17	0.34	pCi/L	ND
Ancho Canyon at TA–39	08/04	RO/TOT	1	UF	^{90}Sr	73.77	4.58	1.63	pCi/L	Detect
Ancho Canyon at TA–39	08/10	RO/TOT	1	UF	^{90}Sr	63.58	4.00	1.55	pCi/L	Detect
Ancho Canyon near Bandelier	07/08	RO/D	1	F	^{90}Sr	0.79	0.24	0.44	pCi/L	Detect
Ancho Canyon near Bandelier	06/18	RO/TOT	1	UF	^{90}Sr	60.95	3.27	0.54	pCi/L	Detect
Ancho Canyon near Bandelier	07/08	RO/TOT	1	UF	^{90}Sr	19.98	1.19	0.42	pCi/L	Detect
TA–55	08/14	RO/D	1	F	^{90}Sr	0.30	0.35	0.76	pCi/L	ND
TA–55	08/14	RO/TOT	1	UF	^{90}Sr	–0.08	0.32	0.72	pCi/L	ND
Area L	08/14	RO/TOT	1	UF	^{90}Sr	–0.31	0.46	1.03	pCi/L	ND

Table 5-2. Strontium-90 in Surface Water and Runoff for 1999 (Cont.)
(LANL's 1999 strontium-90 data are not valid because of analytical laboratory problems; the data appear in this report for documentary purposes only.)

Station Name	Date	Matrix[a]	Code[b]	F/UF[c]	Analyte	Value	Uncertainity	Detection Limit	Units	Detect?
G–SWMS–1	07/29	RO/D	1	F	^{90}Sr	–0.05	0.16	0.36	pCi/L	ND
G–SWMS–1	07/29	RO/TOT	1	UF	^{90}Sr	21.67	1.24	0.34	pCi/L	Detect
G–SWMS–2	05/24	RO/TOT	1	UF	^{90}Sr	33.82	1.82	0.30	pCi/L	Detect
G–SWMS–2	07/08	RO/TOT	1	UF	^{90}Sr	11.91	0.71	0.27	pCi/L	Detect
G–SWMS–2	07/29	RO/TOT	1	UF	^{90}Sr	12.11	0.95	0.68	pCi/L	Detect
G–SWMS–3	07/29	RO/D	1	F	^{90}Sr	0.69	0.18	0.33	pCi/L	Detect
G–SWMS–3	05/28	RO/TOT	1	UF	^{90}Sr	101.40	5.15	0.33	pCi/L	Detect
G–SWMS–3	06/17	RO/TOT	1	UF	^{90}Sr	76.50	4.00	0.46	pCi/L	Detect
G–SWMS–3	07/15	RO/TOT	1	UF	^{90}Sr	43.97	2.58	0.86	pCi/L	Detect
G–SWMS–3	07/29	RO/TOT	1	UF	^{90}Sr	10.82	0.71	0.37	pCi/L	Detect
G–SWMS–4	05/22	RO/TOT	1	UF	^{90}Sr	7.74	0.53	0.30	pCi/L	Detect
G–SWMS–4	06/21	RO/TOT	1	UF	^{90}Sr	2.08	0.25	0.34	pCi/L	Detect
G–SWMS–4	07/15	RO/TOT	1	UF	^{90}Sr	2.26	0.26	0.34	pCi/L	Detect
G–SWMS–5	06/17	RO/TOT	1	UF	^{90}Sr	28.48	1.53	0.26	pCi/L	Detect
G–SWMS–5	07/08	RO/TOT	1	UF	^{90}Sr	6.39	0.45	0.29	pCi/L	Detect
G–SWMS–6	08/14	RO/D	1	F	^{90}Sr	0.29	0.42	0.94	pCi/L	ND
G–SWMS–6	08/31	RO/D	1	F	^{90}Sr	0.55	0.36	0.73	pCi/L	ND
G–SWMS–6	05/24	RO/TOT	1	UF	^{90}Sr	13.91	0.83	0.30	pCi/L	Detect
G–SWMS–6	06/13	RO/TOT	1	UF	^{90}Sr	15.15	0.87	0.25	pCi/L	Detect
G–SWMS–6	07/08	RO/TOT	1	UF	^{90}Sr	16.33	0.94	0.27	pCi/L	Detect
G–SWMS–6	07/29	RO/TOT	1	UF	^{90}Sr	20.00	1.14	0.31	pCi/L	Detect
G–SWMS–6	08/14	RO/TOT	1	UF	^{90}Sr	5.59	0.65	0.81	pCi/L	Detect
G–SWMS–6	08/31	RO/TOT	1	UF	^{90}Sr	14.49	1.01	0.55	pCi/L	Detect

[a] Matrix: SW–surface water; RO–runoff; D–dissolved; TOT–total.
[b] Codes: 1–primary analysis; 2–secondary analysis; R–lab replicate; D–lab duplicate.
[c] F/UF: F–filtered; UF–unfiltered.
[d] ND = not detected.

Table 5-3. Detections of Radionuclides[a] and Comparison to Department of Energy Derived Concentration Guides[b] in Surface Water and Runoff Samples for 1999

Station Name	Date	Code[c]	F/UF[d]	Matrix[e]	Analyte	Value	Uncertainty[f]	Detection Limit	Units	DOE DCG	Ratio of Value to DCG	Ratio of Value to Minimum Standard	Minimum Standard	Minimum Standard Type
Ancho Canyon at TA-39	08/04	1	UF	RO/TOT	^{241}Am	0.314	0.076	0.151	pCi/L					
Ancho Canyon at TA-39	08/10	1	UF	RO/TOT	^{241}Am	0.167	0.030	0.039	pCi/L					
Ancho Canyon at TA-39	08/04	1	UF	RO/TOT	Beta	1,010.0	297.0		pCi/L	1,000	1.01	20.20	50	EPA Screening Level
Ancho Canyon at TA-39	07/27	1	UF	RO/TOT	^{137}Cs	6.51	1.64	3.22	pCi/L					
Ancho Canyon at TA-39	08/04	1	UF	RO/TOT	^{137}Cs	5.57	1.83	4.13	pCi/L					
Ancho Canyon at TA-39	08/10	1	UF	RO/TOT	^{137}Cs	5.77	1.61	3.77	pCi/L					
Ancho Canyon at TA-39	08/04	1	UF	RO/TOT	Gamma	207	52	80	pCi/L					
Ancho Canyon at TA-39	08/10	1	UF	RO/TOT	^{238}Pu	0.238	0.046	0.076	pCi/L					
Ancho Canyon at TA-39	07/27	1	UF	RO/TOT	^{239,240}Pu	0.207	0.040	0.068	pCi/L					
Ancho Canyon at TA-39	08/04	1	UF	RO/TOT	^{239,240}Pu	0.314	0.061	0.103	pCi/L					
Ancho Canyon at TA-39	08/10	1	UF	RO/TOT	^{239,240}Pu	0.774	0.084	0.066	pCi/L					
Ancho Canyon at TA-39	08/04	1	UF	RO/TOT	U	14.00	1.00		µg/L					
Ancho Canyon at TA-39	08/04	1	UF	RO/TOT	U	6.30	0.63		µg/L					
Ancho Canyon at TA-39	08/10	1	UF	RO/TOT	U	12.60	0.40		µg/L					
Ancho Canyon at TA-39	08/10	1	UF	RO/TOT	U	5.16	0.52		µg/L					
Ancho Canyon near Bandelier	06/18	1	UF	RO/TOT	^{241}Am	0.399	0.058	0.079	pCi/L					
Ancho Canyon near Bandelier	07/27	1	UF	RO/TOT	^{241}Am	0.000	0.000	0.000	pCi/L					
Ancho Canyon near Bandelier	06/18	1	UF	RO/TOT	Beta	829.0	251.0		pCi/L	1,000	0.83	16.58	50	EPA Screening Level
Ancho Canyon near Bandelier	06/18	1	UF	RO/TOT	^{137}Cs	5.59	1.03	2.42	pCi/L					
Ancho Canyon near Bandelier	07/08	1	UF	RO/TOT	^{137}Cs	2.80	0.92	2.80	pCi/L					
Ancho Canyon near Bandelier	07/27	1	UF	RO/TOT	^{137}Cs	12.49	2.27	5.34	pCi/L					
Ancho Canyon near Bandelier	06/18	1	UF	RO/TOT	Gamma	162	52	80	pCi/L					
Ancho Canyon near Bandelier	07/27	1	UF	RO/TOT	Gamma	315	52	80	pCi/L					
Ancho Canyon near Bandelier	07/27	1	UF	RO/TOT	^{238}Pu	0.000	0.000	0.000	pCi/L					
Ancho Canyon near Bandelier	06/18	1	UF	RO/TOT	^{239,240}Pu	0.775	0.102	0.097	pCi/L					
Ancho Canyon near Bandelier	07/08	1	UF	RO/TOT	^{239,240}Pu	0.285	0.063	0.109	pCi/L					
Ancho Canyon near Bandelier	07/27	1	UF	RO/TOT	^{239,240}Pu	0.000	0.000	0.000	pCi/L					
Ancho Canyon near Bandelier	06/18	1	UF	RO/TOT	U	170.00	20.00		µg/L	800	0.21	8.50	20	Proposed EPA Primary Drinking Water Standard
Ancho Canyon near Bandelier	07/08	1	UF	RO/TOT	U	12.00	1.00		µg/L					
Ancho Canyon near Bandelier	08/03	1	UF	RO/TOT	U	5.30	0.50		µg/L					
Ancho Canyon near Bandelier	08/04	1	UF	RO/TOT	U	9.00	1.00		µg/L					
Area L	08/14	1	UF	RO/TOT	^{137}Cs	3.67	0.90	2.42	pCi/L					
Cañada del Buey at WR	06/17	1	UF	RO/TOT	Alpha	208.0	55.6		pCi/L	30	6.93	13.87	15	EPA Primary Drinking Water Standard
Cañada del Buey at WR	06/17	1	F	RO/D	^{241}Am	0.074	0.019	0.041	pCi/L					
Cañada del Buey at WR	06/17	1	UF	RO/TOT	^{241}Am	0.488	0.062	0.051	pCi/L					

Table 5-3. Detections of Radionuclides[a] and Comparison to Department of Energy Derived Concentration Guides[b] in Surface Water and Runoff Samples for 1999 (Cont.)

Station Name	Date	Code[c]	F/UF[d]	Matrix[e]	Analyte	Value	Uncertainty[f]	Detection Limit	Units	DOE DCG	Ratio of Value to DCG	Ratio of Value to Minimum Standard	Minimum Standard	Minimum Standard Type
Cañada del Buey at WR	08/06	1	UF	RO/TOT	^{241}Am	0.137	0.033	0.081	pCi/L					
Cañada del Buey at WR	08/23	1	UF	RO/TOT	^{241}Am	0.319	0.049	0.040	pCi/L					
Cañada del Buey at WR	09/16	1	UF	RO/TOT	^{241}Am	0.235	0.039	0.059	pCi/L					
Cañada del Buey at WR	06/17	1	UF	RO/TOT	Beta	160.0	46.5		pCi/L	1,000	0.16	3.20	50	EPA Screening Level
Cañada del Buey at WR	08/23	1	UF	RO/TOT	^{137}Cs	3.67	0.90	2.42	pCi/L					
Cañada del Buey at WR	08/06	1	UF	RO/TOT	Gamma	201	52	80	pCi/L					
Cañada del Buey at WR	08/23	1	UF	RO/TOT	Gamma	179	51	80	pCi/L					
Cañada del Buey at WR	09/16	1	UF	RO/TOT	Gamma	230	50	80	pCi/L					
Cañada del Buey at WR	06/17	1	UF	RO/TOT	^{238}Pu	0.578	0.054	0.052	pCi/L					
Cañada del Buey at WR	08/06	1	UF	RO/TOT	^{238}Pu	0.119	0.038	0.073	pCi/L					
Cañada del Buey at WR	08/23	1	UF	RO/TOT	^{238}Pu	0.136	0.037	0.046	pCi/L					
Cañada del Buey at WR	09/16	1	UF	RO/TOT	^{238}Pu	0.161	0.037	0.069	pCi/L					
Cañada del Buey at WR	06/17	1	UF	RO/TOT	^{239,240}Pu	2.044	0.110	0.047	pCi/L	30	0.07	1.70	1.2	DOE Drinking Water DCG
Cañada del Buey at WR	08/06	1	UF	RO/TOT	^{239,240}Pu	0.147	0.043	0.073	pCi/L					
Cañada del Buey at WR	08/23	1	UF	RO/TOT	^{239,240}Pu	0.288	0.055	0.113	pCi/L					
Cañada del Buey at WR	09/16	1	UF	RO/TOT	^{239,240}Pu	1.305	0.107	0.092	pCi/L	30	0.04	1.09	1.2	DOE Drinking Water DCG
Cañada del Buey at WR	06/17	1	UF	RO/TOT	U	6.47	0.65		µg/L					
Cañada del Buey at WR	08/06	1	UF	RO/TOT	U	11.50	0.50		µg/L					
Cañada del Buey at WR	08/06	1	UF	RO/TOT	U	5.43	0.54		µg/L					
Cañada del Buey at WR	08/23	1	UF	RO/TOT	U	14.00	1.00		µg/L					
Cañada del Buey at WR	08/23	1	UF	RO/TOT	U	7.41	0.74		µg/L					
DP Canyon near Los Alamos	06/23	1	UF	RO/TOT	Alpha	165.0	49.9		pCi/L	30	5.50	11.00	15	EPA Primary Drinking Water Standard
DP Canyon near Los Alamos	06/23	1	F	RO/D	^{241}Am	0.043	0.011	0.024	pCi/L					
DP Canyon near Los Alamos	06/23	1	UF	RO/TOT	^{241}Am	7.362	0.336	0.112	pCi/L	30	0.25	6.14	1.2	DOE Drinking Water DCG
DP Canyon near Los Alamos	08/14	1	UF	RO/TOT	^{241}Am	2.576	0.180	0.065	pCi/L	30	0.09	2.15	1.2	DOE Drinking Water DCG
DP Canyon near Los Alamos	09/16	1	UF	RO/TOT	^{241}Am	4.443	0.201	0.053	pCi/L	30	0.15	3.70	1.2	DOE Drinking Water DCG
DP Canyon near Los Alamos	06/23	1	UF	RO/TOT	Beta	282.0	73.3		pCi/L	1,000	0.28	5.64	50	EPA Screening Level
DP Canyon near Los Alamos	09/16	1	UF	RO/TOT	Beta	324.0	93.5		pCi/L	1,000	0.32	6.48	50	EPA Screening Level
DP Canyon near Los Alamos	06/23	1	UF	RO/TOT	^{137}Cs	22.01	2.87	2.64	pCi/L					
DP Canyon near Los Alamos	08/14	1	UF	RO/TOT	^{137}Cs	5.36	1.39	3.01	pCi/L					
DP Canyon near Los Alamos	09/16	1	UF	RO/TOT	^{137}Cs	16.17	2.26	2.67	pCi/L					
DP Canyon near Los Alamos	09/16	1	UF	RO/TOT	Gamma	221	49	80	pCi/L					

Table 5-3. Detections of Radionuclides[a] and Comparison to Department of Energy Derived Concentration Guides[b] in Surface Water and Runoff Samples for 1999 (Cont.)

Station Name	Date	Code[c]	F/UF[d]	Matrix[e]	Analyte	Value	Uncertainty[f]	Detection Limit	Units	DOE DCG	Ratio of Value to DCG	Ratio of Value to Minimum Standard	Minimum Standard	Minimum Standard Type
DP Canyon near Los Alamos	06/23	1	UF	RO/TOT	^{238}Pu	0.645	0.085	0.061	pCi/L					
DP Canyon near Los Alamos	08/14	1	UF	RO/TOT	^{238}Pu	0.062	0.019	0.032	pCi/L					
DP Canyon near Los Alamos	06/23	1	UF	RO/TOT	^{239,240}Pu	2.928	0.201	0.089	pCi/L	30	0.10	2.44	1.2	DOE Drinking Water DCG
DP Canyon near Los Alamos	08/14	1	UF	RO/TOT	^{239,240}Pu	0.962	0.076	0.057	pCi/L					
DP Canyon near Los Alamos	09/16	1	UF	RO/TOT	^{239,240}Pu	1.835	0.126	0.041	pCi/L	30	0.06	1.53	1.2	DOE Drinking Water DCG
G-SWMS-1	07/29	1	UF	RO/TOT	Beta	421.0	129.0		pCi/L	1,000	0.42	8.42	50	EPA Screening Level
G-SWMS-1	07/29	1	UF	RO/TOT	Gamma	180	51	80	pCi/L					
G-SWMS-1	07/29	1	UF	RO/TOT	^{238}Pu	1.016	0.072	0.044	pCi/L					
G-SWMS-1	07/29	1	F	RO/D	^{239,240}Pu	0.039	0.012	0.019	pCi/L					
G-SWMS-1	07/29	1	UF	RO/TOT	^{239,240}Pu	0.410	0.044	0.039	pCi/L					
G-SWMS-1	07/29	1	UF	RO/TOT	U	5.00	0.60		µg/L					
G-SWMS-1	07/29	1	UF	RO/TOT	U	5.52	0.55		µg/L					
G-SWMS-2	05/24	1	UF	RO/TOT	Alpha	256.0	51.4		pCi/L	30	8.53	17.07	15	EPA Primary Drinking Water Standard
G-SWMS-2	07/08	1	UF	RO/TOT	Alpha	161.0	46.2		pCi/L	30	5.37	10.73	15	EPA Primary Drinking Water Standard
G-SWMS-2	07/29	1	UF	RO/TOT	Alpha	128.0	41.0		pCi/L	30	4.27	8.53	15	EPA Primary Drinking Water Standard
G-SWMS-2	05/24	1	UF	RO/TOT	^{241}Am	0.220	0.046	0.107	pCi/L					
G-SWMS-2	07/08	1	UF	RO/TOT	^{241}Am	0.060	0.012	0.020	pCi/L					
G-SWMS-2	07/29	1	UF	RO/TOT	^{241}Am	0.721	0.216	0.038	pCi/L					
G-SWMS-2	05/24	1	UF	RO/TOT	Beta	195.0	22.6		pCi/L	1,000	0.20	3.90	50	EPA Screening Level
G-SWMS-2	07/08	1	UF	RO/TOT	Beta	194.0	52.9		pCi/L	1,000	0.19	3.88	50	EPA Screening Level
G-SWMS-2	05/24	1	UF	RO/TOT	^{137}Cs	1.54	0.35	0.97	pCi/L					
G-SWMS-2	07/29	1	UF	RO/TOT	^{137}Cs	26.64	4.29	6.36	pCi/L					
G-SWMS-2	07/29	1	UF	RO/TOT	Gamma	199	52	80	pCi/L					
G-SWMS-2	05/24	1	UF	RO/TOT	^{238}Pu	0.107	0.027	0.045	pCi/L					
G-SWMS-2	07/29	1	UF	RO/TOT	^{238}Pu	0.088	0.021	0.034	pCi/L					
G-SWMS-2	05/24	1	UF	RO/TOT	^{239,240}Pu	1.284	0.096	0.041	pCi/L	30	0.04	1.07	1.2	DOE Drinking Water DCG
G-SWMS-2	07/08	1	UF	RO/TOT	^{239,240}Pu	0.270	0.044	0.045	pCi/L					
G-SWMS-2	07/29	1	UF	RO/TOT	^{239,240}Pu	0.302	0.038	0.024	pCi/L					
G-SWMS-3	05/28	1	UF	RO/TOT	Alpha	72.1	15.1		pCi/L	30	2.40	4.81	15	EPA Primary Drinking Water Standard
G-SWMS-3	06/17	1	UF	RO/TOT	Alpha	278.0	83.5		pCi/L	30	9.27	18.53	15	EPA Primary Drinking Water Standard

Table 5-3. Detections of Radionuclides[a] and Comparison to Department of Energy Derived Concentration Guides[b] in Surface Water and Runoff Samples for 1999 (Cont.)

Station Name	Date	Code[c]	F/UF[d]	Matrix[e]	Analyte	Value	Uncertainty[f]	Detection Limit	Units	DOE DCG	Ratio of Value to DCG	Ratio of Value to Minimum Standard	Minimum Standard	Minimum Standard Type
G-SWMS-3	07/15	1	UF	RO/TOT	Alpha	429.0	128.0		pCi/L	30	14.30	28.60	.5	EPA Primary Drinking Water Standard
G-SWMS-3	05/28	1	UF	RO/TOT	^{241}Am	1.001	0.085	0.046	pCi/L					
G-SWMS-3	06/17	1	UF	RO/TOT	^{241}Am	0.391	0.041	0.038	pCi/L					
G-SWMS-3	07/15	1	UF	RO/TOT	^{241}Am	1.060	0.113	0.132	pCi/L					
G-SWMS-3	07/29	1	UF	RO/TOT	^{241}Am	1.613	0.160	0.094	pCi/L	30	0.05	1.34	1.2	DOE Drinking Water DCG
G-SWMS-3	05/28	1	UF	RO/TOT	Beta	59.7	7.6		pCi/L	1,000	0.06	1.19	50	EPA Screening Level
G-SWMS-3	06/17	1	UF	RO/TOT	Beta	383.0	105.0		pCi/L	1,000	0.38	7.66	50	EPA Screening Level
G-SWMS-3	07/15	1	UF	RO/TOT	Beta	504.0	143.0		pCi/L	1,000	0.50	10.08	50	EPA Screening Level
G-SWMS-3	05/28	1	UF	RO/TOT	Gamma	199	52	80	pCi/L					
G-SWMS-3	06/17	1	UF	RO/TOT	Gamma	222	53	80	pCi/L					
G-SWMS-3	07/15	1	UF	RO/TOT	Gamma	191	53	80	pCi/L					
G-SWMS-3	07/29	1	UF	RO/TOT	Gamma	160	51	80	pCi/L					
G-SWMS-3	05/28	1	UF	RO/TOT	^{238}Pu	0.370	0.047	0.060	pCi/L					
G-SWMS-3	06/17	1	UF	RO/TOT	^{238}Pu	0.427	0.070	0.120	pCi/L					
G-SWMS-3	07/15	1	UF	RO/TOT	^{238}Pu	0.976	0.124	0.094	pCi/L					
G-SWMS-3	07/29	1	UF	RO/TOT	^{238}Pu	0.658	0.073	0.049	pCi/L					
G-SWMS-3	05/28	1	UF	RO/TOT	^{239,240}Pu	1.930	0.116	0.037	pCi/L	30	0.06	1.61	1.2	DOE Drinking Water DCG
G-SWMS-3	06/17	1	UF	RO/TOT	^{239,240}Pu	2.155	0.157	0.135	pCi/L	30	0.07	1.80	1.2	DOE Drinking Water DCG
G-SWMS-3	07/15	1	UF	RO/TOT	^{239,240}Pu	3.064	0.243	0.076	pCi/L	30	0.10	2.55	1.2	DOE Drinking Water DCG
G-SWMS-3	07/29	1	UF	RO/TOT	^{239,240}Pu	3.076	0.180	0.091	pCi/L	30	0.10	2.56	1.2	DOE Drinking Water DCG
G-SWMS-3	05/28	1	UF	RO/TOT	U	9.00	1.00		µg/L					
G-SWMS-3	07/15	1	UF	RO/TOT	U	9.00	1.00		µg/L					
G-SWMS-3	07/29	1	UF	RO/TOT	U	12.40	0.70		µg/L					
G-SWMS-4	05/22	1	UF	RO/TOT	Alpha	20.0	4.9		pCi/L	30	0.67	1.33	15	EPA Primary Drinking Water Standard
G-SWMS-4	06/21	1	UF	RO/TOT	Alpha	36.1	9.4		pCi/L	30	1.20	2.41	15	EPA Primary Drinking Water Standard
G-SWMS-4	07/15	1	UF	RO/TOT	Alpha	24.3	7.1		pCi/L	30	0.81	1.62	15	EPA Primary Drinking Water Standard
G-SWMS-4	05/22	1	UF	RO/TOT	^{241}Am	2.485	0.179	0.067	pCi/L	30	0.08	2.07	1.2	DOE Drinking Water DCG

Table 5-3. Detections of Radionuclides[a] and Comparison to Department of Energy Derived Concentration Guides[b] in Surface Water and Runoff Samples for 1999 (Cont.)

Station Name	Date	Code[c]	F/UF[d]	Matrix[e]	Analyte	Value	Uncertainty[f]	Detection Limit	Units	DOE DCG	Ratio of Value to DCG	Ratio of Value to Minimum Standard	Minimum Standard	Minimum Standard Type
G-SWMS-4	06/21	1	UF	RO/TOT	^{241}Am	15.168	0.665	0.073	pCi/L	30	0.51	12.64	1.2	DOE Drinking Water DCG
G-SWMS-4	07/15	1	UF	RO/TOT	^{241}Am	10.608	0.861	0.089	pCi/L	30	0.35	8.84	1.2	DOE Drinking Water DCG
G-SWMS-4	05/22	1	UF	RO/TOT	Beta	29.0	4.8		pCi/L					
G-SWMS-4	06/21	1	UF	RO/TOT	Beta	26.6	7.5		pCi/L					
G-SWMS-4	07/15	1	UF	RO/TOT	Beta	22.9	6.8		pCi/L					
G-SWMS-4	07/15	1	UF	RO/TOT	Gamma	238	53	80	pCi/L					
G-SWMS-4	05/22	1	UF	RO/TOT	^{238}Pu	0.093	0.024	0.046	pCi/L					
G-SWMS-4	07/15	1	UF	RO/TOT	^{238}Pu	0.119	0.029	0.045	pCi/L					
G-SWMS-4	05/22	1	UF	RO/TOT	$^{239,240}Pu$	0.395	0.047	0.035	pCi/L					
G-SWMS-4	06/21	1	UF	RO/TOT	$^{239,240}Pu$	0.940	0.065	0.034	pCi/L					
G-SWMS-4	07/15	1	UF	RO/TOT	$^{239,240}Pu$	1.227	0.098	0.036	pCi/L	30	0.04	1.02	1.2	DOE Drinking Water DCG
G-SWMS-5	06/17	1	UF	RO/TOT	Alpha	93.4	27.0		pCi/L	30	3.11	6.23	15	EPA Primary Drinking Water Standard
G-SWMS-5	07/08	1	UF	RO/TOT	Alpha	60.2	17.0		pCi/L	30	2.01	4.01	15	EPA Primary Drinking Water Standard
G-SWMS-5	06/17	1	UF	RO/TOT	^{241}Am	0.235	0.040	0.046	pCi/L					
G-SWMS-5	09/17	1	UF	RO/TOT	^{241}Am	0.125	0.036	0.084	pCi/L					
G-SWMS-5	06/17	1	UF	RO/TOT	Beta	92.3	27.1		pCi/L	1,000	0.09	1.85	50	EPA Screening Level
G-SWMS-5	07/08	1	UF	RO/TOT	Beta	71.6	19.3		pCi/L	1,000	0.07	1.43	50	EPA Screening Level
G-SWMS-5	09/17	1	UF	RO/TOT	Beta	29.1	9.2		pCi/L					
G-SWMS-5	06/17	1	UF	RO/TOT	^{238}Pu	0.084	0.024	0.041	pCi/L					
G-SWMS-5	07/08	1	UF	RO/TOT	^{238}Pu	0.075	0.018	0.044	pCi/L					
G-SWMS-5	06/17	1	UF	RO/TOT	$^{239,240}Pu$	1.236	0.093	0.048	pCi/L	30	0.04	1.03	1.2	DOE Drinking Water DCG
G-SWMS-5	07/08	1	UF	RO/TOT	$^{239,240}Pu$	0.182	0.025	0.021	pCi/L					
G-SWMS-6	05/24	1	UF	RO/TOT	Alpha	45.2	9.9		pCi/L	30	1.51	3.01	15	EPA Primary Drinking Water Standard
G-SWMS-6	06/13	1	UF	RO/TOT	Alpha	323.0	106.0		pCi/L	30	10.77	21.53	15	EPA Primary Drinking Water Standard
G-SWMS-6	07/08	1	UF	RO/TOT	Alpha	234.0	74.4		pCi/L	30	7.80	15.60	15	EPA Primary Drinking Water Standard
G-SWMS-6	06/13	1	UF	RO/TOT	^{241}Am	0.421	0.047	0.067	pCi/L					
G-SWMS-6	07/08	1	UF	RO/TOT	^{241}Am	0.619	0.083	0.084	pCi/L					
G-SWMS-6	07/29	1	UF	RO/TOT	^{241}Am	0.469	0.053	0.070	pCi/L					

Table 5-3. Detections of Radionuclides[a] and Comparison to Department of Energy Derived Concentration Guides[b] in Surface Water and Runoff Samples for 1999 (Cont.)

Station Name	Date	Code[c]	F/UF[d]	Matrix[e]	Analyte	Value	Uncertainty[f]	Detection Limit	Units	DOE DCG	Ratio of Value to DCG	Ratio of Value to Minimum Standard	Minimum Standard	Minimum Standard Type
G-SWMS-6	08/14	1	UF	RO/TOT	^{241}Am	0.086	0.023	0.038	pCi/L					
G-SWMS-6	08/31	1	UF	RO/TOT	^{241}Am	0.517	0.072	0.053	pCi/L					
G-SWMS-6	05/24	1	UF	RO/TOT	Beta	46.5	6.7		pCi/L					
G-SWMS-6	06/13	1	UF	RO/TOT	Beta	402.0	123.0		pCi/L	1,000	0.40	8.04	50	EPA Screening Level
G-SWMS-6	07/08	1	UF	RO/TOT	Beta	260.0	79.7		pCi/L	1,000	0.26	5.20	50	EPA Screening Level
G-SWMS-6	08/31	1	F	RO/D	Gamma	499	51	80	pCi/L					
G-SWMS-6	07/08	1	UF	RO/TOT	Gamma	166	52	80	pCi/L					
G-SWMS-6	07/29	1	UF	RO/TOT	Gamma	216	52	80	pCi/L					
G-SWMS-6	08/31	1	UF	RO/TOT	Gamma	623	62	80	pCi/L					
G-SWMS-6	05/24	1	UF	RO/TOT	^{238}Pu	0.644	0.058	0.060	pCi/L					
G-SWMS-6	06/13	1	UF	RO/TOT	^{238}Pu	0.195	0.049	0.076	pCi/L					
G-SWMS-6	07/08	1	UF	RO/TOT	^{238}Pu	0.393	0.064	0.097	pCi/L					
G-SWMS-6	07/29	1	UF	RO/TOT	^{238}Pu	0.167	0.033	0.034	pCi/L					
G-SWMS-6	08/31	1	UF	RO/TOT	^{238}Pu	0.127	0.033	0.054	pCi/L					
G-SWMS-6	05/24	1	UF	RO/TOT	^{239,240}Pu	6.878	0.260	0.014	pCi/L	30	0.23	5.73	1.2	DOE Drinking Water DCG
G-SWMS-6	06/13	1	UF	RO/TOT	^{239,240}Pu	1.557	0.142	0.067	pCi/L	30	0.05	1.30	1.2	DOE Drinking Water DCG
G-SWMS-6	07/08	1	UF	RO/TOT	^{239,240}Pu	0.764	0.088	0.062	pCi/L					
G-SWMS-6	07/29	1	UF	RO/TOT	^{239,240}Pu	0.577	0.062	0.044	pCi/L					
G-SWMS-6	08/14	1	UF	RO/TOT	^{239,240}Pu	0.160	0.029	0.034	pCi/L					
G-SWMS-6	08/31	1	UF	RO/TOT	^{239,240}Pu	0.669	0.071	0.033	pCi/L					
G-SWMS-6	07/20	1	UF	RO/TOT	U	6.60	0.90		μg/L					
G-SWMS-6	08/31	1	UF	RO/TOT	U	5.66	0.57		μg/L					
LA Canyon below TA-2	09/16	1	UF	RO/TOT	^{241}Am	0.220	0.037	0.063	pCi/L					
LA Canyon below TA-2	09/16	1	UF	RO/TOT	^{238}Pu	0.173	0.036	0.038	pCi/L					
LA Canyon below TA-2	09/16	1	UF	RO/TOT	^{239,240}Pu	6.298	0.289	0.055	pCi/L	30	0.21	5.25	1.2	DOE Drinking Water DCG
LA Canyon near LA	04/30	1	UF	RO/TOT	Alpha	81.8	17.1		pCi/L	30	2.73	5.45	15	EPA Primary Drinking Water Standard
LA Canyon near LA	05/03	1	UF	RO/TOT	Alpha	18.1	4.3		pCi/L	30	0.60	1.21	15	EPA Primary Drinking Water Standard
LA Canyon near LA	07/08	1	UF	RO/TOT	Alpha	160.0	48.7		pCi/L	30	5.33	10.67	15	EPA Primary Drinking Water Standard
LA Canyon near LA	04/30	1	F	RO/D	^{241}Am	0.083	0.026	0.073	pCi/L					
LA Canyon near LA	08/10	1	F	RO/D	^{241}Am	0.069	0.019	0.053	pCi/L					
LA Canyon near LA	04/30	1	UF	RO/TOT	^{241}Am	9.466	0.411	0.045	pCi/L	30	0.32	7.89	1.2	DOE Drinking Water DCG

Table 5-3. Detections of Radionuclides[a] and Comparison to Department of Energy Derived Concentration Guides[b] in Surface Water and Runoff Samples for 1999 (Cont.)

Station Name	Date	Code[c]	F/UF[d]	Matrix[e]	Analyte	Value	Uncertainty[f]	Detection Limit	Units	DOE DCG	Ratio of Value to DCG	Ratio of Value to Minimum Standard	Minimum Standard	Minimum Standard Type
LA Canyon near LA	05/03	1	UF	RO/TOT	^{241}Am	0.939	0.086	0.057	pCi/L					
LA Canyon near LA	07/08	1	UF	RO/TOT	^{241}Am	7.393	0.240	0.018	pCi/L	30	0.25	6.16	1.2	DOE Drinking Water DCG
LA Canyon near LA	08/09	1	UF	RO/TOT	^{241}Am	2.921	0.187	0.099	pCi/L	30	0.10	2.43	1.2	DOE Drinking Water DCG
LA Canyon near LA	08/10	1	UF	RO/TOT	^{241}Am	3.038	0.148	0.050	pCi/L	30	0.10	2.53	1.2	DOE Drinking Water DCG
LA Canyon near LA	04/30	1	UF	RO/TOT	Beta	85.2	10.1		pCi/L	1,000	0.09	1.70	50	EPA Screening Level
LA Canyon near LA	07/08	1	UF	RO/TOT	Beta	191.0	55.1		pCi/L	1,000	0.19	3.82	50	EPA Screening Level
LA Canyon near LA	04/30	1	F	RO/D	^{137}Cs	0.93	0.18	0.09	pCi/L					
LA Canyon near LA	04/30	1	UF	RO/TOT	^{137}Cs	4.02	0.40	0.08	pCi/L					
LA Canyon near LA	05/03	1	UF	RO/TOT	^{137}Cs	1.81	0.36	0.93	pCi/L					
LA Canyon near LA	07/08	1	UF	RO/TOT	^{137}Cs	42.27	5.04	2.78	pCi/L					
LA Canyon near LA	08/09	1	UF	RO/TOT	^{137}Cs	10.32	2.53	4.57	pCi/L					
LA Canyon near LA	08/10	1	UF	RO/TOT	^{137}Cs	7.23	1.48	2.37	pCi/L					
LA Canyon near LA	04/30	1	UF	RO/TOT	^{238}Pu	0.106	0.028	0.074	pCi/L					
LA Canyon near LA	05/03	1	UF	RO/TOT	^{238}Pu	0.184	0.038	0.057	pCi/L					
LA Canyon near LA	07/08	1	UF	RO/TOT	^{238}Pu	1.531	0.122	0.071	pCi/L					
LA Canyon near LA	08/09	1	UF	RO/TOT	^{238}Pu	0.222	0.040	0.060	pCi/L					
LA Canyon near LA	08/10	1	UF	RO/TOT	^{238}Pu	0.220	0.040	0.072	pCi/L					
LA Canyon near LA	04/30	1	F	RO/D	^{239,240}Pu	0.033	0.009	0.013	pCi/L					
LA Canyon near LA	08/10	1	F	RO/D	^{239,240}Pu	0.112	0.023	0.054	pCi/L					
LA Canyon near LA	04/30	1	UF	RO/TOT	^{239,240}Pu	1.787	0.101	0.063	pCi/L	30	0.06	1.49	1.2	DOE Drinking Water DCG
LA Canyon near LA	05/03	1	UF	RO/TOT	^{239,240}Pu	1.568	0.116	0.060	pCi/L	30	0.05	1.31	1.2	DOE Drinking Water DCG
LA Canyon near LA	07/08	1	UF	RO/TOT	^{239,240}Pu	15.778	0.638	0.078	pCi/L	30	0.53	13.15	1.2	DOE Drinking Water DCG
LA Canyon near LA	08/09	1	UF	RO/TOT	^{239,240}Pu	2.471	0.149	0.045	pCi/L	30	0.08	2.06	1.2	DOE Drinking Water DCG
LA Canyon near LA	08/10	1	UF	RO/TOT	^{239,240}Pu	5.291	0.235	0.036	pCi/L	30	0.18	4.41	1.2	DOE Drinking Water DCG
LA Canyon near LA	07/13	1	UF	RO/TOT	U	8.20	0.70		µg/L					
LA Canyon near LA	08/09	1	UF	RO/TOT	U	7.33	0.73		µg/L					
North Fork Ancho Canyon at TA-39	09/16	1	UF	RO/TOT	^{241}Am	0.196	0.033	0.056	pCi/L					
North Fork Ancho Canyon at TA-39	09/16	1	UF	RO/TOT	Gamma	159	49	80	pCi/L					

Table 5-3. Detections of Radionuclides[a] and Comparison to Department of Energy Derived Concentration Guides[b] in Surface Water and Runoff Samples for 1999 (Cont.)

Station Name	Date	Code[c]	F/UF[d]	Matrix[e]	Analyte	Value	Uncertainty[f]	Detection Limit	Units	DOE DCG	Ratio of Value to DCG	Ratio of Value to Minimum Standard	Minimum Standard	Minimum Standard Type
North Fork Ancho Canyon at TA-39	09/16	1	UF	RO/TOT	^{238}Pu	0.050	0.015	0.024	pCi/L					
North Fork Ancho Canyon at TA-39	09/16	1	UF	RO/TOT	^{239,240}Pu	0.137	0.025	0.024	pCi/L					
North Fork Ancho Canyon at TA-39	09/16	1	UF	RO/TOT	U	8.80	0.90		μg/L					
Pajarito Canyon above SR-4	06/17	1	UF	RO/TOT	^{241}Am	7.853	0.238	0.023	pCi/L	30	0.26	6.54	1.2	DOE Drinking Water DCG
Pajarito Canyon above SR-4	06/17	1	UF	RO/TOT	^{238}Pu	0.100	0.031	0.086	pCi/L					
Pajarito Canyon above SR-4	06/17	1	F	RO/D	^{239,240}Pu	0.444	0.041	0.017	pCi/L					
Pajarito Canyon above SR-4	06/17	1	UF	RO/TOT	^{239,240}Pu	1.565	0.109	0.055	pCi/L	30	0.05	1.30	1.2	DOE Drinking Water DCG
Pajarito Canyon above Threemile Canyon	09/16	1	F	RO/D	^{137}Cs	29.43	8.43	3.87	pCi/L					
Pajarito Canyon above Threemile Canyon	09/16	1	UF	RO/TOT	^{239,240}Pu	0.088	0.027	0.051	pCi/L					
Potrillo Canyon near White Rock	08/31	1	UF	RO/TOT	^{241}Am	0.085	0.023	0.051	pCi/L					
Potrillo Canyon near White Rock	09/16	1	UF	RO/TOT	^{241}Am	0.055	0.017	0.034	pCi/L					
Potrillo Canyon near White Rock	08/31	1	UF	RO/TOT	^{137}Cs	3.85	1.22	2.11	pCi/L					
Potrillo Canyon near White Rock	08/31	1	UF	RO/TOT	Gamma	470	51	80	pCi/L					
Potrillo Canyon near White Rock	09/16	1	UF	RO/TOT	Gamma	147	49	80	pCi/L					
Potrillo Canyon near White Rock	08/31	1	UF	RO/TOT	^{239,240}Pu	0.431	0.067	0.076	pCi/L					
Sandia Canyon below Power Plant	05/28	1	UF	RO/TOT	Alpha	24.3	5.8		pCi/L	30	0.81	1.62	15	EPA Primary Drinking Water Standard
Sandia Canyon below Power Plant	05/28	1	UF	RO/TOT	Beta	30.2	5.4		pCi/L					
Sandia Canyon below Wetlands	07/12	1	UF	RO/TOT	Beta	36.0	12.0		pCi/L					
Sandia Canyon below Wetlands	07/12	1	UF	RO/TOT	^{238}Pu	1.183	0.079	0.050	pCi/L					
Sandia Canyon near Roads & Grounds at TA-3	05/28	1	UF	RO/TOT	Alpha	19.6	4.9		pCi/L	30	0.65	1.31	15	EPA Primary Drinking Water Standard

Table 5-3. Detections of Radionuclides[a] and Comparison to Department of Energy Derived Concentration Guides[b] in Surface Water and Runoff Samples for 1999 (Cont.)

Station Name	Date	Code[c]	F/UF[d]	Matrix[e]	Analyte	Value	Uncertainty[f]	Detection Limit	Units	DOE DCG	Ratio of Value to DCG	Ratio of Value to Minimum Standard	Minimum Standard	Minimum Standard Type
Sandia Canyon near Roads & Grounds at TA-3	07/14	1	UF	RO/TOT	^{241}Am	0.045	0.011	0.014	pCi/L					
Sandia Canyon near Roads & Grounds at TA-3	05/28	1	UF	RO/TOT	Beta	25.8	4.9		pCi/L					
Acid Weir	06/23	1	UF	SW	^{241}Am	0.033	0.009	0.022	pCi/L					
Acid Weir	06/23	1	UF	SW	$^{239,240}Pu$	0.528	0.045	0.036	pCi/L					
Frijoles at Rio Grande	12/22	1	UF	SW	Gamma	286	50	0	pCi/L					
Jemez River	08/02	1	UF	SW	^{241}Am	0.039	0.011	0.035	pCi/L					
Jemez River	08/02	1	UF	SW	Gamma	154	51	80	pCi/L					
Los Alamos at Upper GS	05/26	1	UF	SW	$^{239,240}Pu$	0.051	0.015	0.028	pCi/L					
Mortandad at GS-1	05/27	1	UF	SW	Alpha	27.5	9.1		pCi/L	30	0.92	1.83	15	EPA Primary Drinking Water Standard
Mortandad at GS-1	05/27	1	UF	SW	^{241}Am	4.438	0.154	0.048	pCi/L	30	0.15	3.70	1.2	DOE Drinking Water DCG
Mortandad at GS-1	05/27	1	UF	SW	Beta	81.6	19.9		pCi/L	1,000	0.08	1.63	50	EPA Screening Level
Mortandad at GS-1	05/27	1	UF	SW	^{3}H	2,480	760	410	pCi/L					
Mortandad at GS-1	05/27	1	UF	SW	^{238}Pu	8.108	0.250	0.028	pCi/L	40	0.20	5.07	1.6	DOE Drinking Water DCG
Mortandad at GS-1	05/27	1	UF	SW	$^{239,240}Pu$	3.757	0.140	0.032	pCi/L	30	0.13	3.13	1.2	DOE Drinking Water DCG
Mortandad at GS-1	05/27	1	UF	SW	^{137}Cs	28.63	3.54	2.21	pCi/L					
Pueblo at SR-502	08/04	1	UF	SW	Gamma	175	51	80	pCi/L					
Pueblo at SR-502	08/04	1	UF	SW	$^{239,240}Pu$	0.129	0.020	0.016	pCi/L					
Rio Chama at Chamita	06/16	1	UF	SW	^{241}Am	0.063	0.015	0.030	pCi/L					
Rio Chama at Chamita	06/16	1	UF	SW	^{241}Am	0.036	0.010	0.018	pCi/L					
Rio Grande at Otowi (bank)	08/03	1	UF	SW	Gamma	184	51	80	pCi/L					
Rio Grande at Otowi Upper (bank)	08/03	1	UF	SW	Gamma	154	51	80	pCi/L					
SCS-3	06/16	1	UF	SW	^{238}Pu	0.208	0.034	0.042	pCi/L					

[a] Detection defined as value ≥ 3× uncertainty and ≥ detection limit, except values shown for uranium ≥ 5 μg/L, for gross alpha ≥ 5 pCi/L, and for gross beta ≥ 20 pCi/L.
[b] Values indicated by entries in righthand columns are greater than the minimum standard shown. The minimum standard is either a DOE DCG for DOE-administered drinking water systems or an EPA drinking water standard.
[c] Codes: 1–primary analysis; 2–secondary analysis; R–lab replicate; D–lab duplicate.
[d] F/UF: F–filtered; UF–unfiltered.
[e] Matrix: SW–surface water; RO–runoff; D–dissolved; TOT–total.
[f] One standard deviation radioactivity counting uncertainty.

Table 5-4. Detections of Strontium-90[a] and Comparison to Department of Energy Derived Concentration Guides[b] in Surface Water and Runoff Samples for 1999
(LANL's 1999 strontium-90 data are not valid because of analytical laboratory problems; the data appear in this report for documentary purposes only.)

Station Name	Date	Code[c]	F/UF[d]	Matrix[e]	Analyte	Value	Uncertainty[f]	Detection Limit	Units	DOE DCG	Ratio of Value to DCG	Ratio of Value to Minimum Standard	Minimum Standard	Minimum Standard Type
Ancho Canyon at TA-39	08/04	1	UF	RO/TOT	^{90}Sr	73.77	4.58	1.63	pCi/L	1,000	0.07	9.22	8	EPA Primary Drinking Water Standard
Ancho Canyon at TA-39	08/10	1	UF	RO/TOT	^{90}Sr	63.58	4.00	1.55	pCi/L	1,000	0.06	7.95	8	EPA Primary Drinking Water Standard
Ancho Canyon near Bandelier	07/08	1	F	RO/D	^{90}Sr	0.79	0.24	0.44	pCi/L					
Ancho Canyon near Bandelier	06/18	1	UF	RO/TOT	^{90}Sr	60.95	3.27	0.54	pCi/L	1,000	0.06	7.62	8	EPA Primary Drinking Water Standard
Ancho Canyon near Bandelier	07/08	1	UF	RO/TOT	^{90}Sr	19.98	1.19	0.42	pCi/L	1,000	0.02	2.50	8	EPA Primary Drinking Water Standard
Cañada del Buey at WR	06/17	1	UF	RO/TOT	^{90}Sr	58.82	3.05	0.29	pCi/L	1,000	0.06	7.35	8	EPA Primary Drinking Water Standard
Cañada del Buey at WR	08/06	1	UF	RO/TOT	^{90}Sr	36.37	2.22	0.74	pCi/L	1,000	0.04	4.55	8	EPA Primary Drinking Water Standard
Cañada del Buey at WR	08/23	1	UF	RO/TOT	^{90}Sr	55.07	3.18	0.75	pCi/L	1,000	0.06	6.88	8	EPA Primary Drinking Water Standard
DP Canyon near Los Alamos	06/23	1	F	RO/D	^{90}Sr	10.05	0.66	0.35	pCi/L	1,000	0.01	1.26	8	EPA Primary Drinking Water Standard
DP Canyon near Los Alamos	06/23	1	UF	RO/TOT	^{90}Sr	32.25	1.73	0.29	pCi/L	1,000	0.03	4.03	8	EPA Primary Drinking Water Standard
DP Canyon near Los Alamos	08/14	1	UF	RO/TOT	^{90}Sr	14.17	1.11	0.82	pCi/L	1,000	0.01	1.77	8	EPA Primary Drinking Water Standard
G-SWMS-1	07/29	1	UF	RO/TOT	^{90}Sr	21.67	1.24	0.34	pCi/L	1,000	0.02	2.71	8	EPA Primary Drinking Water Standard
G-SWMS-2	05/24	1	UF	RO/TOT	^{90}Sr	33.82	1.82	0.30	pCi/L	1,000	0.03	4.23	8	EPA Primary Drinking Water Standard
G-SWMS-2	07/08	1	UF	RO/TOT	^{90}Sr	11.91	0.71	0.27	pCi/L	1,000	0.01	1.49	8	EPA Primary Drinking Water Standard
G-SWMS-2	07/29	1	UF	RO/TOT	^{90}Sr	12.11	0.95	0.68	pCi/L	1,000	0.01	1.51	8	EPA Primary Drinking Water Standard
G-SWMS-3	07/29	1	F	RO/D	^{90}Sr	0.69	0.18	0.33	pCi/L					
G-SWMS-3	05/28	1	UF	RO/TOT	^{90}Sr	101.40	5.15	0.33	pCi/L	1,000	0.10	12.68	8	EPA Primary Drinking Water Standard
G-SWMS-3	06/17	1	UF	RO/TOT	^{90}Sr	76.50	4.00	0.46	pCi/L	1,000	0.08	9.56	8	EPA Primary Drinking Water Standard
G-SWMS-3	07/15	1	UF	RO/TOT	^{90}Sr	43.97	2.58	0.86	pCi/L	1,000	0.04	5.50	8	EPA Primary Drinking Water Standard
G-SWMS-3	07/29	1	UF	RO/TOT	^{90}Sr	10.82	0.71	0.37	pCi/L	1,000	0.01	1.35	8	EPA Primary Drinking Water Standard

Table 5-4. Detections of Strontium-90[a] and Comparison to Department of Energy Derived Concentration Guides[b] in Surface Water and Runoff Samples for 1999 (Cont.)
(LANL's 1999 strontium-90 data are not valid because of analytical laboratory problems; the data appear in this report for documentary purposes only.)

Station Name	Date	Code[c]	F/UF[d]	Matrix[e]	Analyte	Value	Uncertainty[f]	Detection Limit	Units	DOE DCG	Ratio of Value to DCG	Ratio of Value to Minimum Standard	Minimum Standard	Minimum Standard Type
G-SWMS-4	05/22	1	UF	RO/TOT	^{90}Sr	7.74	0.53	0.30	pCi/L					
G-SWMS-4	06/21	1	UF	RO/TOT	^{90}Sr	2.08	0.25	0.34	pCi/L					
G-SWMS-4	07/15	1	UF	RO/TOT	^{90}Sr	2.26	0.26	0.34	pCi/L					
G-SWMS-5	06/17	1	UF	RO/TOT	^{90}Sr	28.48	1.53	0.26	pCi/L	1,000	0.03	3.56	8	EPA Primary Drinking Water Standard
G-SWMS-5	07/08	1	UF	RO/TOT	^{90}Sr	6.39	0.45	0.29	pCi/L					
G-SWMS-6	05/24	1	UF	RO/TOT	^{90}Sr	13.91	0.83	0.30	pCi/L	1,000	0.01	1.74	8	EPA Primary Drinking Water Standard
G-SWMS-6	06/13	1	UF	RO/TOT	^{90}Sr	15.15	0.87	0.25	pCi/L	1,000	0.02	1.89	8	EPA Primary Drinking Water Standard
G-SWMS-6	07/08	1	UF	RO/TOT	^{90}Sr	16.33	0.94	0.27	pCi/L	1,000	0.02	2.04	8	EPA Primary Drinking Water Standard
G-SWMS-6	07/29	1	UF	RO/TOT	^{90}Sr	20.00	1.14	0.31	pCi/L	1,000	0.02	2.50	8	EPA Primary Drinking Water Standard
G-SWMS-6	08/14	1	UF	RO/TOT	^{90}Sr	5.59	0.65	0.81	pCi/L					
G-SWMS-6	08/31	1	UF	RO/TOT	^{90}Sr	14.49	1.01	0.55	pCi/L	1,000	0.01	1.81	8	EPA Primary Drinking Water Standard
LA Canyon near LA	04/30	1	F	RO/D	^{90}Sr	5.47	0.42	0.32	pCi/L					
LA Canyon near LA	05/03	1	F	RO/D	^{90}Sr	3.31	0.30	0.31	pCi/L					
LA Canyon near LA	07/08	1	F	RO/D	^{90}Sr	5.15	0.41	0.35	pCi/L					
LA Canyon near LA	08/09	1	F	RO/D	^{90}Sr	2.31	0.31	0.42	pCi/L					
LA Canyon near LA	08/10	1	F	RO/D	^{90}Sr	3.22	0.81	1.47	pCi/L					
LA Canyon near LA	04/30	1	UF	RO/TOT	^{90}Sr	32.06	1.74	0.30	pCi/L	1,000	0.03	4.01	8	EPA Primary Drinking Water Standard
LA Canyon near LA	05/03	1	UF	RO/TOT	^{90}Sr	4.28	0.37	0.35	pCi/L					
LA Canyon near LA	07/08	1	UF	RO/TOT	^{90}Sr	32.91	1.75	0.26	pCi/L	1,000	0.03	4.11	8	EPA Primary Drinking Water Standard
LA Canyon near LA	08/09	1	UF	RO/TOT	^{90}Sr	29.80	1.67	0.39	pCi/L	1,000	0.03	3.72	8	EPA Primary Drinking Water Standard
LA Canyon near LA	08/10	1	UF	RO/TOT	^{90}Sr	36.76	2.29	0.84	pCi/L	1,000	0.04	4.59	8	EPA Primary Drinking Water Standard
Pajarito Canyon above SR-4	06/17	1	F	RO/D	^{90}Sr	0.46	0.14	0.27	pCi/L					
Pajarito Canyon above SR-4	06/17	1	UF	RO/TOT	^{90}Sr	10.26	0.64	0.27	pCi/L	1,000	0.01	1.28	8	EPA Primary Drinking Water Standard
Potrillo Canyon near White Rock	08/31	1	UF	RO/TOT	^{90}Sr	14.17	0.96	0.49	pCi/L	1,000	0.01	1.77	8	EPA Primary Drinking Water Standard

Table 5-4. Detections of Strontium-90[a] and Comparison to Department of Energy Derived Concentration Guides[b] in Surface Water and Runoff Samples for 1999 (Cont.)
(LANL's 1999 strontium-90 data are not valid because of analytical laboratory problems; the data appear in this report for documentary purposes only.)

Station Name	Date	Code[c]	F/UF[d]	Matrix[e]	Analyte	Value	Uncertainty[f]	Detection Limit	Units	DOE DCG	Ratio of Value to DCG	Ratio of Value to Minimum Standard	Minimum Standard	Minimum Standard Type
Sandia Canyon below Power	05/28	1	UF	RO/TOT	^{90}Sr	6.95	0.47	0.26	pCi/L					
Sandia Canyon below	07/12	1	UF	RO/TOT	^{90}Sr	3.94	0.34	0.32	pCi/L					
Sandia Canyon near Roads & Grounds at TA-3	05/28	1	UF	RO/TOT	^{90}Sr	5.56	0.39	0.25	pCi/L					
Sandia Canyon near Roads & Grounds at TA-3	07/14	1	UF	RO/TOT	^{90}Sr	1.57	0.22	0.32	pCi/L					
Sandia Canyon near Roads & Grounds at TA-3	08/10	1	UF	RO/TOT	^{90}Sr	4.33	0.81	1.33	pCi/L					
Acid Weir	06/23	1	UF	SW	^{90}Sr	1.33	0.21	0.33	pCi/L					
Los Alamos at Upper GS	05/26	1	UF	SW	^{90}Sr	2.85	0.27	0.30	pCi/L					
Los Alamos Canyon Reservoir	06/23	1	UF	SW	^{90}Sr	8.66	0.57	0.31	pCi/L	1,000	0.01	1.08	8	EPA Primary Drinking Water Standard
Mortandad at GS-1	05/27	1	UF	SW	^{90}Sr	16.45	0.96	0.31	pCi/L	1,000	0.02	2.06	8	EPA Primary Drinking Water Standard
Pueblo 1	06/23	1	UF	SW	^{90}Sr	21.36	1.19	0.27	pCi/L	1,000	0.02	2.67	8	EPA Primary Drinking Water Standard
Rio Chama at Chamita	06/16	1	UF	SW	^{90}Sr	0.66	0.19	0.36	pCi/L					
Rio Chama at Chamita	06/16	1	UF	SW	^{90}Sr	0.70	0.18	0.34	pCi/L					
Rio Grande at Otowi (bank)	08/03	1	UF	SW	^{90}Sr	1.76	0.46	0.82	pCi/L					
SCS-1	05/27	1	UF	SW	^{90}Sr	3.57	0.34	0.37	pCi/L					
SCS-3	06/16	1	UF	SW	^{90}Sr	0.67	0.18	0.35	pCi/L					

[a] Detection defined as value ≥ 3× uncertainty and ≥ detection limit, except values shown for uranium ≥ 5 μg/L, for gross alpha ≥ 5 pCi/L, and for gross beta ≥ 20 pCi/L.
[b] Values indicated by entries in righthand columns are greater than the minimum standard shown. The minimum standard is either a DOE DCG for DOE-administered drinking water systems or an EPA drinking water standard.
[c] Codes: 1–primary analysis; 2–secondary analysis; R–lab replicate; D–lab duplicate.
[d] F/UF: F–filtered; UF–unfiltered.
[e] Matrix: SW–surface water; RO–runoff; D–dissolved; TOT–total.
[f] One standard deviation radioactivity counting uncertainty.

Table 5-5 Summary of TA-50 Radionuclide, Nitrate, and Fluoride Discharges[a]

Radionuclide	1963–1977 Total Activity Released (mCi)[b]	1997 Total Annual Activity (mCi)	1997 Mean Activity (pCi/L)	1997 Ratio of Activity to DCG[c]	1998 Total Annual Activity (mCi)	1998 Mean Activity (pCi/L)	1998 Ratio of Activity to DCG[c]	1999 Total Annual Activity (mCi)	1999 Mean Activity (pCi/L)	1999 Ratio of Activity to DCG[c]
^{3}H	25,150	1,330	76,300	0.04	1,228	52,840	0.03	485	24,252	0.01
^{241}Am	7	2.56	147	4.90	2	99.1	3.30	1.1	55.0	1.83
^{137}Cs	848	2.48	142	0.05	1	43.4	0.01	1.5	76.9	0.026
^{238}Pu	51	1.34	76.7	1.92	2	97.9	2.45	2.4	121.3	3.03
$^{239,240}Pu$	39	0.80	45.9	1.53	0.91	39	1.30	1.40	70.0	2.33
^{89}Sr	<1	0.83	47.7	0.002	2	86.8	0.004	0.36	18.2	0.0009
^{90}Sr	295	0.50	28.5	0.03	0.82	35.3	0.04	0.52	26.0	0.026
^{234}U	NA	0.08	4.88	0.01	0.12	5.1	0.01	0.17	8.6	0.017
^{235}U	2	0.007	0.44	0.0007	0.053	2.3	0.004	0.0047	0.24	0.0004

Constituent	1997 Total Annual Mass (kg)	1997 Mean Concentration (mg/L)	1997 Ratio of Concentration to MCL[d]	1998 Total Annual Mass (kg)	1998 Mean Concentration (mg/L)	1998 Ratio of Concentration to MCL[d]	1999 Total Annual Mass (kg)	1999 Mean Concentration (mg/L)	1999 Ratio of Concentration to MCL[d]
NO_3-N	1,220	69.6	7.0	1,420	61.1	6.1	486	24.2	2.4
F	34.9	2.00	1.2	37.6	1.62	1.0	22.6	1.12	0.7
Total effluent volume ($\times 10^7$ liters)	1.75			2.32			2.00		

[a]Compiled from Radioactive Liquid Waste Group (FWO-RLW) Annual Reports. Data for 1999 are preliminary.
[b]DOE 1979; decay corrected through 12/77.
[c]Public dose limit.
[d]New Mexico Groundwater Limit.

Table 5-6. Chemical Quality of Surface Water and Runoff Samples for 1999 (mg/L[a])

Station Name	Date	Matrix[b]	F/UF[c]	SiO_2	Ca	Mg	K	Na	Cl	SO_4	CO_3 Alkalinity	Total Alkalinity	F	PO_4-P	NO_3-N	CN	TDS[d]	TSS[e]	Hardness as $CaCO_3$	pH[f]	Conductance (μS/cm)
Regional Stations																					
Rio Chama at Chamita	06/16	RO/TOT	F	14	40.7	7.8	<0.7[g]	15.8	3.8	59.5	<5	85	0.14	<0.03	<0.01		196		134.0	8.3	316
Rio Chama at Chamita	06/16	SW	F	14	38.7	7.5	1.1	14.9	3.8	53.0	<5	78	0.16	<0.03	<0.01		210		127.5	8.3	316
Rio Chama at Chamita	06/16	SW	UF													<0.01		20			
Rio Chama at Chamita	06/16	SW	UF													<0.01		16			
Rio Grande at Embudo	10/05	SW	F	24	25.9	5.0	3.0	15.4	3.9	26.2	<5	84	0.34	0.06	0.06		150		85.1	8.1	200
Rio Grande at Embudo	10/05	SW	UF													0.04		11			
Rio Grande at Otowi Upper (bank)	08/03	SW	F	21	28.5	4.9	2.4	13.9	3.6	34.1	<5	86	0.29	<0.03	0.09		160		91.3	8.2	238
Rio Grande at Otowi Upper (bank)	08/03	SW	UF													0.04		1,366			
Rio Grande at Otowi (bank)	08/03	SW	F		28.1	4.8	1.9	14.0							<0.03	0.11				89.8	
Rio Grande at Otowi (bank)	08/03	SW	UF													0.01		374			
Rio Grande at Otowi (bank)	08/04	SW	F	21					3.7	34.4	<5	83	0.30					168		7.1	235
Rio Grande at Frijoles (bank)	09/22	SW	F	23	28.5	5.0	2.4	14.0	3.7	30.1	<5	84	0.28	<0.03	0.02		172		91.6	8.2	243
Rio Grande at Frijoles (bank)	09/22	SW	F	23	28.8	5.0	2.1	14.0	3.8	30.1	<5	88	0.30	<0.03	0.02		162		92.7	8.2	243
Rio Grande at Frijoles (bank)	09/22	SW	UF													0.02		129			
Rio Grande at Frijoles (bank)	09/22	SW	UF													0.01		98			
Rio Grande at Cochiti	09/20	SW	F											<0.03	0.02						
Rio Grande at Cochiti	09/23	SW	F	23	25.4	4.3	2.9	12.6	3.8	30.0	<5	92	0.30				182		81.2	8.2	231
Rio Grande at Cochiti	09/23	SW	UF													0.01		142			
Jemez River	08/02	SW	F	16	26.5	2.3	1.2	5.0	1.8	2.5	<5	84	0.23				110		75.4	8.0	159
Jemez River	08/02	SW	F	15	26.3	2.3	1.4	5.1	1.8	2.4	<5	81	0.24				108		75.2	7.9	160
Jemez River	08/02	SW	UF													0.04					
Jemez River	08/02	SW	UF													0.02		198			
Jemez River	08/03	SW	F											<0.03	0.02						
Jemez River	08/04	SW	UF															196			
Pararito Plateau																					
Guaje Canyon:																					
Guaje Canyon	11/16	SW	F	50	6.0	2.1	1.8	6.0	<1.0	2.4	<5	36	0.12	0.05	0.10		88		23.6	7.4	74
Guaje Canyon	11/16	SW	UF													0.03		1			
Acid/Pueblo Canyon:																					
Acid Weir	06/23	SW	F	21	16.3	1.7	4.0	29.5	45.0	5.2	<5	44	0.21	0.27	0.66		138		47.8	6.9	260
Acid Weir	06/23	SW	UF													<0.01		10			
Pueblo 1	06/23	SW	F	18	13.1	2.2	3.5	27.8	31.2	5.9	<5	54	0.14	0.32	0.03		126		41.6	7.5	226
Pueblo 1	06/23	SW	UF													<0.01		2			
Pueblo 3	05/20	SW	F	76	28.3	7.0	11.3	67.6	42.8	11.0	<5	231	0.68	6.56	0.40		364		99.3	7.8	605
Pueblo 3	05/20	SW	UF													0.01		3.4			

Table 5-6. Chemical Quality of Surface Water and Runoff Samples for 1999 (mg/L[a]) (Cont.)

Station Name	Date	Matrix[b]	F/UF[c]	SiO_2	Ca	Mg	K	Na	Cl	SO_4	CO_3 Alkalinity	Total Alkalinity	F	PO_4-P	NO_3-N	CN	TDS[d]	TSS[e]	Hardness as $CaCO_3$	pH[f]	Conductance (μS/cm)
Pararito Plateau (Cont.)																					
Acid/Pueblo Canyon: (Cont.)																					
Pueblo at SR-502	08/02	SW	UF															<1			
Pueblo at SR-502	12/01	SW	UF															76			
DP/Los Alamos Canyon:																					
Los Alamos Canyon Reservoir	06/23	SW	F	33	7.5	2.5	2.3	6.0	5.8	3.8	<5	30	0.07	0.09	<0.01		80		29.0	8.4	88
Los Alamos Canyon Reservoir	06/23	SW	UF													<0.01		<1			
Los Alamos at Upper Gaging Station	05/26	SW	UF															2			
Sandia Canyon:																					
SCS-1	05/27	SW	F	94	21.1	6.2	10.9	101.7	87.0	46.0	<5	128	0.37	3.25	4.77		484		78.3	8.2	684
SCS-1	05/27	SW	UF													0.03		28			
SCS-2	05/19	SW	F	83	23.1	5.6	13.4	153.1	101.0	138.0	<5	165	0.64	3.38	1.72		642		80.9	8.5	917
SCS-2	05/19	SW	UF													0.02		2.4			
SCS-3	06/16	SW	F	80	19.8	4.8	10.1	109.7	75.4	63.8	<5	132	0.51	3.10	2.95		456		69.1	8.6	686
SCS-3	06/16	SW	UF													<0.01		13			
Mortandad Canyon:																					
Mortandad at Gaging Station 1	05/27	SW	F	65	30.8	3.0	4.9	28.4	8.0	10.4	<5	122	0.74	0.36	2.54		240		89.5	8.0	302
Mortandad at Gaging Station 1	05/27	SW	UF													0.03		<1			
Mortandad at Rio Grande (A-11)	09/20	SW	F	83	29.2	5.6	13.5	68.5	57.7	34.0	<5	129	0.42				388		96.2	8.0	563
Mortandad at Rio Grande (A-11)	09/20	SW	UF													0.01		6			
Mortandad at Rio Grande (A-11)	09/23	SW	F											0.98	5.06						
Pajarito Canyon:																					
Pajarito at Rio Grande	09/21	SW	F	69	20.3	4.2	2.7	12.2	4.4	5.4	<5	87	0.43	<0.03	0.66		170		68.1	8.3	197
Pajarito at Rio Grande	09/21	SW	UF													0.01		<1			
Water Canyon:																					
Water Canyon at Beta	11/17	SW	F	39	11.7	3.6	3.5	15.0	14.0	2.4	<5	63	0.13	0.07	0.01		142		44.3	7.1	153
Water Canyon at Beta	11/17	SW	UF													0.03		4			
Ancho Canyon:																					
Ancho at Rio Grande	09/21	SW	F	76	14.7	3.4	2.1	9.8	3.4	1.9	<5	74	0.34	<0.03	0.05		150		50.4	8.4	143
Ancho at Rio Grande	09/21	SW	UF													0.01		2			
Frijoles Canyon:																					
Frijoles at Monument Headquarters	12/22	SW	F	64	7.7	2.5	2.6	9.1	2.4	1.7	<5	48	0.11	<0.02	0.07		102		29.7	7.6	108
Frijoles at Monument Headquarters	12/22	SW	UF													0.04		1			
Frijoles at Rio Grande	12/22	SW	F	62	8.0	2.6	2.9	9.3	2.8	1.7	<5	45	0.13	<0.02	0.05		90		30.9	7.6	108
Frijoles at Rio Grande	12/22	SW	UF													0.03		15			

Table 5-6. Chemical Quality of Surface Water and Runoff Samples for 1999 (mg/L[a]) (Cont.)

Station Name	Date	Matrix[b]	F/UF[c]	SiO_2	Ca	Mg	K	Na	Cl	SO_4	CO_3 Alkalinity	Total Alkalinity	F	PO_4-P	NO_3-N	CN	TDS[d]	TSS[e]	Hardness as $CaCO_3$	pH[f]	Conductance (µS/cm)
Runoff Stations																					
Perimeter:																					
LA Canyon near Los Alamos	04/30	RO/D	F	12	12.0	1.8	3.0	15.0	36.8	4.0	<5	41	0.13				182		37.4	7.8	157
LA Canyon near Los Alamos	04/30	RO/TOT	UF															3,900			
LA Canyon near Los Alamos	05/03	RO/D	F	34	11.0	2.5	2.1	15.0	23.2	4.0	<5	34	0.06	0.18	0.06		92		37.8	7.5	159
LA Canyon near Los Alamos	05/03	RO/TOT	UF													0.01		654			
LA Canyon near Los Alamos	07/08	RO/TOT	UF															11,625			
LA Canyon near Los Alamos	08/09	RO/D	F		18.6	2.4	4.2	6.0													
LA Canyon near Los Alamos	08/09	RO/TOT	UF		77.2	14.1	12.2	7.8										25,575			
LA Canyon near Los Alamos	08/10	RO/TOT	UF															3,340			
LA Canyon near Los Alamos	08/10	RO/TOT	UF															3,836			
LA Canyon below TA-2	09/16	RO/TOT	UF															4,270			
LA Canyon below TA-2	09/16	RO/TOT	UF															7,840			
DP Canyon near Los Alamos	06/23	RO/TOT	UF													<0.01		3,304			
DP Canyon near Los Alamos	06/23	RO/TOT	UF															3,160			
DP Canyon near Los Alamos	08/14	RO/TOT	UF															1,132			
DP Canyon near Los Alamos	08/14	RO/TOT	UF															968			
DP Canyon near Los Alamos	09/16	RO/TOT	UF															4,730			
DP Canyon near Los Alamos	09/16	RO/TOT	UF															13,610			
Sandia Canyon below Power Plant	05/28	RO/TOT	UF															1,430			
Sandia Canyon below Power Plant	07/14	RO/TOT	UF															656			
Sandia Canyon below Power Plant	07/14	RO/TOT	UF															720			
Sandia Canyon below Wetlands	07/14	RO/TOT	UF															1,393			
Sandia Canyon below Wetlands	07/18	RO/TOT	UF															1,368			
Sandia Canyon below Wetlands	07/18	RO/TOT	UF															1,536			
Sandia Canyon below Wetlands	08/10	RO/TOT	UF															422			
Sandia Canyon below Wetlands	08/10	RO/TOT	UF															508			
Sandia Canyon near Roads & Grounds at TA-3	05/28	RO/TOT	UF															870			
Sandia Canyon near Roads & Grounds at TA-3	07/14	RO/TOT	UF															160			
Sandia Canyon near Roads & Grounds at TA-3	07/14	RO/TOT	UF															160			
Sandia Canyon near Roads & Grounds at TA-3	08/10	RO/TOT	UF															1,676			
Sandia Canyon near Roads & Grounds at TA-3	08/10	RO/TOT	UF															2,202			
Sandia Canyon Truck Route	09/14	RO/TOT	UF															5,100			
Sandia Canyon Truck Route	09/14	RO/TOT	UF															2,960			

Table 5-6. Chemical Quality of Surface Water and Runoff Samples for 1999 (mg/L[a]) (Cont.)

Station Name	Date	Matrix[b]	F/UF[c]	SiO_2	Ca	Mg	K	Na	Cl	SO_4	CO_3 Alkalinity	Total Alkalinity	F	PO_4-P	NO_3-N	CN	TDS[d]	TSS[e]	Hardness as $CaCO_3$	pH[f]	Conductance (μS/cm)
Runoff Stations (Cont.)																					
Perimeter: (Cont.)																					
Cañada del Buey at White Rock	06/17	RO/D	F	5	8.8	1.2	2.4	1.2	1.0	1.4	<5	33	0.10	0.12	0.20		38		26.9	7.5	56
Cañada del Buey at White Rock	06/17	RO/TOT	UF		120.8	13.4	12.5	1.6								<0.01		11,292			
Cañada del Buey at White Rock	06/17	RO/TOT	UF															18,380			
Cañada del Buey at White Rock	07/08	RO/TOT	UF															6,812			
Cañada del Buey at White Rock	07/08	RO/TOT	UF															5,368			
Cañada del Buey at White Rock	08/06	RO/TOT	UF															14,625			
Cañada del Buey at White Rock	08/06	RO/TOT	UF															15,150			
Cañada del Buey at White Rock	08/23	RO/TOT	UF															25,420			
Cañada del Buey at White Rock	08/23	RO/TOT	UF															20,500			
Cañada del Buey at White Rock	09/16	RO/TOT	UF															12,520			
Cañada del Buey at White Rock	09/16	RO/TOT	UF															22,290			
Pajarito Canyon above Threemile Canyon	09/16	RO/TOT	UF															2,000			
Pajarito Canyon above Threemile Canyon	09/16	RO/TOT	UF															1,030			
Pajarito Canyon above SR-4	06/17	RO/D	F	9	7.7	1.9	5.4	8.7	10.8	7.9	<5	23	0.13	0.11	0.28		78		27.0	7.0	118
Pajarito Canyon above SR-4	06/17	RO/TOT	UF		15.7	7.3	10.1	9.6								<0.01		1,120			
Pajarito Canyon above SR-4	06/17	RO/TOT	UF															2,492			
Potrillo Canyon near White Rock	08/31	RO/TOT	UF															6,430			
Potrillo Canyon near White Rock	08/31	RO/TOT	UF															6,150			
Potrillo Canyon near White Rock	09/16	RO/TOT	UF															3,850			
Potrillo Canyon near White Rock	09/16	RO/TOT	UF															4,820			
North Fork Ancho Canyon at TA-39	09/16	RO/TOT	UF															11,090			
North Fork Ancho Canyon at TA-39	09/16	RO/TOT	UF															22,320			
Ancho Canyon at TA-39	07/27	RO/TOT	UF		75.3	18.0	18.5	3.3										12,940	262.0		
Ancho Canyon at TA-39	08/04	RO/TOT	UF															14,288			
Ancho Canyon at TA-39	08/04	RO/TOT	UF															21,695			
Ancho Canyon at TA-39	08/10	RO/TOT	UF															18,570			
Ancho Canyon at TA-39	08/10	RO/TOT	UF															11,480			
Ancho Canyon near Bandelier	07/08	RO/D	F		<0.1	<0.0	4.1	<0.1											0.1		
Ancho Canyon near Bandelier	07/08	RO/TOT	UF		66.5	16.6	15.1	3.5										7,880			
Ancho Canyon near Bandelier	07/08	RO/TOT	UF															19,908			
Ancho Canyon near Bandelier	07/27	RO/TOT	UF															11,395			
Ancho Canyon near Bandelier	07/27	RO/TOT	UF															7,380			
Ancho Canyon near Bandelier	08/03	RO/TOT	UF															4,785			
Ancho Canyon near Bandelier	08/03	RO/TOT	UF															11,745			
Ancho Canyon near Bandelier	08/04	RO/TOT	UF		85.6	21.5	19.8	3.2										10,425	302.0		
Ancho Canyon near Bandelier	08/04	RO/TOT	UF															12,390			

Table 5-6. Chemical Quality of Surface Water and Runoff Samples for 1999 (mg/L[a]) (Cont.)

Station Name	Date	Matrix[b]	F/UF[c]	SiO_2	Ca	Mg	K	Na	Cl	SO_4	CO_3 Alkalinity	Total Alkalinity	F	PO_4-P	NO_3-N	CN	TDS[d]	TSS[e]	Hardness as $CaCO_3$	pH[f]	Conductance (µS/cm)
Runoff Stations (Cont.)																					
Mesa Top:																					
TA-55	08/14	RO/TOT	UF															16			
Area L	08/14	RO/TOT	UF					0.4										2			
Area G:																					
G-SWMS-1	07/29	RO/TOT	UF		71.4	18.4	11.4	5.5										6,285	254.0		
G-SWMS-1	07/29	RO/TOT	UF															14,210			
G-SWMS-2	05/24	RO/TOT	UF															6,280			
G-SWMS-2	07/14	RO/TOT	UF															3,930			
G-SWMS-2	07/29	RO/TOT	UF		49.1	7.9	4.8	5.4										3,445	155.0		
G-SWMS-2	07/29	RO/TOT	UF															4,040			
G-SWMS-3	05/28	RO/TOT	UF															15,440			
G-SWMS-3	06/17	RO/TOT	UF															25,520			
G-SWMS-3	07/15	RO/TOT	UF															22,210			
G-SWMS-3	07/15	RO/TOT	UF															30,375			
G-SWMS-3	07/29	RO/D	F		13.5	2.1	4.4	6.4											42.4		
G-SWMS-3	07/29	RO/TOT	UF		130.0	36.4	30.7	10.3										11,560	474.0		
G-SWMS-3	07/29	RO/TOT	UF															22,200			
G-SWMS-4	05/24	RO/TOT	UF															600			
G-SWMS-4	06/21	RO/TOT	UF															462			
G-SWMS-4	06/21	RO/TOT	UF															430			
G-SWMS-4	07/15	RO/TOT	UF															430			
G-SWMS-4	07/15	RO/TOT	UF															334			
G-SWMS-5	06/17	RO/TOT	UF															6,580			
G-SWMS-5	07/08	RO/TOT	UF		13.4	4.9	6.1	2.6										1,596	53.8		
G-SWMS-5	07/08	RO/TOT	UF															2,548			
G-SWMS-5	09/17	RO/TOT	UF															495			
G-SWMS-5	09/17	RO/TOT	UF															1,440			
G-SWMS-6	05/24	RO/TOT	UF															1,912			
G-SWMS-6	06/13	RO/TOT	UF															6,286			
G-SWMS-6	07/08	RO/TOT	UF		81.2	12.0	6.2	3.4										43,140	252.0		
G-SWMS-6	07/29	RO/TOT	UF															8,715			
G-SWMS-6	08/14	RO/TOT	UF															1,570			
G-SWMS-6	08/14	RO/TOT	UF															1,900			
G-SWMS-6	08/31	RO/TOT	UF															20,005			
G-SWMS-6	08/31	RO/TOT	UF															15,205			

Table 5-6. Chemical Quality of Surface Water and Runoff Samples for 1999 (mg/L[a]) (Cont.)

Station Name	Date	Matrix[b]	F/UF[c]	SiO_2	Ca	Mg	K	Na	Cl	SO_4	CO_3 Alkalinity	Total Alkalinity	F	PO_4-P	NO_3-N	CN	TDS[d]	TSS[e]	Hardness as $CaCO_3$	pH[f]	Conductance (μS/cm)
Water Quality Standards[h]																					
EPA Primary Drinking Water Standard										500			4		10	0.2					
EPA Secondary Drinking Water Standard									250	250							500			6.8–8.5	
EPA Health Advisory								20													
NMWQCC Groundwater Limit									250	600			1.6		10	0.2	1,000			6–9	

[a] Except where noted.
[b] Matrix: SW–surface water; RO–runoff; D–dissolved; TOT–total.
[c] F/UF: F–filtered; UF–unfiltered.
[d] Total dissolved solids.
[e] Total suspended solids.
[f] Standard units.
[g] Less than symbol (<) means measurement was below the specified limit of detection of the analytical method.
[h] Standards given here for comparison only; see Appendix A.

Table 5-7. Trace Metals in Surface Water and Runoff Samples for 1999 (µg/L)

Station Name	Date	Matrix[a]	F/UF[b]	Ag	Al	As	B	Ba	Be	Cd	Co	Cr	Cu	Fe	Hg
Regional Stations															
Rio Chama at Chamita	06/16	SW	F	<6[c]	79	<2	24	62	<1	<3	<6	<5	<4	44	
Rio Chama at Chamita	06/16	SW	F	<6	81	<2	23	59	<1	<3	<6	<5	<4	<30	
Rio Chama at Chamita	06/16	SW	UF												<0.10
Rio Chama at Chamita	06/16	SW	UF												<0.10
Rio Grande at Embudo	10/05	SW	F	<6	85	2	31	29	1	<3	<6	<5	6	<30	
Rio Grande at Embudo	10/05	SW	UF												<0.10
Rio Grande at Otowi Upper (bank)	08/03	SW	F	<6	<40	3	54	60	1	<3	<6	<5	<4	<30	
Rio Grande at Otowi Upper (bank)	08/03	SW	UF												<0.10
Rio Grande at Otowi (bank)	08/03	SW	F	<6	<40	2	37	63	1	<3	<6	<5	6	<30	
Rio Grande at Otowi (bank)	08/03	SW	UF												<0.10
Rio Grande at Frijoles (bank)	09/22	SW	F	<6	310	<2	36	57	1	<3	<6	<5	6	111	
Rio Grande at Frijoles (bank)	09/22	SW	F	<6	101	2	25	48	1	<3	<6	<5	6	43	
Rio Grande at Frijoles (bank)	09/22	SW	UF												<0.10
Rio Grande at Frijoles (bank)	09/22	SW	UF												<0.10
Rio Grande at Cochiti	09/23	SW	UF												<0.10
Jemez River	08/02	SW	UF												<0.10
Jemez River	08/02	SW	UF												<0.10
Pajarito Plateau															
Guaje Canyon:															
Guaje Canyon	11/16	SW	F	<6	475	<2	<10	10	<1	<3	<14	<5	<4	214	
Guaje Canyon	11/16	SW	UF												<0.10
Acid/Pueblo Canyon:															
Acid Weir	06/23	SW	F	<6	<200	<2	207	30	<1	<3	<20	<41	<4	<200	
Acid Weir	06/23	SW	F							<3					
Acid Weir	06/23	SW	UF												<0.10
Pueblo 1	06/23	SW	F	<6	433	2	33	27	<1	<3	<20	<41	<4	293	
Pueblo 1	06/23	SW	F							<3					
Pueblo 1	06/23	SW	UF												<0.10
Pueblo 3	05/20	SW	F	<6	<40	4	266	21	<1	<3	<6	6	<4	1,119	
Pueblo 3	05/20	SW	UF												<0.10
Pueblo at SR-502	08/03	SW	F	<6	<40	12	366	11	1	<3	<6	<5	4	206	
Pueblo at SR-502	08/03	SW	UF												
Pueblo at SR-502	08/04	SW	UF												<0.10
Pueblo at SR-502	12/01	SW	F	9	79	5	325	11	<1	<3	<6	<5	<6	109	
Pueblo at SR-502	12/01	SW	UF												<0.10
DP/Los Alamos Canyon:															
Los Alamos Canyon Reservoir	06/23	SW	F	<6	<200	<2	<9	17	<1	<3	<20	<41	<4	<200	

Table 5-7. Trace Metals in Surface Water and Runoff Samples for 1999 (µg/L) (Cont.)

Station Name	Date	Matrix[a]	F/UF[b]	Ag	Al	As	B	Ba	Be	Cd	Co	Cr	Cu	Fe	Hg
Pajarito Plateau (Cont.)															
DP/Los Alamos Canyon: (Cont.)															
Los Alamos Canyon Reservoir	06/23	SW	F							<3					
Los Alamos Canyon Reservoir	06/23	SW	UF												<0.10
Los Alamos at Upper Gaging Station	05/26	SW	F	<6	<40	<2	<9	39	<1	<3	<6	<5	<4	54	
Los Alamos at Upper Gaging Station	05/26	SW	UF												<0.10
Sandia Canyon:															
SCS-1	05/27	SW	UF												<0.10
SCS-2	05/19	SW	F	<6	165	4	93	29	<1	<3	<6	8	4	420	
SCS-2	05/19	SW	UF												<0.10
SCS-3	06/16	SW	F	<6	119		73	23	<1	<3	<6	9	5	166	
SCS-3	06/16	SW	UF												<0.10
Mortandad Canyon:															
Mortandad at Gaging Station 1	05/27	SW	F	<6	64	<2	126	21	<1	<3	<6	<5	7	136	
Mortandad at Gaging Station 1	05/27	SW	UF												<0.10
Mortandad at Rio Grande (A-11)	09/20	SW	F	<6	86	2	472	90	1	<3	<16	<5	23	<30	
Pajarito Canyon:															
Pajarito at Rio Grande	09/21	SW	F	<6	130	<2	28	38	1	<3	<6	<5	9	<30	
Pajarito at Rio Grande	09/21	SW	UF												<0.10
Water Canyon:															
Water Canyon at Beta	11/17	SW	F	<6	1,557	<2	14	293	<1	<3	<6	<5	<4	825	
Water Canyon at Beta	11/17	SW	UF												<0.10
Ancho Canyon:															
Ancho at Rio Grande	09/21	SW	F	<6	130	<2	9	35	<1	<3	<6	<5	6	141	
Ancho at Rio Grande	09/21	SW	UF												<0.10
Frijoles Canyon:															
Frijoles at Monument Headquarters	12/22	SW	F	<6	189	<7	<19	11	<1	<3	<6	<5	<4	161	
Frijoles at Monument Headquarters	12/22	SW	UF												<0.10
Frijoles at Rio Grande	12/22	SW	F	<6	216	<4	20	12	<1	<3	<6	<5	<5	160	
Frijoles at Rio Grande	12/22	SW	UF												<0.10
Runoff Stations															
Perimeter:															
LA Canyon near Los Alamos	04/30	RO/D	F	<6	220	2	25	47	<1	<3	<6	<5	<5	150	
LA Canyon near Los Alamos	04/30	RO/TOT	UF												<0.10
LA Canyon near Los Alamos	04/30	RO/TOT	UF	<6	130	<2	19	26	<1	<3	<6	<5	6	66	

Table 5-7. Trace Metals in Surface Water and Runoff Samples for 1999 (µg/L) (Cont.)

Station Name	Date	Matrix[a]	F/UF[b]	Ag	Al	As	B	Ba	Be	Cd	Co	Cr	Cu	Fe	Hg
Runoff Stations (Cont.)															
Perimeter: (Cont.)															
LA Canyon near Los Alamos	05/03	RO/D	F	<6	180	<2	18	27	<1	<3	<6	6	<4	71	
LA Canyon near Los Alamos	05/03	RO/TOT	UF	<6	9,100	<4	20	130	1	<3	<6	12	10	6,800	<0.10
LA Canyon near Los Alamos	08/09	RO/D	F	14	846	<2	11	53	1	<3	<6	<5	<4	335	
LA Canyon near Los Alamos	08/09	RO/TOT	UF	<6	45,659	8	30	1,194	13	4	38	24	41	23,276	0.18
LA Canyon near Los Alamos	08/10	RO/TOT	UF	<144	14,088	2	<89	503	5	<8	<20	15	73	12,801	0.50
LA Canyon near Los Alamos	08/10	RO/TOT	UF												
LA Canyon below TA-2	09/16	RO/TOT	UF	18	18,014	6	35	549	5	<3	25	15	80	15,234	0.86
DP Canyon near Los Alamos	06/23	RO/D	F	<14.4	279	<2	369	22	<1	<3	<20	11	28	329	
DP Canyon near Los Alamos	06/23	RO/TOT	UF	<14.4	28,800	8	<342	496	5	<3	<20	45	72	24,800	<0.10
DP Canyon near Los Alamos	08/14	RO/TOT	UF	11	18,664	<6	<164	268	2	<3	14	<22	32	11,654	<0.10
DP Canyon near Los Alamos	09/16	RO/TOT	UF	<15	23,527	9	56	422	4	<3	15	22	93	19,633	0.12
Sandia Canyon below Power Plant	05/28	RO/TOT	UF	<6	3,918	<2	<9	258	<1	<3	7	13	97	3,480	<0.10
Sandia Canyon below Power Plant	07/14	RO/TOT	UF												<0.10
Sandia Canyon below Wetlands	07/14	RO/TOT	UF												<0.10
Sandia Canyon below Wetlands	07/18	RO/TOT	UF												<0.10
Sandia Canyon below Wetlands	08/10	RO/TOT	UF												<0.10
Sandia Canyon near Roads & Grounds at TA-3	05/28	RO/TOT	UF	<6	2,984	<2	<9	174	<1	<3	<6	10	89	3,223	<0.10
Sandia Canyon near Roads & Grounds at TA-3	07/14	RO/TOT	UF												<0.10
Sandia Canyon near Roads & Grounds at TA-3	08/10	RO/TOT	UF	<144	13,062	3	<89	280	2	<8	<20	21	74	12,241	<0.10
Sandia Canyon near Roads & Grounds at TA-3	08/10	RO/TOT	UF												
Sandia Canyon Truck Route	09/14	RO/TOT	UF	19	6,230	5	67	401	4	<3	15	55	104	6,603	
Sandia Canyon Truck Route	09/16	RO/TOT	UF												0.88
Cañada del Buey at White Rock	06/17	RO/D	F	<6	2,527	<2	161	39	1	<3	<20	<40	4	1,289	
Cañada del Buey at White Rock	06/17	RO/D	F							<3					
Cañada del Buey at White Rock	06/17	RO/TOT	UF	<6	13,189	2	16	2,835	11	4.8	53	<40	12	625	<0.10
Cañada del Buey at White Rock	06/17	RO/TOT	UF							5					
Cañada del Buey at White Rock	07/08	RO/TOT	UF												<0.10
Cañada del Buey at White Rock	08/06	RO/TOT	UF												0.16
Cañada del Buey at White Rock	08/23	RO/TOT	UF												0.54
Cañada del Buey at White Rock	09/16	RO/TOT	UF												0.20
Pajarito Canyon above Threemile Canyon	09/16	RO/TOT	UF	17	6,900	4	37	406	3	3	15	<5	64	7,448	0.24
Pajarito Canyon above SR-4	06/17	RO/D	F	<6	727	<2	30	36	<1	<3	<20	<40	<4	472	
Pajarito Canyon above SR-4	06/17	RO/D	F							<3					
Pajarito Canyon above SR-4	06/17	RO/TOT	UF	<6	23,584	7	30	336	3	<3	<20	<40	18	15,959	<0.10
Pajarito Canyon above SR-4	06/17	RO/TOT	UF							<3					

Table 5-7. Trace Metals in Surface Water and Runoff Samples for 1999 (µg/L) (Cont.)

Station Name	Date	Matrix[a]	F/UF[b]	Ag	Al	As	B	Ba	Be	Cd	Co	Cr	Cu	Fe	Hg
Runoff Stations (Cont.)															
Perimeter: (Cont.)															
Potrillo Canyon near White Rock	08/31	RO/D	F	<6	989	<2	20	38	7	8	7	14	14	434	
Potrillo Canyon near White Rock	08/31	RO/TOT	UF	<6	19,096	2	24	915	8	<3	25	9	29	6,737	<0.10
North Fork Ancho Canyon at TA-39	09/16	RO/TOT	UF												0.24
Ancho Canyon at TA-39	07/27	RO/TOT	UF	<6	62,182	8	29	1,844	15	<4	57	26	39	26,065	0.26
Ancho Canyon at TA-39	08/04	RO/TOT	UF												<0.10
Ancho Canyon at TA-39	08/10	RO/TOT	UF												0.12
Ancho Canyon near Bandelier	07/08	RO/D	F	142	<200	<2	70	<2	<1	<3	<20	5	<4	76	
Ancho Canyon near Bandelier	07/08	RO/D	F							5					
Ancho Canyon near Bandelier	07/08	RO/TOT	UF	11	53,484	5	21	1,552	14	<3	46	26	63	26,519	<0.10
Ancho Canyon near Bandelier	07/08	RO/TOT	UF							4					
Ancho Canyon near Bandelier	07/27	RO/TOT	UF												<0.10
Ancho Canyon near Bandelier	08/03	RO/TOT	UF												<0.10
Ancho Canyon near Bandelier	08/04	RO/TOT	UF	<6	77,197	11	29	1,961	17	3	60	34	53	40,119	0.24
Mesa Top:															
TA-55	08/14	RO/TOT	UF	14	296	<2	<164	10	<1	<3	<11	<5	31	259	<0.10
Area L	08/14	RO/TOT	UF	<6	95	<2	25	31	1	<3	<6	<5	5	64	<0.10
Area G:															
G-SWMS-1	07/29	RO/TOT	UF	<6	51,069	9	29	1,043	7	<3	29	39	43	34,768	0.10
G-SWMS-2	05/24	RO/TOT	UF	<6	23,736	3	17	773	6	<3	15	10	28	10,863	<0.10
G-SWMS-2	07/29	RO/TOT	UF	<6	7,408	<2	36	461	3	<3	9	<5	18	2,848	<0.10
G-SWMS-3	05/28	RO/TOT	UF	<6	27,131	2	14	2,194	15	<3	61	11	30	2,937	<0.10
G-SWMS-3	07/15	RO/TOT	UF	<6	64,915	<7	20	3,474	25	5	97	31	62	26,918	<0.10
G-SWMS-3	07/29	RO/D	F	<6	764	2	15	42	<1	<3	<6	<5	4	456	
G-SWMS-3	07/29	RO/TOT	UF	6	139,302	16	38	2,503	19	4	74	79	91	84,676	0.64
G-SWMS-4	05/24	RO/TOT	UF	<6	11,999	5	24	317	2	<3	7	8	27	7,210	<0.10
G-SWMS-4	07/15	RO/TOT	UF	<194	<11,152	<2	<68	<637	<1	<6	<20	<5	<4	<5,196	<0.10
G-SWMS-5	06/17	RO/TOT	UF	<6	15,628	3	158	422	4	<3	<20	14	23	7,930	<0.10
G-SWMS-5	06/17	RO/TOT	UF							<3					
G-SWMS-5	07/08	RO/TOT	UF	<6	17,840	5	<317	237	3	<3	<20	21	25	12,517	
G-SWMS-5	07/08	RO/TOT	UF							<3					
G-SWMS-5	09/16	RO/TOT	UF												<0.10
G-SWMS-5	09/17	RO/TOT	UF	17	2,238	2	64	77	1	<3	<6	<5	31	1,184	
G-SWMS-6	05/24	RO/TOT	UF	<6	5,872	<2	24	323	2	<3	8	5	14	2,752	<0.10
G-SWMS-6	07/08	RO/TOT	UF	<6	18,067	<2	26	957	7	<3	<20	9	32	6,255	<0.10
G-SWMS-6	07/08	RO/TOT	UF							3					
G-SWMS-6	07/20	RO/TOT	UF												<0.10

Table 5-7. Trace Metals in Surface Water and Runoff Samples for 1999 (µg/L) (Cont.)

Station Name	Date	Matrix[a]	F/UF[b]	Ag	Al	As	B	Ba	Be	Cd	Co	Cr	Cu	Fe	Hg
Runoff Stations (Cont.)															
Area G: (Cont.)															
G-SWMS-6	07/29	RO/TOT	UF												0.10
G-SWMS-6	08/14	RO/D	F	14	322	<2	<164	27	<1	<3	<6	<5	<20	229	
G-SWMS-6	08/14	RO/TOT	UF	14	11,379	<3	<164	173	2	<3	8	12	49	8,336	<0.10
G-SWMS-6	08/31	RO/D	F	<6	226	<2	18	36	1	<3	<6	8	<13	76	
G-SWMS-6	08/31	RO/TOT	UF	<6	18,901	3	25	1,006	7	3	25	10	42	6,444	<0.10
Water Quality Standards[d]															
EPA Primary Drinking Water Standard						50		2,000	4	5		100			2
EPA Secondary Drinking Water Standard					50–200									300	
EPA Action Level													1,300		
EPA Health Advisory															
NMWQCC Livestock Watering Standard					5,000	200	5,000			50	1,000	1,000	500		10
NMWQCC Groundwater Limit				50	5,000	100	750	1,000		10	50	50	1,000	1,000	2
NMWQCC Wildlife Habitat Standard															0.012

Table 5-7. Trace Metals in Surface Water and Runoff Samples for 1999 (µg/L) (Cont.)

Station Name	Date	Matrix[a]	F/UF[b]	Mn	Mo	Ni	Pb	Sb	Se	Sn	Sr	Ti	V	Zn
Regional Stations														
Rio Chama at Chamita	06/16	SW	F	3	<10	<42	<60	<4		<60	333	<3	<7	<110
Rio Chama at Chamita	06/16	SW	F	3	<10	<42	<60	<4		<60	314	<3	<7	<110
Rio Chama at Chamita	06/16	SW	UF						<3					
Rio Chama at Chamita	06/16	SW	UF						<3					
Rio Grande at Embudo	10/05	SW	F	6	<12	<20	<60	<4		<60	196	<3	<8	<10
Rio Grande at Embudo	10/05	SW	UF						<3					
Rio Grande at Otowi Upper (bank)	08/03	SW	F	3	<11	<20	<60	<4		<86	243	<3	<7	<10
Rio Grande at Otowi Upper (bank)	08/03	SW	UF						<3					
Rio Grande at Otowi (bank)	08/03	SW	F	3	<10	<20	<60	<4		<60	248	<3	<7	<10
Rio Grande at Otowi (bank)	08/03	SW	UF						<3					
Rio Grande at Frijoles (bank)	09/22	SW	F	58	<10	<20	<60	<4		<60	229	<3	<7	<10
Rio Grande at Frijoles (bank)	09/22	SW	F	25	<10	<20	<60	<4		<60	229	<3	7	<10
Rio Grande at Frijoles (bank)	09/22	SW	UF						<3					
Rio Grande at Frijoles (bank)	09/22	SW	UF						<3					
Rio Grande at Cochiti	09/23	SW	UF						<3					
Jemez River	08/02	SW	UF						<3					
Jemez River	08/02	SW	UF						<3					
Pajarito Plateau														
Guaje Canyon:														
Guaje Canyon	11/16	SW	F	1	<10	<20	<60	<4		<60	27	<3	<7	<10
Guaje Canyon	11/16	SW	UF						<3					
Acid/Pueblo Canyon:														
Acid Weir	06/23	SW	F	<7	<10	<30	<60	<3		<60	85	<3	<20	<40
Acid Weir	06/23	SW	F					<3						
Acid Weir	06/23	SW	UF						<3					
Pueblo 1	06/23	SW	F	<7	<10	<30	<60	<3		<60	72	<3	<20	<40
Pueblo 1	06/23	SW	F					<3						
Pueblo 1	06/23	SW	UF						<3					
Pueblo 3	05/20	SW	F	869	<10	<20	<60	<4		<60	124	<3	10	15
Pueblo 3	05/20	SW	UF						<3					
Pueblo at SR-502	08/03	SW	F	162	<10	<20	<60	<4		<60	112	<3	<7	30
Pueblo at SR-502	08/03	SW	UF						<3					
Pueblo at SR-502	08/04	SW	UF						<3					
Pueblo at SR-502	12/01	SW	F	28	<10	<20	<60	<4		<60	77	<3	12	16
Pueblo at SR-502	12/01	SW	UF						<3					
DP/Los Alamos Canyon:														
Los Alamos Canyon Reservoir	06/23	SW	F	<7	<10	<30	<60	<3		<60	56	<3	<20	<40

Table 5-7. Trace Metals in Surface Water and Runoff Samples for 1999 (µg/L) (Cont.)

Station Name	Date	Matrix[a]	F/UF[b]	Mn	Mo	Ni	Pb	Sb	Se	Sn	Sr	Ti	V	Zn
Pajarito Plateau (Cont.)														
DP/Los Alamos Canyon: (Cont.)														
Los Alamos Canyon Reservoir	06/23	SW	F					<3						
Los Alamos Canyon Reservoir	06/23	SW	UF						<3					
Los Alamos at Upper Gaging Station	05/26	SW	F	10	29	<20	<60	<4		<60	87	<3	<7	<10
Los Alamos at Upper Gaging Station	05/26	SW	UF						<3					
Sandia Canyon:														
SCS-1	05/27	SW	UF						<3					
SCS-2	05/19	SW	F	5	214	<20	<60	<4		<60	106	<3	10	33
SCS-2	05/19	SW	UF						<3					
SCS-3	06/16	SW	F	4	142	<42				<60	89		8	<110
SCS-3	06/16	SW	UF						<3					
Mortandad Canyon:														
Mortandad at Gaging Station 1	05/27	SW	F	4	119	<20	<60	<4		<60	59	<3	<7	15
Mortandad at Gaging Station 1	05/27	SW	UF						<3					
Mortandad at Rio Grande (A-11)	09/20	SW	F	10	<10	<20	<60	<4		<60	135	<3	11	28
Pajarito Canyon:														
Pajarito at Rio Grande	09/21	SW	F	3	<10	<20	<60	<4		<60	113	<3	14	<10
Pajarito at Rio Grande	09/21	SW	UF						<3					
Water Canyon:														
Water Canyon at Beta	11/17	SW	F	4	<10	<20	<60	<4		<60	78	<3	<7	<10
Water Canyon at Beta	11/17	SW	UF						<3					
Ancho Canyon:														
Ancho at Rio Grande	09/21	SW	F	5	<10	<20	<60	<4		<60	69	<3	9	<10
Ancho at Rio Grande	09/21	SW	UF						<3					
Frijoles Canyon:														
Frijoles at Monument Headquarters	12/22	SW	F	7	<10	<20	<60	<4		<60	44	<3	<7	19
Frijoles at Monument Headquarters	12/22	SW	UF						<3					
Frijoles at Rio Grande	12/22	SW	F	1	<10	<20	<60	<4		<60	45	<3	<7	<10
Frijoles at Rio Grande	12/22	SW	UF						<3					
Runoff Stations														
Perimeter:														
LA Canyon near Los Alamos	04/30	RO/D	F	44	13	<20	<60	<4		<73	61	<3	<7	<33
LA Canyon near Los Alamos	04/30	RO/TOT	UF						5					
LA Canyon near Los Alamos	04/30	RO/TOT	UF	2	11	<20	<60	<4		<60	58	<3	<7	<33

Table 5-7. Trace Metals in Surface Water and Runoff Samples for 1999 (µg/L) (Cont.)

Station Name	Date	Matrix[a]	F/UF[b]	Mn	Mo	Ni	Pb	Sb	Se	Sn	Sr	Ti	V	Zn
Runoff Stations (Cont.)														
Perimeter: (Cont.)														
LA Canyon near Los Alamos	05/03	RO/D	F	2	<10	<21	<60	<4		<60	60	<3	<7	10
LA Canyon near Los Alamos	05/03	RO/TOT	UF	490	13	<20	<60	<4	3	<60	83	<3	12	91
LA Canyon near Los Alamos	08/09	RO/D	F	26	<19	<20	<60	<4		<60	79	<3	<7	11
LA Canyon near Los Alamos	08/09	RO/TOT	UF	3,837	<10	40	260	<4	4	<60	345	<3	76	304
LA Canyon near Los Alamos	08/10	RO/TOT	UF	2,060	<10	<43	170	<3	<3	<60	160	<3	37	487
LA Canyon near Los Alamos	08/10	RO/TOT	UF						<3					
LA Canyon below TA-2	09/16	RO/TOT	UF	2,166	<10	<44	150	<4	<3	<60	155	<3	39	477
DP Canyon near Los Alamos	06/23	RO/D	F	5	<10	<20	<60	<3		<60	38.2	<3	<20	<30
DP Canyon near Los Alamos	06/23	RO/TOT	UF	1,530	<10	38	230	<3	<3	<60	126	<3	50	540
DP Canyon near Los Alamos	08/14	RO/TOT	UF	499	<10	<20	<60	5	<3	<60	92	<3	25	130
DP Canyon near Los Alamos	09/16	RO/TOT	UF	1,449	<10	<72	150	<4	<3	<60	124	<3	41	600
Sandia Canyon below Power Plant	05/28	RO/TOT	UF	595	<10	<20	<60	<4	<3	<60	66	<3	18	318
Sandia Canyon below Power Plant	07/14	RO/TOT	UF						<3					
Sandia Canyon below Wetlands	07/14	RO/TOT	UF						<3					
Sandia Canyon below Wetlands	07/18	RO/TOT	UF						<3					
Sandia Canyon below Wetlands	08/10	RO/TOT	UF						<3					
Sandia Canyon near Roads & Grounds at TA-3	05/28	RO/TOT	UF	364	<10	<20	130	<4	<3	<60	42	<3	10	500
Sandia Canyon near Roads & Grounds at TA-3	07/14	RO/TOT	UF						<3					
Sandia Canyon near Roads & Grounds at TA-3	08/10	RO/TOT	UF	630	<10	29	142	<3	<3	<60	69	<3	25	643
Sandia Canyon near Roads & Grounds at TA-3	08/10	RO/TOT	UF						<3					
Sandia Canyon Truck Route	09/14	RO/TOT	UF	2,014	14	<20	69	<4		<60	118	<3	33	500
Sandia Canyon Truck Route	09/16	RO/TOT	UF						<3					
Cañada del Buey at White Rock	06/17	RO/D	F	27	<10	<30	<60	<3		<60	40	<3	<20	<40
Cañada del Buey at White Rock	06/17	RO/D	F					<1,000						
Cañada del Buey at White Rock	06/17	RO/TOT	UF	5,451	<10	60	<60	<3	<3	<60	550	<3	<20	84
Cañada del Buey at White Rock	06/17	RO/TOT	UF					<1,000	<3					
Cañada del Buey at White Rock	07/08	RO/TOT	UF						<3					
Cañada del Buey at White Rock	08/06	RO/TOT	UF						3					
Cañada del Buey at White Rock	08/23	RO/TOT	UF						<3					
Cañada del Buey at White Rock	09/16	RO/TOT	UF						<3					
Pajarito Canyon above Threemile Canyon	09/16	RO/TOT	UF	1,239	<10	36	<60	<4	<3	<60	109	<3	29	160
Pajarito Canyon above SR-4	06/17	RO/D	F	29	<10	<30	<60	<3		<60	44	<3	<20	<40
Pajarito Canyon above SR-4	06/17	RO/D	F					<1,000						
Pajarito Canyon above SR-4	06/17	RO/TOT	UF	713	<10	<30	<60	<3	<3	<60	103	<3	30	109
Pajarito Canyon above SR-4	06/17	RO/TOT	UF					2,649	<3					

Table 5-7. Trace Metals in Surface Water and Runoff Samples for 1999 (µg/L) (Cont.)

Station Name	Date	Matrix[a]	F/UF[b]	Mn	Mo	Ni	Pb	Sb	Se	Sn	Sr	Ti	V	Zn
Runoff Stations (Cont.)														
Perimeter: (Cont.)														
Potrillo Canyon near White Rock	08/31	RO/D	F	36	<18	<24	<60	<4		<60	33	<3	14	13
Potrillo Canyon near White Rock	08/31	RO/TOT	UF	2,172	<10	<20	<60	<4	4	<60	193	<3	46	70
North Fork Ancho Canyon at TA-39	09/16	RO/TOT	UF						6					
Ancho Canyon at TA-39	07/27	RO/TOT	UF	4,152	<10	68	94	<4	<3	<60	467	<3	95	221
Ancho Canyon at TA-39	08/04	RO/TOT	UF						<3					
Ancho Canyon at TA-39	08/10	RO/TOT	UF						3					
Ancho Canyon near Bandelier	07/08	RO/D	F	5	<10	<20	<60	<3		<60	2	<3	<20	<40
Ancho Canyon near Bandelier	07/08	RO/D	F											
Ancho Canyon near Bandelier	07/08	RO/TOT	UF	3,446	<10	60	130	<3	<3	<60	363	<3	77	194
Ancho Canyon near Bandelier	07/08	RO/TOT	UF											
Ancho Canyon near Bandelier	07/27	RO/TOT	UF						<3					
Ancho Canyon near Bandelier	08/03	RO/TOT	UF						<3					
Ancho Canyon near Bandelier	08/04	RO/TOT	UF	4,678	<10	70	120	<4	<3	<60	486	<3	97	250
Mesa Top:														
TA-55	08/14	RO/TOT	UF	18	<10	<20	<60	<4	<4	<60	10	<3	<7	65
Area L	08/14	RO/TOT	UF	21	<10	<20	<60	<4	<3	<60	20	<3	<7	193
Area G:														
G-SWMS-1	07/29	RO/TOT	UF	2,227	<10	57	80	<4	<3	<60	317	<3	88	288
G-SWMS-2	05/24	RO/TOT	UF	1,472	<10	<34	65	<4	<3	<60	240	<3	52	192
G-SWMS-2	07/29	RO/TOT	UF	1,048	<10	<20	<60	<4	<3	<60	187	<3	31	110
G-SWMS-3	05/28	RO/TOT	UF	5,699	<10	56	128	<4	<3	<60	560	<3	72	187
G-SWMS-3	07/15	RO/TOT	UF	8,901	<10	112	130	<3	<3	<60	784	<3	147	635
G-SWMS-3	07/29	RO/D	F	14	<10	<20	<60	<4		<60	69	<3	9	<10
G-SWMS-3	07/29	RO/TOT	UF	6,091	<10	108	140	<4	<3	<60	621	<3	168	585
G-SWMS-4	05/24	RO/TOT	UF	831	<10	<20	<60	<4	<3	<60	173	<3	25	147
G-SWMS-4	07/15	RO/TOT	UF	<2,138	<10	<212	<60	<3	<3	<60	<136	<3	<20	<133
G-SWMS-5	06/17	RO/TOT	UF	1,002	<10	<20	<60	<3	<3	<60	103	<3	27	134
G-SWMS-5	06/17	RO/TOT	UF											
G-SWMS-5	07/08	RO/TOT	UF	518	<10	24	<60	<3		<60	70	<3	23	102
G-SWMS-5	07/08	RO/TOT	UF											
G-SWMS-5	09/16	RO/TOT	UF						<3					
G-SWMS-5	09/17	RO/TOT	UF	183	<10	<20	<60	<4		<60	29	<3	<7	47
G-SWMS-6	05/24	RO/TOT	UF	610	<10	<20	<60	<4	<3	<60	137	<3	25	111
G-SWMS-6	07/08	RO/TOT	UF	2,079	<10	44	<60	<3	<3	<60	319	<3	54	243
G-SWMS-6	07/08	RO/TOT	UF											
G-SWMS-6	07/20	RO/TOT	UF						<3					

Table 5-7. Trace Metals in Surface Water and Runoff Samples for 1999 (µg/L) (Cont.)

Station Name	Date	Matrix[a]	F/UF[b]	Mn	Mo	Ni	Pb	Sb	Se	Sn	Sr	Ti	V	Zn
Runoff Stations (Cont.)														
Area G: (Cont.)														
G-SWMS-6	07/29	RO/TOT	UF						<3					
G-SWMS-6	08/14	RO/D	F	6	<10	<20	<60	7		<60	42	<3	7	10
G-SWMS-6	08/14	RO/TOT	UF	545	<10	<81	68	<4	<3	<60	64	<3	17	204
G-SWMS-6	08/31	RO/D	F	13	<10	<20	<60	<4		<60	54	<3	8	10
G-SWMS-6	08/31	RO/TOT	UF	2,537	<14	<30	<60	<4	5	<60	279	<3	57	331
Water Quality Standards[d]														
EPA Primary Drinking Water Standard						100		6	50			2		
EPA Secondary Drinking Water Standard				50										5,000
EPA Action Level							15							
EPA Health Advisory											25,000–90,000		80–110	
NMWQCC Livestock Watering Standard							100		50				100	25,000
NMWQCC Groundwater Limit				200	1,000	200	50		50					10,000
NMWQCC Wildlife Habitat Standard									2					

[a] Matrix: SW–surface water; RO–runoff; D–dissolved; TOT–total.
[b] F/UF: F–filtered; UF–unfiltered.
[c] Less than symbol (<) means measurement was below the specified limit of detection of the analytical method.
[d] Standards given here for comparison only; see Appendix A. Note that New Mexico Livestock Watering and Groundwater limits are based on dissolved concentrations, whereas many of these analyses are of unfiltered samples; thus, concentrations may include suspended sediment quantities.

Table 5-8. Number of Samples Collected for Each Suite of Organic Compounds in Surface Water and Runoff Samples in 1999

			Organic Suite[a]			
Station Name	**Date**	**Matrix[b]**	**HE**	**PCB**	**Semivolatile**	**Volatile**
Ancho Canyon near Bandelier	06/18	RO/TOT	1			
Ancho Canyon near Bandelier	07/08	RO/TOT	1			
Area L	08/14	RO/TOT		1	1	
Cañada Del Buey at WR	06/17	RO/TOT		1	1	
Cañada Del Buey at WR	07/08	RO/TOT	1			
Cañada Del Buey at WR	09/16	RO/TOT	1	1	1	
DP Canyon near Los Alamos	06/23	RO/TOT	1		1	
DP Canyon near Los Alamos	08/14	RO/TOT		1	1	
DP Canyon near Los Alamos	09/16	RO/TOT		1	1	
G-SWMS-1	07/29	RO/TOT	1	1	1	
G-SWMS-3	07/15	RO/TOT	1	1	1	
G-SWMS-3	07/29	RO/TOT	1	1	1	
G-SWMS-4	07/15	RO/TOT	1	1	1	
G-SWMS-5	09/17	RO/TOT	1			
G-SWMS-6	06/14	RO/TOT		1	1	
G-SWMS-6	07/29	RO/TOT		1	1	
G-SWMS-6	08/14	RO/TOT		1	1	
G-SWMS-6	08/31	RO/TOT		1	1	
LA Canyon below TA-2	09/16	RO/TOT		1	1	
LA Canyon near LA	08/09	RO/TOT		1	1	
LA Canyon near LA	08/10	RO/TOT		1	1	
Pajarito Canyon above SR-4	06/17	RO/TOT	1	1	1	
Pajarito Canyon above Threemile Canyon	09/16	RO/TOT		1	1	
Potrillo Canyon near White Rock	08/31	RO/TOT		1	1	
Potrillo Canyon near White Rock	09/16	RO/TOT	1			
Sandia Canyon below Power Plant	06/02	RO/TOT		1		
Sandia Canyon below Power Plant	07/14	RO/TOT		1		
Sandia Canyon below Wetlands	07/12	RO/TOT		1		
Sandia Canyon below Wetlands	07/18	RO/TOT		1		
Sandia Canyon below Wetlands	08/10	RO/TOT		1		
Sandia Canyon near Roads & Grounds at TA-3	07/14	RO/TOT		1		
Sandia Canyon near Roads & Grounds at TA-3	08/10	RO/TOT		1	1	
Sandia Canyon Truck Route	09/14	RO/TOT		1		
TA-55	08/14	RO/TOT		1	1	
Acid Weir	06/23	SW		1	1	1
Ancho at Rio Grande	09/22	SW		1	1	1
Frijoles at Monument HQ	12/21	SW	1	1	1	1
Frijoles at Rio Grande	12/21	SW	1		1	1
Guaje Canyon	11/16	SW		1	1	1
Los Alamos Canyon Reservoir	06/23	SW		1	1	1
Pajarito at Rio Grande	09/21	SW		1	1	1
Pueblo 1	06/23	SW		1	1	1
Pueblo 3	05/20	SW		1	1	1
Pueblo at SR-502	12/01	SW				1
SCS-2	05/19	SW		1	1	1
Water Canyon at Beta	11/17	SW		1	1	1

[a] High explosives, polychlorinated biphenyls, semivolatiles, and volatiles.
[b] Matrix: SW–surface water; RO–runoff; D–dissolved; TOT–total.

Table 5-9. Station Descriptions for Special Sediment Sampling during 1999

Station Name	Description	Sample Date
White Rock, Cañada del Buey		
Site #1 Bonnie View South bank 1	0–34 cm	10/28
Site #1 Bonnie View South bank 2	34–90 cm	10/28
Site #1 Bonnie View Stream Channel 3	0–2 cm (wdth intgrt)	10/28
Site #2 Rover South bank 1	0–14 cm	10/28
Site #2 Rover South bank 2	14–35 cm	10/28
Site #2 Rover South bank 3	35–45 cm	10/28
Site #2 Rover Stream Channel 4	0–2 cm (wdth intgrt)	10/28
Site #3 Lejano South bank 1	5–29 cm	10/28
Site #3 Lejano South bank 2	29–65 cm	10/28
Site #3 Lejano Stream Channel 3	0–2 cm (wdth intgrt)	10/28
Site #4 Meadow Lane South bank 1	0–45 cm	10/28
Site #4 Meadow Lane South bank 2	45–74 cm	10/28
Site #4 Meadow Lane South bank 3	74–95 cm	10/28
Site #4 Meadow Lane Stream Channel 5	0–2 cm (wdth intgrt)	10/28
Site #5 Overlook Park South bank 1	0–17 cm	10/28
Site #5 Overlook Park South bank 2	17–66 cm	10/28
Site #5 Overlook Park South bank 3	66–120 cm	10/28
Site #5 Overlook Park South bank 4	120–166 cm	10/28
Site #5 Overlook Park Stream Channel 5	0–2 cm (wdth intgrt)	10/28
Site #5 Overlook Park Stream Channel Dup 6	0–2 cm (wdth intgrt)	10/28
Special EPA Sampling		
Ancho Canyon 1	0–5 cm	12/16
Ancho Canyon 2	0–17 cm	12/16
Ancho Canyon 3	6–16 cm	12/16
Ancho Canyon 4	0–7 cm	12/16
Ancho Canyon 5	10–24 cm	12/16
Bayo Canyon 1	0–14 cm	12/13
Bayo Canyon 2	14–27 cm	12/13
Bayo Canyon 3	10–22 cm	12/13
Bayo Canyon 4	4–11 cm	12/13
Cañada del Buey 1	10–17 cm	12/15
Cañada del Buey 2	5–15 cm	12/15
Cañada del Buey 3	1–13 cm	12/16
Cañada del Buey 4	0–2 cm	12/15
Cañada del Buey 4	0–2 cm	12/15
Cañada del Buey 5A	18–26 cm	12/15
Cañada del Buey 5B	30–39 cm	12/16
Cañada del Buey 6	0–7.5 cm	12/15
Cañada del Buey 7	0–7 cm	12/15
Cañada del Buey 8	20–33 cm	12/15
Mortandad Canyon 1	0–5 cm	12/14
Mortandad Canyon 2	0–8 cm	12/14
Mortandad Canyon 3	15–24 cm	12/14
Mortandad Canyon 4	0–5 cm	12/14
Mortandad Canyon 5A	0–13 cm	12/14
Mortandad Canyon 5B	22–30 cm	12/14

Table 5-9. Station Descriptions for Special Sediment Sampling during 1999 (Cont.)

Station Name	Description	Sample Date
Special EPA Sampling		
Pajarito Canyon 1	0–17 cm	12/16
Pajarito Canyon 2	0–24 cm	12/16
Pajarito Canyon 3	0–21 cm	12/16
Pajarito Canyon 4	0–5 cm	12/16
Sandia Canyon 1	0–17 cm	12/13
Sandia Canyon 2	0–3 cm	12/13
Sandia Canyon 3	8–19 cm	12/13
Sandia Canyon 4	2–12 cm	12/13
Sandia Canyon 5	0–18 cm	12/13
Sandia Canyon 6	0–12 cm	12/13

Table 5-10. Radiochemical Analysis of Sediments for 1999 (pCi/g)[a,b]

Station Name	Date	Code[c]	^{3}H (pCi/L)		^{137}Cs		U (mg/kg)		^{238}Pu		$^{239,240}Pu$		^{241}Am		Gross Alpha		Gross Beta		Gross Gamma	
Regional Stations																				
Rio Chama at Chamita	05/04	1	90	600	0.05	0.01	0.90	0.20	0.0028	0.0018	0.0025	0.0014			3.14	1.47	2.97	1.53	0.4	0.2
Rio Grande at Embudo	05/04	1	140	600	0.13	0.02	1.20	0.20	–0.0010	0.0003	0.0019	0.0029			3.91	1.80	3.80	1.90	1.2	0.2
Rio Grande at Otowi (bank)	08/03	1	140	610	0.02	0.03	0.86	0.08	0.0007	0.0007	0.0001	0.0009	0.0192	0.0028	1.67	0.69	1.09	0.55	1.9	0.2
Rio Grande at Otowi Upper (bank)	08/03	1	80	610	0.01	0.03	1.70	0.10	0.0029	0.0011	0.0012	0.0008	0.0242	0.0038	3.87	1.52	2.86	1.27	3.0	0.3
Rio Grande at Frijoles (bank)	12/21	1	–290	670	0.06	0.03	1.02	0.05											2.1	0.2
Rio Grande at Frijoles (wdth intgrt)																				
Rio Grande at Cochiti Spillway	09/23	1	–40	740	0.12	0.02	1.11	0.07	0.0016	0.0009	0.0046	0.0014			3.97	1.54	2.33	1.13	2.3	0.2
Rio Grande at Bernalillo	05/04	1	190	600	0.14	0.02	1.30	0.20	0.0100	0.0029	0.0088	0.0028			3.35	1.87	2.12	1.79	2.3	0.2
Jemez River	08/02	1	130	610	0.05	0.04	0.50	0.04	0.0063	0.0012	0.0030	0.0008	0.0022	0.0008	0.91	0.69	1.00	0.73	2.6	0.3
Reservoirs on Rio Chama (New Mexico)																				
Heron Upper	08/31	1	–190	600	0.38	0.05	1.20	0.20							3.99	1.20	3.66	1.21	2.6	0.3
Heron Middle	08/31	1	130	630	0.27	0.04	1.20	0.10							4.00	1.20	2.82	1.04	4.8	0.5
Heron Lower	08/31	1	740	670	0.23	0.04	1.10	0.20							6.85	1.78	4.23	1.32	5.5	0.5
El Vado Upper	09/02	1					3.10	0.40												
El Vado Upper	08/31	1	600	660	0.19	0.03									5.32	1.47	3.15	1.11	2.8	0.3
El Vado Middle	08/31	1	190	630	0.18	0.04	1.80	0.10							6.25	1.66	4.18	1.31	3.3	0.3
El Vado Lower	08/31	1	80	620	0.23	0.03	1.40	0.20							4.83	1.37	3.43	1.17	3.1	0.3
Abiquiu Upper	08/30	1					2.40	0.30												
Abiquiu Middle	10/12	1	3,090	920	0.40	0.05	2.10	0.50							12.60	3.71	7.47	2.62	3.2	0.3
Abiquiu Middle	10/12	D	4,440	980	0.13	0.03									7.12	2.23	5.75	1.95	2.4	0.2
Abiquiu Lower	10/12	D	6,500	1,100	0.12	0.03									6.11	2.02	4.47	1.66	1.8	0.2
Abiquiu Lower	10/12	1	3,320	930	0.11	0.03	1.90	0.20							4.94	1.76	3.42	1.41	1.9	0.2
Reservoirs on Rio Grande (Colorado)																				
Rio Grande Upper	09/02	1	–150	600	0.67	0.08	3.30	0.30							11.00	2.58	7.90	2.03	4.5	0.5
Rio Grande Middle	09/02	1	50	620	0.37	0.05	1.70	0.20							10.40	2.47	6.33	1.73	4.1	0.4
Rio Grande Lower	09/02	2	–190	600	0.53	0.07	1.70	0.20							10.10	2.41	6.78	1.82	4.3	0.4
Rio Grande Lower	09/02	1	210	630	0.57	0.08	2.90	0.40							10.50	2.48	7.33	1.92	4.0	0.4
Reservoirs on Rio Grande (New Mexico)																				
Cochiti Upper	10/13	1	–250	730	0.16	0.05	3.90	0.20							6.67	2.43	5.27	2.11	2.4	0.2
Cochiti Middle	10/13	1	980	800	0.30	0.05	2.90	0.30							8.88	3.29	8.88	3.31	3.3	0.3
Cochiti Middle	10/13	2	130	750	0.26	0.05	2.30	0.20							9.07	2.96	6.70	2.44	3.3	0.3
Cochiti Lower	10/13	1	100	750	0.30	0.05	3.70	0.30							10.80	3.72	10.50	3.68	3.4	0.3
Other Reservoirs (New Mexico)																				
Guaje Reservoir	11/16	1	1,480	700	0.51	0.10	10.90	0.60							22.30	4.73	14.40	3.26	4.1	0.3
Guaje Reservoir	11/16	D			0.56	0.07									23.00	4.87	13.30	3.05	3.7	0.4

Table 5-10. Radiochemical Analysis of Sediments for 1999 (pCi/g)[a,b] (Cont.)

Station Name	Date	Code[c]	^{3}H (pCi/L)		^{137}Cs		U (mg/kg)		^{238}Pu		^{239,240}Pu		^{241}Am		Gross Alpha		Gross Beta		Gross Gamma	
Pajarito Plateau Stations																				
Guaje Canyon:																				
Guaje at SR-502	12/01	2	240	710	0.08	0.04	0.22	0.02											2.9	0.3
Guaje at SR-502	12/01	1	–120	690	0.05	0.02	0.29	0.02											3.0	0.3
Bayo Canyon:																				
Bayo at SR-502	08/03	1	150	610	0.06	0.01	0.32	0.03	0.0028	0.0010	0.0024	0.0013	0.0082	0.0021	3.02	1.00	1.84	0.74	2.7	0.3
Acid/Pueblo Canyons:																				
Acid Weir	04/27	1	190	630	0.20	0.04	0.58	0.02	0.0290	0.0023	6.6021	0.1717	0.4200	0.0140	16.00	3.54	4.47	1.37	2.2	0.2
Pueblo 1	04/27	1	40	620	0.02	0.02	0.25	0.02	–0.0002	0.0002	0.0049	0.0011	0.0020	0.0007	2.97	0.98	2.86	1.05	2.3	0.2
Pueblo 2	05/24	D					0.20	0.03												
Pueblo 2	05/24	1	480	630	0.04	0.01			0.0005	0.0005	0.9672	0.0313			2.96	0.99	1.43	0.68	2.5	0.2
Hamilton Bend Spring	05/24	D					0.35	0.04												
Hamilton Bend Spring	05/24	1	290	620	0.04	0.01			0.0038	0.0013	0.5096	0.0209			2.87	0.97	2.19	0.85	3.2	0.3
Pueblo 3	05/24	2	260	620	0.00	0.09			0.0012	0.0006	0.1796	0.0083			1.40	0.62	1.67	0.73	2.8	0.3
Pueblo 3	05/24	D					0.27	0.03												
Pueblo 3	05/24	1	500	640	0.01	0.06			0.0038	0.0011	0.2046	0.0092			1.92	0.75	1.72	0.74	2.9	0.3
Pueblo at SR-502	08/04	1	–20	600	0.03	0.02	0.59	0.05	0.0031	0.0010	1.0782	0.0336	0.0353	0.0042	5.33	1.85	5.15	1.82	3.4	0.3
DP/Los Alamos Canyons:																				
Los Alamos at Bridge	04/27	2	70	620	0.09	0.02	0.77	0.03	0.0010	0.0006	0.0025	0.0007	0.0013	0.0005	4.87	1.38	3.55	1.19	2.3	0.2
Los Alamos at Bridge	04/27	1	100	620	0.05	0.03	0.35	0.02	0.0016	0.0007	0.0027	0.0009	0.0021	0.0007	3.78	1.15	2.93	1.07	2.6	0.3
Los Alamos at LAO-1	04/23	1	30	590	0.10	0.01	0.90	0.40	0.0141	0.0019	0.1384	0.0065	0.0063	0.0014	4.09	1.23	2.89	1.00	2.3	0.2
DPS-1	04/23	1	1,830	720	0.31	0.04	0.60	0.30	0.0105	0.0018	0.0246	0.0027	0.1087	0.0079	2.49	0.87	2.53	0.90	2.0	0.2
DPS-4	04/27	1	560	660	1.59	0.18	0.33	0.02	0.0277	0.0036	0.0989	0.0071	0.2562	0.0098	3.77	1.15	6.17	1.70	4.6	0.5
Los Alamos at Upper GS	04/23	1	540	630	0.08	0.01	0.40	0.20	0.0006	0.0005	0.2182	0.0087	0.0051	0.0012	2.30	0.84	1.41	0.67	1.9	0.2
Los Alamos at LAO-3	04/23	1	190	600	0.69	0.08	0.60	0.40	0.0022	0.0009	0.3185	0.0131	0.1011	0.0061	2.67	0.93	3.95	1.22	1.5	0.2
Los Alamos at LAO-4.5	04/23	1	–80	580	1.26	0.14	0.50	0.40	0.0233	0.0021	0.1088	0.0052	0.1488	0.0086	2.63	0.92	3.12	1.05	1.4	0.2
Los Alamos at SR-4	08/03	1	240	620	0.05	0.04	0.66	0.03	0.0051	0.0015	0.0344	0.0032	0.0516	0.0052	2.99	1.00	2.99	1.00	3.3	0.3
Los Alamos at Totavi	08/03	1	150	610	0.02	0.03	0.45	0.02	0.0011	0.0010	0.0074	0.0019	0.0005	0.0007	3.78	1.17	2.56	0.90	2.5	0.3
Los Alamos at Otowi	08/03	1	460	640	0.08	0.04	0.48	0.04	0.0016	0.0010	0.0430	0.0040	0.0245	0.0042	5.99	1.62	3.68	1.15	3.0	0.3
Sandia Canyon:																				
Sandia at SR-4	08/03	1	270	620	0.05	0.04	0.11	0.02	0.0023	0.0009	0.0003	0.0005	0.0096	0.0026	2.01	0.78	1.86	0.74	2.5	0.3
Mortandad Canyon:																				
Mortandad near CMR Building	04/29	1	50	610	0.00	0.03	0.27	0.01	0.0324	0.0045	0.0201	0.0036			4.52	1.32	3.30	1.07	1.9	0.2
Mortandad West of GS-1	04/29	1	530	640	0.24	0.04	1.99	0.03	0.0159	0.0031	0.0409	0.0050			5.75	1.57	4.78	1.38	2.9	0.3
Mortandad at GS-1	04/29	1	4,870	900	16.50	1.80	0.38	0.01	12.1292	0.3870	10.4218	0.3333			82.50	16.90	20.70	5.17	16.2	1.6
Mortandad at MCO-5	04/29	1	2,260	750	18.00	2.00	0.23	0.01	3.2056	0.1131	8.0920	0.2771			23.30	4.93	17.10	0.45	16.5	1.6

Table 5-10. Radiochemical Analysis of Sediments for 1999 (pCi/g)[a,b] (Cont.)

Station Name	Date	Code[c]	^{3}H (pCi/L)		^{137}Cs		U (mg/kg)		^{238}Pu		^{239,240}Pu		^{241}Am		Gross Alpha		Gross Beta		Gross Gamma	
Pajarito Plateau Stations (Cont.)																				
Mortandad Canyon: (Cont.)																				
Mortandad at MCO-5	04/29	2	3,500	830	21.90	2.40	0.53	0.01	31.2870	1.1610	78.3171	2.8163			9.22	2.25	7.61	1.94	20.4	2.0
Mortandad at MCO-7	04/29	1	1,080	680	4.21	0.47	0.35	0.02	0.6212	0.0302	1.9244	0.0790			8.58	2.13	6.77	1.78	4.8	0.5
Mortandad at MCO-9	04/29	1	370	630	0.38	0.05	1.13	0.01	0.0146	0.0030	0.0497	0.0054			4.94	1.41	4.50	1.32	5.3	0.5
Mortandad at MCO-13 (A-5)	08/05	2	180	620	0.22	0.05	1.30	0.20	0.0044	0.0015	0.0211	0.0025	0.0088	0.0022	7.60	1.93	5.21	1.46	3.1	0.3
Mortandad at MCO-13 (A-5)	08/05	1	230	620	0.34	0.05	0.55	0.07	0.0009	0.0006	0.0164	0.0023	0.0203	0.0057	6.06	1.63	4.86	1.39	3.3	0.3
Mortandad A-6	08/05	1	440	630	0.39	0.07	0.81	0.03	0.0008	0.0006	0.0176	0.0024	0.0240	0.0043	12.10	2.80	7.91	2.00	3.7	0.4
Mortandad A-7	08/05	1	210	620	0.17	0.05	0.69	0.08	0.0030	0.0010	0.0131	0.0020	0.0092	0.0018	4.92	1.40	4.45	1.31	3.1	0.3
Mortandad at SR-4 (A-9)	08/05	1	140	610	0.15	0.05	1.40	0.30	0.0001	0.0004	0.0064	0.0014	0.0038	0.0014	4.32	1.28	3.74	1.16	3.8	0.4
Mortandad at SR-4 (A-9)	08/05	2	260	620	0.20	0.05	1.30	0.20	0.0051	0.0015	0.0049	0.0013	0.0352	0.0039	9.54	2.31	7.30	1.88	4.0	0.4
Mortandad at Rio Grande (A-11)	09/20	1	60	750	0.02	0.02	0.43	0.02	0.0028	0.0012	0.0043	0.0015			3.04	1.01	3.27	1.06	2.8	0.3
Cañada del Buey:																				
Cañada del Buey at SR-4	05/24	D					0.28	0.05												
Cañada del Buey at SR-4	05/24	1	220	620	0.04	0.01			0.0015	0.0008	0.0066	0.0014			1.77	0.71	1.50	0.69	2.1	0.2
CDB_01	07/20	1	130	610	0.11	0.02	0.58	0.06	0.0029	0.0009	0.0087	0.0014	0.0052	0.0096	6.00	1.50	4.81	0.90	3.4	0.3
CDB_02	07/20	1	60	610	0.22	0.03	0.98	0.03	0.0013	0.0008	0.0016	0.0008	–0.0046	0.0091	5.90	1.40	4.19	0.82	3.2	0.3
CDB_02	07/20	2	–70	600	0.20	0.02	0.81	0.06	0.0039	0.0013	0.0112	0.0019	–0.0066	0.0088	8.40	1.90	4.14	0.82	3.3	0.3
CDB_02	07/20	3	–40	600	0.19	0.03	0.78	0.05	0.0013	0.0007	0.0100	0.0016	–0.0070	0.0088	5.20	1.40	4.21	0.83	3.1	0.3
TA-54 Area G:																				
G-0	04/14	D	890	690	0.15	0.03	3.13	0.31	0.0237	0.0030	0.1255	0.0087	0.0916	0.0061	6.92	1.80	4.38	1.29	3.7	0.4
G-0	04/14	2					1.10	0.10												
G-0	04/14	1					1.50	0.10												
G-1	04/14	1	350	650	0.22	0.06	0.68	0.04	0.0245	0.0030	0.0105	0.0020	0.0022	0.0009	2.01	0.78	1.87	0.76	2.7	0.3
G-2	04/14	1	1,020	700	0.06	0.01	0.94	0.07	0.0019	0.0009	0.0077	0.0016	0.0016	0.0007	3.19	1.03	2.50	0.89	2.5	0.3
G-3	04/14	1	590	670	0.19	0.03	1.46	0.04	0.0030	0.0010	0.0162	0.0022	0.0055	0.0013	6.48	1.72	4.85	1.40	3.3	0.3
G-4 R-1	04/14	1	4,100	880	0.18	0.03	1.35	0.09	0.0066	0.0015	0.0469	0.0043	0.0093	0.0020	3.00	1.00	2.39	0.88	2.9	0.3
G-4 R-2	04/14	1	2,560	790	0.32	0.04	0.34	0.02	0.0041	0.0015	0.0662	0.0052	0.0160	0.0024	6.34	1.69	4.76	1.37	3.6	0.4
G-5	04/14	1	1,210	710	0.08	0.01	1.24	0.07	0.0132	0.0029	0.0570	0.0056	0.0311	0.0034	5.31	1.48	3.89	1.20	3.0	0.3
G-6 R	04/14	1	530	660	0.03	0.01	0.48	0.02	0.0097	0.0024	0.2446	0.0144	0.0526	0.0069	3.38	1.09	2.22	0.84	2.8	0.3
G-7	04/15	1	3,010	790	0.30	0.04	0.49	0.02	0.1472	0.0082	0.2612	0.0121	0.0926	0.0073	6.66	1.75	5.99	1.63	3.6	0.4
G-7	04/15	2	3,100	800	0.31	0.04	1.17	0.05	0.1624	0.0088	0.2189	0.0108	0.0428	0.0050	6.03	1.62	4.18	1.27	2.7	0.3
G-8	04/14	1	300	650	0.10	0.02	0.99	0.05	0.0069	0.0018	0.0101	0.0022	0.0111	0.0024	1.90	0.75	1.66	0.71	3.3	0.3
G-9	04/14	1	400	660	0.11	0.02	4.30	0.20	0.3702	0.0161	0.4851	0.0199	0.0185	0.0028	5.59	1.54	4.64	1.35	2.6	0.3
G3_01	07/20	3													3.90	1.00	2.88	0.69		
G3_01	07/20	2	260	620	0.07	0.01	0.66	0.04	0.0124	0.0022	0.0357	0.0038			3.99	1.00	3.21	0.70	4.0	0.4
G3_01	07/20	1	190	620	0.03	0.01	0.90	0.10	0.0045	0.0014	0.0519	0.0047			2.48	0.71	1.92	0.57	2.7	0.3
G3_02	07/20	2													2.17	0.65	1.79	0.58		
G3_02	07/20	1	1,400	700	0.02	0.01	0.58	0.05	0.0106	0.0022	0.0238	0.0032			5.20	1.20	2.73	0.69	3.4	0.3
TWISP Dome at Silt Fence	07/29	1	6,800	1,000	0.07	0.02	0.93	0.05							6.98	1.80	3.45	1.17	4.9	0.5

Table 5-10. Radiochemical Analysis of Sediments for 1999 (pCi/g)[a,b] (Cont.)

Station Name	Date	Code[c]	^{3}H (pCi/L)		^{137}Cs		U (mg/kg)		^{238}Pu		$^{239,240}Pu$		^{241}Am		Gross Alpha		Gross Beta		Gross Gamma	
Pajarito Plateau Stations (Cont.)																				
Pajarito Canyon:																				
Twomile at SR-501	03/31	1	390	640	0.13	0.02	1.36	0.14	0.0014	0.0010	0.0050	0.0015	0.0143	0.0080	5.24	1.45	4.13	1.25	2.3	0.2
Twomile at SR-501	03/31	D					0.43	0.03												
Pajarito at SR-501	03/31	1	300	640	0.05	0.01	1.00	0.10	0.0010	0.0006	0.0040	0.0011	0.0059	0.0075	2.12	0.80	1.60	0.71	2.2	0.2
Pajarito at SR-501	03/31	D					0.41	0.02												
Pajarito at SR-4	04/15	1	270	610	0.58	0.06	2.00	0.10	0.4241	0.0183	0.0701	0.0055	0.0108	0.0037	3.28	1.06	2.73	0.97	5.0	0.5
Potrillo Canyon:																				
Potrillo at SR-4	05/24	D					0.35	0.03												
Potrillo at SR-4	03/31	1	880	680	0.09	0.01	1.62	0.20	0.0003	0.0014	0.0017	0.0011	0.0091	0.0081	3.52	1.11	3.08	1.03	2.6	0.3
Fence Canyon:																				
Fence at SR-4	04/15	1	570	630	0.52	0.06	0.43	0.03	0.0010	0.0013	0.0273	0.0035	0.0084	0.0018	8.73	2.15	6.35	1.70	5.8	0.6
Cañon de Valle:																				
Cañon de Valle at SR-501	03/31	D	590	650	0.58	0.06	2.19	0.22	0.0021	0.0014	0.0387	0.0045	0.0096	0.0077	6.70	1.76	5.97	1.63	3.6	0.4
Water Canyon:																				
Water at SR-501	03/31	D	150	620	0.08	0.01	1.36	0.14	0.0003	0.0016	0.0061	0.0018	–0.0088	0.0067	2.01	0.80	2.54	0.92	2.4	0.2
Water at SR-4	03/31	1	690	660	0.08	0.01	1.44	0.14	–0.0011	0.0019	–0.0017	0.0015	0.0028	0.0086	4.35	1.28	3.71	1.17	4.2	0.4
Water at SR-4	03/31	D					1.20	0.30												
Indio Canyon:																				
Indio at SR-4	03/31	1	1,160	690	0.10	0.02	1.30	0.13	0.0021	0.0011	0.0045	0.0016	–0.0037	0.0069	2.67	0.92	2.59	0.93	5.1	0.5
Indio at SR-4	03/31	D					1.01	0.09												
Ancho Canyon:																				
Ancho at SR-4	03/31	2	3,040	810	0.08	0.01	1.65	0.17	0.0003	0.0006	0.0039	0.0013	0.0098	0.0006	2.63	0.90	2.43	0.90	3.3	0.3
Ancho at SR-4	03/31	D					0.90	0.06												
Ancho at SR-4	03/31	1	3,870	860	0.13	0.02	1.71	0.17	–0.0015	0.0019	0.0081	0.0023	0.0073	0.0074	2.59	0.90	2.48	0.90	4.1	0.4
Above Ancho Spring	09/21	1	150	750	0.30	0.06	0.89	0.05	0.0041	0.0014	0.0113	0.0023			4.84	1.38	3.68	1.15	3.4	0.3
Ancho at Rio Grande	09/21	1	–60	740	0.29	0.07	0.78	0.03	0.0003	0.0005	0.0092	0.0016			4.28	1.27	3.74	1.16	3.7	0.4
Chaquehui Canyon:																				
Chaquehui at Rio Grande	09/22	2	130	750	0.65	0.09	1.52	0.08	0.0026	0.0014	0.0456	0.0052			7.19	1.85	5.14	1.45	3.9	0.4
Chaquehui at Rio Grande	09/22	1	110	750	0.69	0.11	1.85	0.08	0.0033	0.0014	0.0272	0.0035			6.92	1.80	4.64	1.35	3.7	0.4
Chaquehui at Rio Grande	09/22	2	130	750	0.65	0.09	1.52	0.08	0.0026	0.0014	0.0456	0.0052			7.19	1.85	5.14	1.45	3.9	0.4
Chaquehui at Rio Grande	09/22	1	110	750	0.69	0.11	1.85	0.08	0.0033	0.0014	0.0272	0.0035			6.92	1.80	4.64	1.35	3.7	0.4

Table 5-10. Radiochemical Analysis of Sediments for 1999 (pCi/g)[a,b] (Cont.)

Station Name	Date	Code[c]	^{3}H (pCi/L)		^{137}Cs		U (mg/kg)		^{238}Pu		$^{239,240}Pu$		^{241}Am		Gross Alpha		Gross Beta		Gross Gamma	
Pajarito Plateau Stations (Cont.)																				
TA-49, Area AB:																				
AB-1	04/21	1	350	630	0.37	0.05	1.80	0.20	0.0046	0.0016	0.0181	0.0024	0.0152	0.0074	10.50	2.50	6.11	1.65	3.4	0.3
AB-2	04/21	1	590	650	0.17	0.04	1.80	0.20	–0.0008	0.0009	0.0491	0.0063	0.0098	0.0032	8.07	2.02	4.79	1.39	3.3	0.3
AB-3	04/15	1	230	610	0.42	0.05	1.46	0.05	0.0192	0.0028	1.0830	0.0380	0.2536	0.0136	8.45	2.10	6.38	1.71	9.2	0.9
AB-4	04/21	1	160	610	0.17	0.03	1.08	0.06	0.0004	0.0007	0.0082	0.0014	0.0145	0.0075	8.82	2.17	5.45	1.53	3.0	0.3
AB-4A	04/21	1	300	620	0.41	0.06	1.60	0.10	–0.0002	0.0007	0.0172	0.0026	0.0138	0.0075	10.40	2.47	5.89	1.61	3.2	0.3
AB-5	04/21	1	590	650	0.90	0.11	1.45	0.09	0.0018	0.0012	0.0268	0.0026	0.0206	0.0078	7.12	1.84	5.17	1.47	3.4	0.3
AB-6	04/21	1	330	630	0.20	0.04	0.84	0.04	0.0037	0.0016	0.0106	0.0023	0.0030	0.0016	5.01	1.42	3.43	1.11	2.9	0.3
AB-7	04/21	1	470	640	0.53	0.07	4.80	0.20	0.0008	0.0008	0.0103	0.0018	0.0072	0.0072	5.45	1.51	5.36	1.51	3.2	0.3
AB-8	04/21	1	190	620	0.11	0.04	1.77	0.09	0.0007	0.0005	0.0042	0.0010	0.0139	0.0075	6.05	1.63	3.76	1.18	2.8	0.3
AB-9	04/21	2	420	630	0.27	0.05	0.14	0.01	0.0022	0.0011	0.0194	0.0032	0.0041	0.0016	4.89	1.39	3.56	1.14	2.7	0.3
AB-9	04/21	1	380	630	0.21	0.04	0.92	0.05	0.0007	0.0010	0.0077	0.0013	–0.0005	0.0064	4.07	1.22	3.20	1.07	2.8	0.3
AB-10	04/21	1	380	630	0.25	0.05	0.38	0.02	0.0037	0.0010	0.0092	0.0014	0.0157	0.0069	4.53	1.32	3.57	1.14	2.7	0.3
AB-11	04/21	1	180	620	0.15	0.04	0.36	0.02	0.0020	0.0012	0.0030	0.0014	0.0019	0.0010	3.76	1.16	3.62	1.15	2.7	0.3
Frijoles Canyon:																				
Frijoles at Monument HQ	12/21	1	40	700	0.09	0.05	0.26	0.01											2.6	0.3
Frijoles at Rio Grande	12/21	1	–210	680	0.09	0.03	1.10	0.10											2.6	0.3
White Rock, Cañada del Buey																				
Site #1 Bonnie View South bank 1	10/28	1	550	640	0.17	0.03	1.08	0.06	0.0039	0.0011	0.0075	0.0014			3.46	1.10	2.76	1.01	3.5	0.4
Site #1 Bonnie View South bank 2	10/28	2	360	620	0.31	0.06	0.47	0.03	0.0020	0.0011	0.0142	0.0023			4.98	1.41	3.62	1.19	3.5	0.3
Site #1 Bonnie View Stream Channel 3	10/28	3	730	650	0.01	0.01	0.23	0.02	0.0004	0.0008	0.0041	0.0010			1.62	0.68	1.48	0.75	2.1	0.2
Site #2 Rover South bank 1	10/28	1	440	630	0.05	0.04	0.33	0.02	0.0004	0.0007	0.0037	0.0014			2.31	0.84	1.46	0.75	2.7	0.3
Site #2 Rover South bank 2	10/28	2	360	620	0.14	0.03	0.99	0.04	0.0009	0.0012	0.0097	0.0027			3.92	1.19	2.68	1.00	3.1	0.3
Site #2 Rover South bank 3	10/28	3	300	620	0.11	0.03	0.63	0.03	0.0015	0.0006	0.0146	0.0019			3.76	1.16	2.59	0.98	3.5	0.3
Site #2 Rover Stream Channel 4	10/28	4	810	660	0.01	0.03	0.85	0.04	0.0011	0.0006	0.0472	0.0032			2.01	0.77	1.58	0.77	1.8	0.2
Site #3 Lejano South bank 1	10/28	1	260	620	0.12	0.03	0.97	0.03	0.0023	0.0008	0.0055	0.0011			4.65	1.34	3.10	1.08	3.8	0.4
Site #3 Lejano South bank 2	10/28	2	390	630	0.10	0.02	1.40	0.10	0.0020	0.0007	0.0058	0.0012			3.92	1.19	2.85	1.03	3.5	0.3
Site #3 Lejano Stream Channel 3	10/28	3	350	620	0.05	0.04	0.92	0.07	0.0004	0.0004	0.0042	0.0010			2.33	0.85	1.80	0.82	2.3	0.2
Site #4 Meadow Lane South bank 1	10/28	1	740	650	0.09	0.03	0.64	0.02	0.0012	0.0008	0.0064	0.0013			3.49	1.10	2.74	1.01	3.9	0.4
Site #4 Meadow Lane South bank 2	10/28	2	330	620	0.04	0.04	0.48	0.02	0.0016	0.0009	0.0048	0.0010			3.86	1.18	3.44	1.15	3.7	0.4
Site #4 Meadow Lane South bank 3	10/28	3	100	610	0.16	0.03	1.00	0.10	0.0031	0.0009	0.0078	0.0014			3.92	1.19	2.91	1.04	3.1	0.3
Site #4 Meadow Lane Stream Channel 5	10/28	5	370	620	–0.01	0.14	0.52	0.03	0.0045	0.0012	0.0084	0.0016			2.96	0.99	1.98	0.85	2.7	0.3
Site #5 Overlook Park South bank 1	10/28	1	230	620	–0.01	0.22	0.38	0.03	0.0007	0.0005	0.0032	0.0011			2.83	0.96	2.44	0.95	3.1	0.3
Site #5 Overlook Park South bank 2	10/28	2	390	630	0.10	0.04	0.71	0.07	0.0054	0.0017	0.0101	0.0021			3.40	1.08	2.72	1.00	3.8	0.4
Site #5 Overlook Park South bank 3	10/28	3	350	620	0.16	0.04	0.84	0.06	0.0042	0.0011	0.7472	0.0262			4.34	1.28	2.52	0.96	3.2	0.3
Site #5 Overlook Park South bank 4	10/28	4	220	610	0.19	0.04	1.18	0.03	0.0005	0.0005	0.0131	0.0017			4.01	1.21	3.10	1.08	3.2	0.3
Site #5 Overlook Park Stream Channel 5	10/28	5	–240	580	0.07	0.04	0.12	0.02	0.0001	0.0004	0.0042	0.0011			1.29	0.59	1.52	0.76	2.8	0.3
Site #5 Overlook Park Stream Channel Dup 6	10/28	6	–50	590	0.06	0.04	0.68	0.04	0.0029	0.0009	0.0068	0.0012			2.20	0.82	1.66	0.79	2.4	0.2

Table 5-10. Radiochemical Analysis of Sediments for 1999 (pCi/g)[a,b] (Cont.)

Station Name	Date	Code[c]	^{3}H (pCi/L)	^{137}Cs	U (mg/kg)	^{238}Pu	^{239,240}Pu	^{241}Am	Gross Alpha	Gross Beta	Gross Gamma
Pajarito Plateau Stations (Cont.)											
Special EPA Sampling											
Ancho Canyon 1	12/16	1	770 670		5.80 0.20						
Ancho Canyon 2	12/16	1	760 670		2.61 0.04						
Ancho Canyon 3	12/16	1	340 640		2.12 0.05						
Ancho Canyon 4	12/16	1	990 680		2.00 0.05						
Ancho Canyon 5	12/16	1	670 660		0.81 0.04						
Bayo Canyon 1	12/13	1	0 690	0.63 0.08	1.70 0.10				3.07 1.01	3.67 1.12	7.0 0.7
Bayo Canyon 2	12/13	1	40 700	0.27 0.04	1.33 0.06				3.60 1.13	3.90 1.17	7.0 0.7
Bayo Canyon 3	12/13	1	–10 690	0.20 0.03	0.97 0.04				3.27 1.06	2.86 0.94	7.6 0.8
Bayo Canyon 4	12/13	1	350 720	0.27 0.04	1.00 0.10				3.00 1.00	2.76 0.92	8.9 0.9
Cañada del Buey 1	12/15	1	300 630		0.79 0.02						
Cañada del Buey 2	12/15	1	290 630		0.74 0.03						
Cañada del Buey 3	12/16	1	–140 680	0.06 0.03	0.54 0.03						2.7 0.3
Cañada del Buey 4	12/15	1	270 630		1.47 0.05						
Cañada del Buey 4	12/15	2	340 640		0.70 0.04						
Cañada del Buey 5A	12/15	1	130 620		0.74 0.07						
Cañada del Buey 5B	12/16	1	–90 690	0.16 0.04	0.42 0.03						3.6 0.4
Cañada del Buey 6	12/15	1	300 630		0.74 0.07						
Cañada del Buey 7	12/15	1	300 630		0.30 0.02						
Cañada del Buey 8	12/15	1	150 620		0.81 0.06						
Mortandad Canyon 1	12/14	1	120 700		0.77 0.02						
Mortandad Canyon 2	12/14	1	190 710		0.60 0.04						
Mortandad Canyon 3	12/14	1	60 700		0.83 0.05						
Mortandad Canyon 4	12/14	1	900 750		0.38 0.02						
Mortandad Canyon 5A	12/14	1	100 700		0.90 0.10						
Mortandad Canyon 5B	12/14	1	–60 690		0.52 0.03						
Pajarito Canyon 1	12/16	1	460 650		1.24 0.06						
Pajarito Canyon 2	12/16	1	400 640		0.82 0.05						
Pajarito Canyon 3	12/16	1	160 620		1.34 0.06						
Pajarito Canyon 4	12/16	1	470 650		1.05 0.04						
Sandia Canyon 1	12/13	1	60 700	0.00 0.26	0.65 0.03				3.52 1.11	1.89 0.71	3.5 0.4
Sandia Canyon 2	12/13	1	110 700	0.10 0.04	0.53 0.01				5.58 1.53	3.58 1.10	3.8 0.4
Sandia Canyon 4	12/13	1	80 700	0.05 0.05	1.17 0.07				2.75 0.94	1.91 0.72	4.3 0.4
Sandia Canyon 3	12/13	1	3,190 880	0.10 0.04	1.12 0.06				3.22 1.05	2.32 0.82	3.6 0.4
Sandia Canyon 5	12/13	1	470 720	0.56 0.09	1.64 0.07				3.94 1.20	2.98 0.97	4.6 0.5
Sandia Canyon 6	12/13	1	330 710	0.09 0.03	1.54 0.06				3.30 1.06	2.73 0.91	7.0 0.7

Table 5-10. Radiochemical Analysis of Sediments for 1999 (pCi/g)[a,b] (Cont.)

Station Name	Date	Code[c]	^{3}H (pCi/L)	^{137}Cs	U (mg/kg)	^{238}Pu	^{239,240}Pu	^{241}Am	Gross Alpha	Gross Beta	Gross Gamma
Standardized Comparisons											
Average Detection Limits			700	0.05	0.25	0.0050[d]	0.0050[d]	0.0050	1.50	1.50	0.8
Background				0.44[e]	4.4[e]	0.006[e]	0.023[e]	0.09[f]	14.8[f]	12[f]	8.2[f]
SAL[g]			20,000	4.4	29	27	24	22			

[a] Except where noted. Two columns are listed; the first is the value; the second is the counting uncertainty (1 std dev).
[b] See Appendix B for an explanation of negative numbers.
[c] Codes: 1–primary analysis; 2–secondary analysis; R–lab replicate; D–lab duplicate.
[d] Sample sizes for ^{238}Pu and ^{239,240}Pu analysis: stream channels 100 g; reservoirs 1,000 g. Limits of detection for ^{238}Pu and ^{239,240}Pu in reservoir samples are 0.0001 pCi/g.
[e] Purtymun et al. (1987a), upper limit for background for sediment samples from 1974–1986.
[f] Preliminary upper limit for background values for channel sediments from 1974–1996 (McLin et al., in preparation).
[g] Screening Action Level, LANL Environmental Restoration Project, 1998; see text for details.

Table 5-11. Strontium-90 Sediments for 1999 (pCi/g)
(LANL's 1999 strontium-90 data are not valid because of analytical laboratory problems; the data appear in this report for documentary purposes only.)

Station Name	Date	Code[a]	Analyte	Value	Uncertainty	Detection Limit	Units	Detect?	Ratio of Value to Background	Ratio of Value to SAL
Rio Chama at Chamita	05/04	1	^{90}Sr	1.46	0.40	2.00	pCi/g	ND[b]		
Rio Grande at Embudo	05/04	1	^{90}Sr	1.62	0.40	2.00	pCi/g	ND		
Rio Grande at Otowi (bank)	08/03	1	^{90}Sr	0.71	0.45	0.95	pCi/g	ND		
Rio Grande at Cochiti	09/23	1	^{90}Sr	6.71	0.78	0.97	pCi/g	Detect	7.71	1.14
Rio Grande at Otowi Upper (bank)	08/03	1	^{90}Sr	1.34	0.44	0.85	pCi/g	Detect	1.54	0.23
Rio Grande at Bernalillo	05/04	1	^{90}Sr	2.00	0.41	2.00	pCi/g	Detect	2.30	0.34
Jemez River	08/02	1	^{90}Sr	1.66	0.45	0.84	pCi/g	Detect	1.91	0.28
Heron Upper	08/31	1	^{90}Sr	0.58	0.31	0.64	pCi/g	ND		
Heron Middle	08/31	1	^{90}Sr	0.80	0.37	0.75	pCi/g	ND		
Heron Lower	08/31	1	^{90}Sr	0.97	0.28	0.52	pCi/g	Detect	1.11	0.16
El Vado Upper	08/31	1	^{90}Sr	0.06	0.28	0.63	pCi/g	ND		
El Vado Middle	08/31	1	^{90}Sr	0.04	0.29	0.66	pCi/g	ND		
El Vado Lower	08/31	1	^{90}Sr	0.80	0.34	0.68	pCi/g	ND		
Abiquiu Middle	10/12	1	^{90}Sr	3.87	0.56	0.83	pCi/g	Detect	4.45	0.66
Abiquiu Middle	10/12	D	^{90}Sr	7.51	0.73	0.75	pCi/g	Detect	8.63	1.27
Abiquiu Lower	10/12	1	^{90}Sr	6.94	0.71	0.78	pCi/g	Detect	7.98	1.18
Abiquiu Lower	10/12	D	^{90}Sr	7.93	0.79	0.85	pCi/g	Detect	9.11	1.34
Rio Grande Upper	09/02	1	^{90}Sr	0.41	0.33	0.70	pCi/g	ND		
Rio Grande Middle	09/02	1	^{90}Sr	–0.74	0.38	0.80	pCi/g	ND		
Rio Grande Lower	09/02	1	^{90}Sr	–0.15	0.33	0.75	pCi/g	ND		
Rio Grande Lower	09/02	1	^{90}Sr	0.93	0.34	0.67	pCi/g	ND		
Cochiti Upper	10/13	1	^{90}Sr	–0.65	0.38	0.82	pCi/g	ND		
Cochiti Middle	10/13	1	^{90}Sr	8.12	0.82	0.90	pCi/g	Detect	9.33	1.38
Cochiti Middle	10/13	1	^{90}Sr	5.59	0.65	0.81	pCi/g	Detect	6.43	0.95
Cochiti Lower	10/13	1	^{90}Sr	7.50	0.78	0.87	pCi/g	Detect	8.62	1.27
Bayo at SR-502	08/03	1	^{90}Sr	1.37	0.45	0.86	pCi/g	Detect	1.57	0.23
Acid Weir	04/27	1	^{90}Sr	–0.80	0.38	0.81	pCi/g	ND		
Pueblo 1	04/27	1	^{90}Sr	–0.30	0.03	0.73	pCi/g	ND		
Pueblo 2	05/24	1	^{90}Sr	1.59	0.38	0.68	pCi/g	Detect	1.83	0.27
Hamilton Bend Spring	05/24	1	^{90}Sr	2.72	0.46	0.73	pCi/g	Detect	3.13	0.46
Pueblo 3	05/24	1	^{90}Sr	2.89	0.46	0.70	pCi/g	Detect	3.32	0.49
Pueblo 3	05/24	1	^{90}Sr	2.53	0.43	0.68	pCi/g	Detect	2.91	0.43

Table 5-11. Strontium-90 Sediments for 1999 (pCi/g) (Cont.)
(LANL's 1999 strontium-90 data are not valid because of analytical laboratory problems; the data appear in this report for documentary purposes only.)

Station Name	Date	Code[a]	Analyte	Value	Uncertainty	Detection Limit	Units	Detect?	Ratio of Value to Background	Ratio of Value to SAL
Pueblo at SR-502	08/04	1	^{90}Sr	2.15	0.48	0.82	pCi/g	Detect	2.47	0.36
Los Alamos at Bridge	04/27	1	^{90}Sr	–0.42	0.35	0.78	pCi/g	ND		
Los Alamos at Bridge	04/27	1	^{90}Sr	–0.08	0.34	0.77	pCi/g	ND		
Los Alamos at LAO-1	04/23	1	^{90}Sr	2.68	0.43	2.00	pCi/g	Detect	3.08	0.45
DPS-1	04/23	1	^{90}Sr	2.33	0.43	2.00	pCi/g	Detect	2.68	0.39
DPS-4	04/27	1	^{90}Sr	0.90	0.34	0.67	pCi/g	ND		
Los Alamos at Upper GS	04/23	1	^{90}Sr	1.93	0.41	2.00	pCi/g	ND		
Los Alamos at LAO-3	04/23	1	^{90}Sr	1.57	0.38	2.00	pCi/g	ND		
Los Alamos at LAO-3	04/23	1	^{90}Sr	1.57	0.38	2.00	pCi/g	ND		
Los Alamos at LAO-4.5	04/23	1	^{90}Sr	1.33	0.38	2.00	pCi/g	ND		
Los Alamos at SR-4	08/03	1	^{90}Sr	2.73	0.50	0.81	pCi/g	Detect	3.14	0.46
Los Alamos at Totavi	08/03	1	^{90}Sr	2.24	0.47	0.79	pCi/g	Detect	2.57	0.38
Los Alamos at Otowi	08/03	1	^{90}Sr	2.47	0.48	0.80	pCi/g	Detect	2.84	0.42
Sandia at SR-4	08/03	1	^{90}Sr	3.10	0.57	0.92	pCi/g	Detect	3.56	0.53
Mortandad near CMR Building	04/29	1	^{90}Sr	0.93	0.36	0.70	pCi/g	ND		
Mortandad west of GS-1	04/29	1	^{90}Sr	1.13	0.35	0.67	pCi/g	Detect	1.30	0.19
Mortandad at GS-1	04/29	1	^{90}Sr	2.51	0.44	0.70	pCi/g	Detect	2.89	0.43
Mortandad at MCO-5	04/29	1	^{90}Sr	2.86	0.45	0.67	pCi/g	Detect	3.29	0.48
Mortandad at MCO-5	04/29	1	^{90}Sr	1.72	0.41	0.73	pCi/g	Detect	1.98	0.29
Mortandad at MCO-7	04/29	1	^{90}Sr	0.78	0.33	0.65	pCi/g	ND		
Mortandad at MCO-9	04/29	1	^{90}Sr	0.83	0.36	0.72	pCi/g	ND		
Mortandad at MCO-13 (A-5)	08/05	1	^{90}Sr	1.95	0.44	0.77	pCi/g	Detect	2.24	0.33
Mortandad at MCO-13 (A-5)	08/05	1	^{90}Sr	2.51	0.46	0.75	pCi/g	Detect	2.89	0.43
Mortandad A-6	08/05	1	^{90}Sr	5.31	0.54	0.59	pCi/g	Detect	6.10	0.90
Mortandad A-7	08/05	1	^{90}Sr	3.40	0.50	0.73	pCi/g	Detect	3.91	0.58
Mortandad at SR-4 (A-9)	08/05	1	^{90}Sr	3.58	0.50	0.69	pCi/g	Detect	4.11	0.61
Mortandad at SR-4 (A-9)	08/05	1	^{90}Sr	2.27	0.46	0.77	pCi/g	Detect	2.61	0.38
Mortandad at Rio Grande (A-11)	09/20	1	^{90}Sr	2.07	0.41	0.68	pCi/g	Detect	2.38	0.35
Cañada del Buey at SR-4	05/24	1	^{90}Sr	1.56	0.39	0.70	pCi/g	Detect	1.79	0.26
CDB_01	07/20	1	^{90}Sr	3.89	0.48	2.00	pCi/g	Detect	4.47	0.66
CDB_02	07/20	1	^{90}Sr	4.89	0.55	2.00	pCi/g	Detect	5.62	0.83
CDB_02	07/20	1	^{90}Sr	4.09	0.49	2.00	pCi/g	Detect	4.70	0.69
CDB_02	07/20	1	^{90}Sr	2.98	0.47	2.00	pCi/g	Detect	3.43	0.51

Table 5-11. Strontium-90 Sediments for 1999 (pCi/g) (Cont.)
(LANL's 1999 strontium-90 data are not valid because of analytical laboratory problems; the data appear in this report for documentary purposes only.)

Station Name	Date	Code[a]	Analyte	Value	Uncertainty	Detection Limit	Units	Detect?	Ratio of Value to Background	Ratio of Value to SAL
G-0	04/14	1	^{90}Sr	5.67	0.57	0.60	pCi/g	Detect	6.52	0.96
G-0	04/14	1	^{90}Sr	5.63	0.57	0.61	pCi/g	Detect	6.47	0.95
G-1	04/14	1	^{90}Sr	2.91	0.44	0.64	pCi/g	Detect	3.34	0.49
G-2	04/14	1	^{90}Sr	1.92	0.39	0.66	pCi/g	Detect	2.21	0.33
G-3	04/14	1	^{90}Sr	3.11	0.43	0.60	pCi/g	Detect	3.57	0.53
G-4 R-1	04/14	1	^{90}Sr	2.50	0.41	0.63	pCi/g	Detect	2.87	0.42
G-4 R-2	04/14	1	^{90}Sr	3.56	0.46	0.61	pCi/g	Detect	4.09	0.60
G-5	04/14	1	^{90}Sr	2.97	0.44	0.65	pCi/g	Detect	3.41	0.50
G-6 R	04/14	1	^{90}Sr	2.20	0.40	0.65	pCi/g	Detect	2.53	0.37
G-7	04/15	1	^{90}Sr	3.35	0.46	2.00	pCi/g	Detect	3.85	0.57
G-7	04/15	1	^{90}Sr	3.02	0.46	2.00	pCi/g	Detect	3.47	0.51
G-8	04/14	1	^{90}Sr	3.57	0.47	0.64	pCi/g	Detect	4.10	0.61
G-9	04/14	1	^{90}Sr	2.33	0.42	0.68	pCi/g	Detect	2.68	0.39
G3_01	07/20	1	^{90}Sr	3.65	0.48	0.65	pCi/g	Detect	4.20	0.62
G3_01	07/20	1	^{90}Sr	3.04	0.47	0.69	pCi/g	Detect	3.49	0.52
G3_02	07/20	1	^{90}Sr	3.38	0.47	0.65	pCi/g	Detect	3.89	0.57
TWISP Dome at Silt Fence	07/29	1	^{90}Sr	0.60	0.33	0.69	pCi/g	ND		
Twomile at SR-501	03/31	1	^{90}Sr	3.25	0.56	0.88	pCi/g	Detect	3.74	0.55
Pajarito at SR-501	03/31	1	^{90}Sr	2.70	0.44	0.67	pCi/g	Detect	3.10	0.46
Pajarito at SR-4	04/15	1	^{90}Sr	4.31	0.51	2.00	pCi/g	Detect	4.95	0.73
Potrillo at SR-4	03/31	1	^{90}Sr	4.43	0.55	0.70	pCi/g	Detect	5.09	0.75
Fence at SR-4	04/15	1	^{90}Sr	4.55	0.53	2.00	pCi/g	Detect	5.23	0.77
Cañon de Valle at SR-501	03/31	1	^{90}Sr	4.38	0.49	0.58	pCi/g	Detect	5.03	0.74
Water at SR-501	03/31	1	^{90}Sr	3.24	0.46	0.64	pCi/g	Detect	3.72	0.55
Water at SR-4	03/31	1	^{90}Sr	3.94	0.49	0.64	pCi/g	Detect	4.53	0.67
Indio at SR-4	03/31	1	^{90}Sr	3.05	0.43	0.62	pCi/g	Detect	3.51	0.52
Ancho at SR-4	03/31	1	^{90}Sr	3.67	0.46	0.61	pCi/g	Detect	4.22	0.62
Ancho at SR-4	03/31	1	^{90}Sr	3.76	0.48	0.62	pCi/g	Detect	4.32	0.64
Above Ancho Spring	09/21	1	^{90}Sr	8.07	0.77	0.79	pCi/g	Detect	9.28	1.37
Ancho at Rio Grande	09/21	1	^{90}Sr	2.55	0.41	0.65	pCi/g	Detect	2.93	0.43

Table 5-11. Strontium-90 Sediments for 1999 (pCi/g) (Cont.)
(LANL's 1999 strontium-90 data are not valid because of analytical laboratory problems; the data appear in this report for documentary purposes only.)

Station Name	Date	Code[a]	Analyte	Value	Uncertainty	Detection Limit	Units	Detect?	Ratio of Value to Background	Ratio of Value to SAL
Chaquehui at Rio Grande	09/22	1	^{90}Sr	7.86	0.75	0.77	pCi/g	Detect	9.03	1.33
Chaquehui at Rio Grande	09/22	1	^{90}Sr	8.38	0.75	0.71	pCi/g	Detect	9.63	1.42
Chaquehui at Rio Grande	09/22	1	^{90}Sr	8.38	0.75	0.71	pCi/g	Detect	9.63	1.42
Chaquehui at Rio Grande	09/22	1	^{90}Sr	7.86	0.75	0.77	pCi/g	Detect	9.03	1.33
AB-1	04/21	1	^{90}Sr	2.75	0.44	0.66	pCi/g	Detect	3.16	0.47
AB-2	04/21	1	^{90}Sr	2.54	0.41	0.62	pCi/g	Detect	2.92	0.43
AB-3	04/15	1	^{90}Sr	4.64	0.55	2.00	pCi/g	Detect	5.33	0.79
AB-4	04/21	1	^{90}Sr	2.76	0.42	0.63	pCi/g	Detect	3.17	0.47
AB-4A	04/21	1	^{90}Sr	2.82	0.42	0.62	pCi/g	Detect	3.24	0.48
AB-5	04/21	1	^{90}Sr	1.78	0.42	0.73	pCi/g	Detect	2.05	0.30
AB-6	04/21	1	^{90}Sr	1.20	0.41	0.78	pCi/g	ND		
AB-7	04/21	1	^{90}Sr	1.45	0.39	0.72	pCi/g	Detect	1.67	0.25
AB-8	04/21	1	^{90}Sr	2.31	0.43	0.71	pCi/g	Detect	2.66	0.39
AB-9	04/21	1	^{90}Sr	2.53	0.43	0.68	pCi/g	Detect	2.91	0.43
AB-9	04/21	1	^{90}Sr	2.50	0.41	0.64	pCi/g	Detect	2.87	0.42
AB-10	04/21	1	^{90}Sr	1.40	0.35	0.62	pCi/g	Detect	1.61	0.24
AB-11	04/21	1	^{90}Sr	2.08	0.41	0.68	pCi/g	Detect	2.39	0.35
Site #1 Bonnie View South bank	10/28	1	^{90}Sr	10.47	1.33	1.75	pCi/g	Detect	12.03	1.77
Site #1 Bonnie View South bank	10/28	1	^{90}Sr	11.45	1.38	1.76	pCi/g	Detect	13.16	1.94
Site #1 BV Stream Channel	10/28	1	^{90}Sr	3.54	0.46	0.62	pCi/g	Detect	4.07	0.60
Site #2 Rover South bank	10/28	1	^{90}Sr	1.65	0.43	0.78	pCi/g	Detect	1.90	0.28
Site #2 Rover South bank	10/28	1	^{90}Sr	13.35	1.33	1.40	pCi/g	Detect	15.34	2.26
Site #2 Rover South bank	10/28	1	^{90}Sr	6.17	0.65	0.73	pCi/g	Detect	7.09	1.05
Site #2 Rover Stream Channel	10/28	1	^{90}Sr	2.90	0.45	0.68	pCi/g	Detect	3.33	0.49
Site #3 Lejano South bank	10/28	1	^{90}Sr	6.66	0.66	0.69	pCi/g	Detect	7.66	1.13
Site #3 Lejano South bank	10/28	1	^{90}Sr	4.52	0.59	0.79	pCi/g	Detect	5.20	0.77
Site #3 Lejano Stream Channel	10/28	1	^{90}Sr	4.94	0.57	0.70	pCi/g	Detect	5.68	0.84
Site #4 Meadow Lane South bank	10/28	1	^{90}Sr	5.39	0.66	0.84	pCi/g	Detect	6.20	0.91
Site #4 Meadow Lane South bank	10/28	1	^{90}Sr	5.71	0.65	0.77	pCi/g	Detect	6.56	0.97
Site #4 Meadow Lane South bank	10/28	1	^{90}Sr	7.39	0.70	0.69	pCi/g	Detect	8.49	1.25
Site #4 Meadow Lane Strm Channel	10/28	1	^{90}Sr	5.96	0.65	0.74	pCi/g	Detect	6.85	1.01

Table 5-11. Strontium-90 Sediments for 1999 (pCi/g) (Cont.)
(LANL's 1999 strontium-90 data are not valid because of analytical laboratory problems; the data appear in this report for documentary purposes only.)

Station Name	Date	Code[a]	Analyte	Value	Uncertainty	Detection Limit	Units	Detect?	Ratio of Value to Background	Ratio of Value to SAL
Site #5 Overlook Park South bank	10/28	1	^{90}Sr	4.45	0.58	0.78	pCi/g	Detect	5.11	0.75
Site #5 Overlook Park South bank	10/28	1	^{90}Sr	6.33	0.66	0.73	pCi/g	Detect	7.28	1.07
Site #5 Overlook Park South bank	10/28	1	^{90}Sr	5.18	0.55	0.61	pCi/g	Detect	5.95	0.88
Site #5 Overlook Park South bank	10/28	1	^{90}Sr	7.02	0.66	0.66	pCi/g	Detect	8.07	1.19
Site #5 Ovrlk Prk Strm Chnl	10/28	1	^{90}Sr	2.88	0.43	0.62	pCi/g	Detect	3.31	0.49
Site #5 Ovrlk Prk Strm Chnl	10/28	1	^{90}Sr	4.05	0.50	0.64	pCi/g	Detect	4.66	0.69

[a]Codes: 1–primary analysis; 2–secondary analysis; R–lab replicate; D–lab duplicate.
[b]ND = not detected.

Table 5-12. Detections of Greater-Than-Background Radionuclides in Sediments for 1999[a]

Station Name	Date	Code[b]	Analyte	Value	Uncertainty[c]	Detection Limit	Background	SAL	Units	Ratio of Value to Background	Ratio of Value to SAL
AB-2	04/21	1	^{239,240}Pu	0.0491	0.0063	0.0035	0.023	24	pCi/g	2.13	0.00
AB-3	04/15	1	^{241}Am	0.2536	0.0136	0.0037	0.09	22	pCi/g	2.82	0.01
AB-3	04/15	1	Gamma	9.2	0.9	0.2	8.2		pCi/g	1.12	
AB-3	04/15	1	^{238}Pu	0.0192	0.0028	0.0052	0.006	27	pCi/g	3.20	0.00
AB-3	04/15	1	^{239,240}Pu	1.0830	0.0380	0.0021	0.023	24	pCi/g	47.09	0.05
AB-5	04/21	1	^{137}Cs	0.90	0.11	0.09	0.44	4.4	pCi/g	2.05	0.21
AB-5	04/21	1	^{239,240}Pu	0.0268	0.0026	0.0024	0.023	24	pCi/g	1.17	0.00
AB-7	04/21	1	^{137}Cs	0.53	0.07	0.09	0.44	4.4	pCi/g	1.20	0.12
AB-7	04/21	1	U	4.80	0.20		4.4	29	mg/kg	1.09	0.17
Abiquiu Lower	10/12	1	^{3}H	3,320	930	820		20,000	pCi/L		0.17
Abiquiu Lower	10/12	D	^{3}H	6,500	1,100	1,200		20,000	pCi/L		0.33
Abiquiu Middle	10/12	D	^{3}H	4,440	980	990		20,000	pCi/L		0.22
Abiquiu Middle	10/12	1	^{3}H	3,090	920	810		20,000	pCi/L		0.15
Acid Weir	04/27	1	Alpha	16.00	3.54		14.8		pCi/g	1.08	
Acid Weir	04/27	1	^{241}Am	0.4200	0.0140	0.0020	0.09	22	pCi/g	4.67	0.02
Acid Weir	04/27	1	^{238}Pu	0.0290	0.0023	0.0017	0.006	27	pCi/g	4.83	0.00
Acid Weir	04/27	1	^{239,240}Pu	6.6021	0.1717	0.0011	0.023	24	pCi/g	287.05	0.28
Ancho at SR-4	03/31	1	^{3}H	3,040	810	410		20,000	pCi/L		0.15
Ancho at SR-4	03/31	1	^{3}H	3,870	860	410		20,000	pCi/L		0.19
Ancho Canyon 1	12/16	1	U	5.80	0.20		4.4	29	mg/kg	1.32	0.20
Bayo Canyon 1	12/13	1	^{137}Cs	0.63	0.08	0.09	0.44	4.4	pCi/g	1.42	0.14
Bayo Canyon 4	12/13	1	Gamma	8.9	0.9	0.2	8.2		pCi/g	1.09	
Cañon de Valle at SR-501	03/31	1	^{137}Cs	0.58	0.07	0.02	0.44	4.4	pCi/g	1.32	0.13
Cañon de Valle at SR-501	03/31	1	^{239,240}Pu	0.0387	0.0045	0.0029	0.023	24	pCi/g	1.68	0.00
Chaquehui at Rio Grande	09/22	1	^{137}Cs	0.65	0.09	0.10	0.44	4.4	pCi/g	1.47	0.15
Chaquehui at Rio Grande	09/22	1	^{137}Cs	0.69	0.11	0.09	0.44	4.4	pCi/g	1.57	0.16
Chaquehui at Rio Grande	09/22	1	^{239,240}Pu	0.0272	0.0035	0.0027	0.023	24	pCi/g	1.18	0.00
Chaquehui at Rio Grande	09/22	1	^{239,240}Pu	0.0456	0.0052	0.0056	0.023	24	pCi/g	1.98	0.00
DPS-1	04/23	1	^{241}Am	0.1087	0.0079	0.0053	0.09	22	pCi/g	1.21	0.00
DPS-1	04/23	1	^{238}Pu	0.0105	0.0018	0.0037	0.006	27	pCi/g	1.75	0.00
DPS-1	04/23	1	^{239,240}Pu	0.0246	0.0027	0.0018	0.023	24	pCi/g	1.07	0.00
DPS-4	04/27	1	^{241}Am	0.2562	0.0098	0.0023	0.09	22	pCi/g	2.85	0.01
DPS-4	04/27	1	^{137}Cs	1.59	0.18	0.09	0.44	4.4	pCi/g	3.61	0.36
DPS-4	04/27	1	^{238}Pu	0.0277	0.0036	0.0053	0.006	27	pCi/g	4.62	0.00

Table 5-12. Detections of Greater-Than-Background Radionuclides in Sediments for 1999[a] (Cont.)

Station Name	Date	Code[b]	Analyte	Value	Uncertainty[c]	Detection Limit	Background	SAL	Units	Ratio of Value to Background	Ratio of Value to SAL
DPS-4	04/27	1	^{239,240}Pu	0.0989	0.0071	0.0038	0.023	24	pCi/g	4.30	0.00
Fence at SR-4	04/15	1	^{137}Cs	0.52	0.06	0.04	0.44	4.4	pCi/g	1.18	0.12
Fence at SR-4	04/15	1	^{239,240}Pu	0.0273	0.0035	0.0022	0.023	24	pCi/g	1.19	0.00
G-7	04/15	1	^{241}Am	0.0926	0.0073	0.0047	0.09	22	pCi/g	1.03	0.00
G-0	04/14	1	^{241}Am	0.0916	0.0061	0.0027	0.09	22	pCi/g	1.02	0.00
G-4 R-1	04/14	1	^{3}H	4,100	880	420		20,000	pCi/L		0.21
G-7	04/15	1	^{3}H	3,100	800	390		20,000	pCi/L		0.16
G-7	04/15	1	^{3}H	3,010	790	400		20,000	pCi/L		0.15
G-4 R-2	04/14	1	^{3}H	2,560	790	420		20,000	pCi/L		0.13
G-9	04/14	1	^{238}Pu	0.3702	0.0161	0.0040	0.006	27	pCi/g	61.70	0.01
G-7	04/15	1	^{238}Pu	0.1624	0.0088	0.0033	0.006	27	pCi/g	27.07	0.01
G-7	04/15	1	^{238}Pu	0.1472	0.0082	0.0046	0.006	27	pCi/g	24.53	0.01
G-1	04/14	1	^{238}Pu	0.0245	0.0030	0.0035	0.006	27	pCi/g	4.08	0.00
G-0	04/14	1	^{238}Pu	0.0237	0.0030	0.0042	0.006	27	pCi/g	3.95	0.00
G-5	04/14	1	^{238}Pu	0.0132	0.0029	0.0066	0.006	27	pCi/g	2.20	0.00
G-0	04/14	1	^{238}Pu	0.0124	0.0024	0.0031	0.006	27	pCi/g	2.07	0.00
G3_01	07/20	1	^{238}Pu	0.0124	0.0022	0.0032	0.006	27	pCi/g	2.07	0.00
G3_02	07/20	1	^{238}Pu	0.0106	0.0022	0.0028	0.006	27	pCi/g	1.77	0.00
G-6 R	04/14	1	^{238}Pu	0.0097	0.0024	0.0036	0.006	27	pCi/g	1.62	0.00
G-8	04/14	1	^{238}Pu	0.0069	0.0018	0.0024	0.006	27	pCi/g	1.15	0.00
G-4 R-1	04/14	1	^{238}Pu	0.0066	0.0015	0.0024	0.006	27	pCi/g	1.10	0.00
G-9	04/14	1	^{239,240}Pu	0.4851	0.0199	0.0028	0.023	24	pCi/g	21.09	0.02
G-7	04/15	1	^{239,240}Pu	0.2612	0.0121	0.0057	0.023	24	pCi/g	11.36	0.01
G-6 R	04/14	1	^{239,240}Pu	0.2446	0.0144	0.0032	0.023	24	pCi/g	10.63	0.01
G-7	04/15	1	^{239,240}Pu	0.2189	0.0108	0.0040	0.023	24	pCi/g	9.52	0.01
G-0	04/14	1	^{239,240}Pu	0.1255	0.0087	0.0035	0.023	24	pCi/g	5.46	0.01
G-0	04/14	1	^{239,240}Pu	0.1072	0.0069	0.0033	0.023	24	pCi/g	4.66	0.00
G-4 R-2	04/14	1	^{239,240}Pu	0.0662	0.0052	0.0027	0.023	24	pCi/g	2.88	0.00
G-5	04/14	1	^{239,240}Pu	0.0570	0.0056	0.0043	0.023	24	pCi/g	2.48	0.00
G3_01	07/20	1	^{239,240}Pu	0.0519	0.0047	0.0021	0.023	24	pCi/g	2.26	0.00
G-4 R-1	04/14	1	^{239,240}Pu	0.0469	0.0043	0.0023	0.023	24	pCi/g	2.04	0.00
G3_01	07/20	1	^{239,240}Pu	0.0357	0.0038	0.0035	0.023	24	pCi/g	1.55	0.00
G3_02	07/20	1	^{239,240}Pu	0.0238	0.0032	0.0023	0.023	24	pCi/g	1.03	0.00
Guaje Reservoir	11/16	1	Alpha	22.30	4.73		14.8		pCi/g	1.51	

Table 5-12. Detections of Greater-Than-Background Radionuclides in Sediments for 1999[a] (Cont.)

Station Name	Date	Code[b]	Analyte	Value	Uncertainty[c]	Detection Limit	Background	SAL	Units	Ratio of Value to Background	Ratio of Value to SAL
Guaje Reservoir	11/16	D	Alpha	23.00	4.87		14.8		pCi/g	1.55	
Guaje Reservoir	11/16	D	Beta	13.30	3.05		12		pCi/g	1.11	
Guaje Reservoir	11/16	1	Beta	14.40	3.26		12		pCi/g	1.20	
Guaje Reservoir	11/16	1	^{137}Cs	0.51	0.10	0.14	0.44	4.4	pCi/g	1.15	0.12
Guaje Reservoir	11/16	1	^{137}Cs	0.56	0.07	0.07	0.44	4.4	pCi/g	1.26	0.13
Guaje Reservoir	11/16	1	U	10.90	0.60		4.4	29	mg/kg	2.48	0.38
Hamilton Bend Spring	05/24	1	$^{239,240}Pu$	0.5096	0.0209	0.0036	0.023	24	pCi/g	22.16	0.02
Jemez River	08/02	1	^{238}Pu	0.0063	0.0012	0.0023	0.006	27	pCi/g	1.05	0.00
Los Alamos at LAO-1	04/23	1	^{238}Pu	0.0141	0.0019	0.0031	0.006	27	pCi/g	2.35	0.00
Los Alamos at LAO-1	04/23	1	$^{239,240}Pu$	0.1384	0.0065	0.0019	0.023	24	pCi/g	6.02	0.01
Los Alamos at LAO-3	04/23	1	^{241}Am	0.1011	0.0061	0.0016	0.09	22	pCi/g	1.12	0.00
Los Alamos at LAO-3	04/23	1	^{137}Cs	0.69	0.08	0.03	0.44	4.4	pCi/g	1.56	0.16
Los Alamos at LAO-3	04/23	1	$^{239,240}Pu$	0.3185	0.0131	0.0015	0.023	24	pCi/g	13.85	0.01
Los Alamos at LAO-4.5	04/23	1	^{241}Am	0.1488	0.0086	0.0031	0.09	22	pCi/g	1.65	0.01
Los Alamos at LAO-4.5	04/23	1	^{137}Cs	1.26	0.14	0.02	0.44	4.4	pCi/g	2.86	0.29
Los Alamos at LAO-4.5	04/23	1	^{238}Pu	0.0233	0.0021	0.0013	0.006	27	pCi/g	3.88	0.00
Los Alamos at LAO-4.5	04/23	1	$^{239,240}Pu$	0.1088	0.0052	0.0019	0.023	24	pCi/g	4.73	0.00
Los Alamos at Otowi	08/03	1	$^{239,240}Pu$	0.0430	0.0040	0.0018	0.023	24	pCi/g	1.87	0.00
Los Alamos at SR-4	08/03	1	$^{239,240}Pu$	0.0344	0.0032	0.0023	0.023	24	pCi/g	1.50	0.00
Los Alamos at Upper GS	04/23	1	$^{239,240}Pu$	0.2182	0.0087	0.0014	0.023	24	pCi/g	9.49	0.01
Mortandad at GS-1	04/29	1	Alpha	82.50	16.90		14.8		pCi/g	5.57	
Mortandad at GS-1	04/29	1	Beta	20.70	5.17		12		pCi/g	1.73	
Mortandad at GS-1	04/29	1	^{137}Cs	16.50	1.80	0.11	0.44	4.4	pCi/g	37.50	3.75
Mortandad at GS-1	04/29	1	Gamma	16.2	1.6	0.2	8.2		pCi/g	1.98	
Mortandad at GS-1	04/29	1	^{3}H	4,870	900	410		20,000	pCi/L		0.24
Mortandad at GS-1	04/29	1	^{238}Pu	12.1292	0.3870	0.0049	0.006	27	pCi/g	2,021.53	0.45
Mortandad at GS-1	04/29	1	$^{239,240}Pu$	10.4218	0.3333	0.0027	0.023	24	pCi/g	453.12	0.43
Mortandad at MCO-5	04/29	1	Alpha	23.30	4.93		14.8		pCi/g	1.57	
Mortandad at MCO-5	04/29	1	Beta	17.10	0.45		12		pCi/g	1.43	
Mortandad at MCO-5	04/29	1	^{137}Cs	21.90	2.40	0.11	0.44	4.4	pCi/g	49.77	4.98
Mortandad at MCO-5	04/29	1	^{137}Cs	18.00	2.00	0.12	0.44	4.4	pCi/g	40.91	4.09
Mortandad at MCO-5	04/29	1	Gamma	20.4	2.0	0.2	8.2		pCi/g	2.49	
Mortandad at MCO-5	04/29	1	Gamma	16.5	1.6	0.2	8.2		pCi/g	2.01	
Mortandad at MCO-5	04/29	1	^{3}H	2,260	750	420		20,000	pCi/L		0.11

Table 5-12. Detections of Greater-Than-Background Radionuclides in Sediments for 1999[a] (Cont.)

Station Name	Date	Code[b]	Analyte	Value	Uncertainty[c]	Detection Limit	Background	SAL	Units	Ratio of Value to Background	Ratio of Value to SAL
Mortandad at MCO-5	04/29	1	^{3}H	3,500	830	420		20,000	pCi/L		0.18
Mortandad at MCO-5	04/29	1	^{238}Pu	3.2056	0.1131	0.0022	0.006	27	pCi/g	534.27	0.12
Mortandad at MCO-5	04/29	1	^{238}Pu	31.2870	1.1610	0.0334	0.006	27	pCi/g	5,214.50	1.16
Mortandad at MCO-5	04/29	1	^{239,240}Pu	8.0920	0.2771	0.0020	0.023	24	pCi/g	351.83	0.34
Mortandad at MCO-5	04/29	1	^{239,240}Pu	78.3171	2.8163	0.0222	0.023	24	pCi/g	3,405.09	3.26
Mortandad at MCO-7	04/29	1	^{137}Cs	4.21	0.47	0.09	0.44	4.4	pCi/g	9.57	0.96
Mortandad at MCO-7	04/29	1	^{238}Pu	0.6212	0.0302	0.0332	0.006	27	pCi/g	103.53	0.02
Mortandad at MCO-7	04/29	1	^{239,240}Pu	1.9244	0.0790	0.0038	0.023	24	pCi/g	83.67	0.08
Mortandad at MCO-9	04/29	1	^{238}Pu	0.0146	0.0030	0.0050	0.006	27	pCi/g	2.43	0.00
Mortandad at MCO-9	04/29	1	^{239,240}Pu	0.0497	0.0054	0.0047	0.023	24	pCi/g	2.16	0.00
Mortandad near CMR Building	04/29	1	^{238}Pu	0.0324	0.0045	0.0066	0.006	27	pCi/g	5.40	0.00
Mortandad West of GS-1	04/29	1	^{238}Pu	0.0159	0.0031	0.0043	0.006	27	pCi/g	2.65	0.00
Mortandad West of GS-1	04/29	1	^{239,240}Puu	0.0409	0.0050	0.0037	0.023	24	pCi/g	1.78	0.00
Pajarito at SR-4	04/15	1	^{137}Cs	0.58	0.06	0.03	0.44	4.4	pCi/g	1.32	0.13
Pajarito at SR-4	04/15	1	^{238}Pu	0.4241	0.0183	0.0040	0.006	27	pCi/g	70.68	0.02
Pajarito at SR-4	04/15	1	^{239,240}Pu	0.0701	0.0055	0.0030	0.023	24	pCi/g	3.05	0.00
Pueblo 2	05/24	1	^{239,240}Pu	0.9672	0.0313	0.0013	0.023	24	pCi/g	42.05	0.04
Pueblo 3	05/24	1	^{239,240}Pu	0.1796	0.0083	0.0017	0.023	24	pCi/g	7.81	0.01
Pueblo 3	05/24	1	^{239,240}Pu	0.2046	0.0092	0.0018	0.023	24	pCi/g	8.90	0.01
Pueblo at SR-502	08/04	1	^{239,240}Pu	1.0782	0.0336	0.0056	0.023	24	pCi/g	46.88	0.04
Rio Grande at Bernalillo	05/04	1	^{238}Pu	0.0100	0.0029	0.0044	0.006	27	pCi/g	1.67	0.00
Rio Grande Lower	09/02	1	^{137}Cs	0.57	0.08	0.09	0.44	4.4	pCi/g	1.30	0.13
Rio Grande Lower	09/02	1	^{137}Cs	0.53	0.07	0.08	0.44	4.4	pCi/g	1.20	0.12
Rio Grande Upper	09/02	1	^{137}Cs	0.67	0.08	0.08	0.44	4.4	pCi/g	1.53	0.15
Sandia Canyon 3	12/13	1	^{3}H	3,190	880	410		20,000	pCi/L		0.16
Sandia Canyon 5	12/13	1	^{137}Cs	0.57	0.09	0.11	0.44	4.4	pCi/g	1.28	0.13
Site #2 Rover Stream Channel 4	10/28	1	^{239,240}Pu	0.0472	0.0032	0.0017	0.023	24	pCi/g	2.05	0.00
Site #5 Overlook Park South bank 3	10/28	1	^{239,240}Pu	0.7472	0.0262	0.0013	0.023	24	pCi/g	32.49	0.03
TWISP Dome at Silt Fence	07/29	1	^{3}H	6,800	1,000	400		20,000	pCi/L		0.34

[a] Above background detection defined as ≥ 3× uncertainty and ≥ detection limit and ≥ background.
[b] Codes: 1–primary analysis; 2–secondary analysis; R–lab replicate; D–lab duplicate.
[c] Radioactivity counting uncertainty (1 std dev).

Table 5-13. Detections of Greater-Than-Background Strontium-90 in Sediments for 1999[a]
(LANL's 1999 strontium-90 data are not valid because of analytical laboratory problems; the data appear in this report for documentary purposes only.)

Station Name	Date	Code[b]	Analyte	Value	Uncertainty[c]	Detection Limit	Background	SAL	Units	Ratio of Value to Background	Ratio of Value to SAL
AB-1	04/21	1	^{90}Sr	2.75	0.44	0.66	0.87	5.9	pCi/g	3.16	0.47
AB-10	04/21	1	^{90}Sr	1.40	0.35	0.62	0.87	5.9	pCi/g	1.61	0.24
AB-11	04/21	1	^{90}Sr	2.08	0.41	0.68	0.87	5.9	pCi/g	2.39	0.35
AB-2	04/21	1	^{90}Sr	2.54	0.41	0.62	0.87	5.9	pCi/g	2.92	0.43
AB-3	04/15	1	^{90}Sr	4.64	0.55	2.00	0.87	5.9	pCi/g	5.33	0.79
AB-4	04/21	1	^{90}Sr	2.76	0.42	0.63	0.87	5.9	pCi/g	3.17	0.47
AB-4A	04/21	1	^{90}Sr	2.82	0.42	0.62	0.87	5.9	pCi/g	3.24	0.48
AB-5	04/21	1	^{90}Sr	1.78	0.42	0.73	0.87	5.9	pCi/g	2.05	0.30
AB-7	04/21	1	^{90}Sr	1.45	0.39	0.72	0.87	5.9	pCi/g	1.67	0.25
AB-8	04/21	1	^{90}Sr	2.31	0.43	0.71	0.87	5.9	pCi/g	2.66	0.39
AB-9	04/21	1	^{90}Sr	2.50	0.41	0.64	0.87	5.9	pCi/g	2.87	0.42
AB-9	04/21	1	^{90}Sr	2.53	0.43	0.68	0.87	5.9	pCi/g	2.91	0.43
Abiquiu Lower	10/12	1	^{90}Sr	6.94	0.71	0.78	0.87	5.9	pCi/g	7.98	1.18
Abiquiu Lower	10/12	D	^{90}Sr	7.93	0.79	0.85	0.87	5.9	pCi/g	9.11	1.34
Abiquiu Middle	10/12	1	^{90}Sr	3.87	0.56	0.83	0.87	5.9	pCi/g	4.45	0.66
Abiquiu Middle	10/12	D	^{90}Sr	7.51	0.73	0.75	0.87	5.9	pCi/g	8.63	1.27
Above Ancho Spring	09/21	1	^{90}Sr	8.07	0.77	0.79	0.87	5.9	pCi/g	9.28	1.37
Ancho at Rio Grande	09/21	1	^{90}Sr	2.55	0.41	0.65	0.87	5.9	pCi/g	2.93	0.43
Ancho at SR-4	03/31	1	^{90}Sr	3.67	0.46	0.61	0.87	5.9	pCi/g	4.22	0.62
Ancho at SR-4	03/31	1	^{90}Sr	3.76	0.48	0.62	0.87	5.9	pCi/g	4.32	0.64
Bayo at SR-502	08/03	1	^{90}Sr	1.37	0.45	0.86	0.87	5.9	pCi/g	1.57	0.23
Cañada del Buey at SR-4	05/24	1	^{90}Sr	1.56	0.39	0.70	0.87	5.9	pCi/g	1.79	0.26
Cañon de Valle at SR-501	03/31	1	^{90}Sr	4.38	0.49	0.58	0.87	5.9	pCi/g	5.03	0.74
CDB_01	07/20	1	^{90}Sr	3.89	0.48	2.00	0.87	5.9	pCi/g	4.47	0.66
CDB_02	07/20	1	^{90}Sr	2.98	0.47	2.00	0.87	5.9	pCi/g	3.43	0.51
CDB_02	07/20	1	^{90}Sr	4.09	0.49	2.00	0.87	5.9	pCi/g	4.70	0.69
CDB_02	07/20	1	^{90}Sr	4.89	0.55	2.00	0.87	5.9	pCi/g	5.62	0.83
Chaquehui at Rio Grande	09/22	1	^{90}Sr	7.86	0.75	0.77	0.87	5.9	pCi/g	9.03	1.33
Chaquehui at Rio Grande	09/22	1	^{90}Sr	8.38	0.75	0.71	0.87	5.9	pCi/g	9.63	1.42
Cochiti Lower	10/13	1	^{90}Sr	7.50	0.78	0.87	0.87	5.9	pCi/g	8.62	1.27
Cochiti Middle	10/13	1	^{90}Sr	5.59	0.65	0.81	0.87	5.9	pCi/g	6.43	0.95
Cochiti Middle	10/13	1	^{90}Sr	8.12	0.82	0.90	0.87	5.9	pCi/g	9.33	1.38

Table 5-13. Detections of Greater-Than-Background Strontium-90 in Sediments for 1999[a] (Cont.)
(LANL's 1999 strontium-90 data are not valid because of analytical laboratory problems; the data appear in this report for documentary purposes only.)

Station Name	Date	Code[b]	Analyte	Value	Uncertainty[c]	Detection Limit	Background	SAL	Units	Ratio of Value to Background	Ratio of Value to SAL
DPS-1	04/23	1	^{90}Sr	2.33	0.43	2.00	0.87	5.9	pCi/g	2.68	0.39
Fence at SR-4	04/15	1	^{90}Sr	4.55	0.53	2.00	0.87	5.9	pCi/g	5.23	0.77
G-0	04/14	1	^{90}Sr	5.63	0.57	0.61	0.87	5.9	pCi/g	6.47	0.95
G-0	04/14	1	^{90}Sr	5.67	0.57	0.60	0.87	5.9	pCi/g	6.52	0.96
G-1	04/14	1	^{90}Sr	2.91	0.44	0.64	0.87	5.9	pCi/g	3.34	0.49
G-2	04/14	1	^{90}Sr	1.92	0.39	0.66	0.87	5.9	pCi/g	2.21	0.33
G-3	04/14	1	^{90}Sr	3.11	0.43	0.60	0.87	5.9	pCi/g	3.57	0.53
G3_01	07/20	1	^{90}Sr	3.04	0.47	0.69	0.87	5.9	pCi/g	3.49	0.52
G3_01	07/20	1	^{90}Sr	3.65	0.48	0.65	0.87	5.9	pCi/g	4.20	0.62
G3_02	07/20	1	^{90}Sr	3.38	0.47	0.65	0.87	5.9	pCi/g	3.89	0.57
G-4 R-1	04/14	1	^{90}Sr	2.50	0.41	0.63	0.87	5.9	pCi/g	2.87	0.42
G-4 R-2	04/14	1	^{90}Sr	3.56	0.46	0.61	0.87	5.9	pCi/g	4.09	0.60
G-5	04/14	1	^{90}Sr	2.97	0.44	0.65	0.87	5.9	pCi/g	3.41	0.50
G-6 R	04/14	1	^{90}Sr	2.20	0.40	0.65	0.87	5.9	pCi/g	2.53	0.37
G-7	04/15	1	^{90}Sr	3.02	0.46	2.00	0.87	5.9	pCi/g	3.47	0.51
G-7	04/15	1	^{90}Sr	3.35	0.46	2.00	0.87	5.9	pCi/g	3.85	0.57
G-8	04/14	1	^{90}Sr	3.57	0.47	0.64	0.87	5.9	pCi/g	4.10	0.61
G-9	04/14	1	^{90}Sr	2.33	0.42	0.68	0.87	5.9	pCi/g	2.68	0.39
Hamilton Bend Spring	05/24	1	^{90}Sr	2.72	0.46	0.73	0.87	5.9	pCi/g	3.13	0.46
Heron Lower	08/31	1	^{90}Sr	0.97	0.28	0.52	0.87	5.9	pCi/g	1.11	0.16
Indio at SR-4	03/31	1	^{90}Sr	3.05	0.43	0.62	0.87	5.9	pCi/g	3.51	0.52
Jemez River	08/02	1	^{90}Sr	1.66	0.45	0.84	0.87	5.9	pCi/g	1.91	0.28
Los Alamos at LAO-1	04/23	1	^{90}Sr	2.68	0.43	2.00	0.87	5.9	pCi/g	3.08	0.45
Los Alamos at Otowi	08/03	1	^{90}Sr	2.47	0.48	0.80	0.87	5.9	pCi/g	2.84	0.42
Los Alamos at SR-4	08/03	1	^{90}Sr	2.73	0.50	0.81	0.87	5.9	pCi/g	3.14	0.46
Los Alamos at Totavi	08/03	1	^{90}Sr	2.24	0.47	0.79	0.87	5.9	pCi/g	2.57	0.38
Mortandad A-6	08/05	1	^{90}Sr	5.31	0.54	0.59	0.87	5.9	pCi/g	6.10	0.90
Mortandad A-7	08/05	1	^{90}Sr	3.40	0.50	0.73	0.87	5.9	pCi/g	3.91	0.58
Mortandad at GS-1	04/29	1	^{90}Sr	2.51	0.44	0.70	0.87	5.9	pCi/g	2.89	0.43
Mortandad at MCO-13 (A-5)	08/05	1	^{90}Sr	1.95	0.44	0.77	0.87	5.9	pCi/g	2.24	0.33
Mortandad at MCO-13 (A-5)	08/05	1	^{90}Sr	2.51	0.46	0.75	0.87	5.9	pCi/g	2.89	0.43
Mortandad at MCO-5	04/29	1	^{90}Sr	1.72	0.41	0.73	0.87	5.9	pCi/g	1.98	0.29

Table 5-13. Detections of Greater-Than-Background Strontium-90 in Sediments for 1999[a] (Cont.)
(LANL's 1999 strontium-90 data are not valid because of analytical laboratory problems; the data appear in this report for documentary purposes only.)

Station Name	Date	Code[b]	Analyte	Value	Uncertainty[c]	Detection Limit	Background	SAL	Units	Ratio of Value to Background	Ratio of Value to SAL
Mortandad at MCO-5	04/29	1	^{90}Sr	2.86	0.45	0.67	0.87	5.9	pCi/g	3.29	0.48
Mortandad at Rio Grande (A-11)	09/20	1	^{90}Sr	2.07	0.41	0.68	0.87	5.9	pCi/g	2.38	0.35
Mortandad at SR-4 (A-9)	08/05	1	^{90}Sr	2.27	0.46	0.77	0.87	5.9	pCi/g	2.61	0.38
Mortandad at SR-4 (A-9)	08/05	1	^{90}Sr	3.58	0.50	0.69	0.87	5.9	pCi/g	4.11	0.61
Mortandad West of GS-1	04/29	1	^{90}Sr	1.13	0.35	0.67	0.87	5.9	pCi/g	1.30	0.19
Pajarito at SR-4	04/15	1	^{90}Sr	4.31	0.51	2.00	0.87	5.9	pCi/g	4.95	0.73
Pajarito at SR-501	03/31	1	^{90}Sr	2.70	0.44	0.67	0.87	5.9	pCi/g	3.10	0.46
Potrillo at SR-4	03/31	1	^{90}Sr	4.43	0.55	0.70	0.87	5.9	pCi/g	5.09	0.75
Pueblo 2	05/24	1	^{90}Sr	1.59	0.38	0.68	0.87	5.9	pCi/g	1.83	0.27
Pueblo 3	05/24	1	^{90}Sr	2.53	0.43	0.68	0.87	5.9	pCi/g	2.91	0.43
Pueblo 3	05/24	1	^{90}Sr	2.89	0.46	0.70	0.87	5.9	pCi/g	3.32	0.49
Pueblo at SR-502	08/04	1	^{90}Sr	2.15	0.48	0.82	0.87	5.9	pCi/g	2.47	0.36
Rio Grande at Bernalillo	05/04	1	^{90}Sr	2.00	0.41	2.00	0.87	5.9	pCi/g	2.30	0.34
Rio Grande at Cochiti	09/23	1	90Sr	6.71	0.78	0.97	0.87	5.9	pCi/g	7.71	1.14
Rio Grande at Otowi Upper (bank)	08/03	1	^{90}Sr	1.34	0.44	0.85	0.87	5.9	pCi/g	1.54	0.23
Sandia at SR-4	08/03	1	^{90}Sr	3.10	0.57	0.92	0.87	5.9	pCi/g	3.56	0.53
Site #1 Bonnie View South bank	10/28	1	^{90}Sr	10.47	1.33	1.75	0.87	5.9	pCi/g	12.03	1.77
Site #1 Bonnie View South bank	10/28	1	^{90}Sr	11.45	1.38	1.76	0.87	5.9	pCi/g	13.16	1.94
Site #1 BV Stream Channel	10/28	1	^{90}Sr	3.54	0.46	0.62	0.87	5.9	pCi/g	4.07	0.60
Site #2 Rover South bank	10/28	1	^{90}Sr	1.65	0.43	0.78	0.87	5.9	pCi/g	1.90	0.28
Site #2 Rover South bank	10/28	1	^{90}Sr	6.17	0.65	0.73	0.87	5.9	pCi/g	7.09	1.05
Site #2 Rover South bank	10/28	1	^{90}Sr	13.35	1.33	1.40	0.87	5.9	pCi/g	15.34	2.26
Site #2 Rover Stream Channel	10/28	1	^{90}Sr	2.90	0.45	0.68	0.87	5.9	pCi/g	3.33	0.49
Site #3 Lejano South bank	10/28	1	^{90}Sr	4.52	0.59	0.79	0.87	5.9	pCi/g	5.20	0.77
Site #3 Lejano South bank	10/28	1	^{90}Sr	6.66	0.66	0.69	0.87	5.9	pCi/g	7.66	1.13
Site #3 Lejano Stream Channel	10/28	1	^{90}Sr	4.94	0.57	0.70	0.87	5.9	pCi/g	5.68	0.84
Site #4 Meadow Ln. South bank	10/28	1	^{90}Sr	5.39	0.66	0.84	0.87	5.9	pCi/g	6.20	0.91
Site #4 Meadow Ln. South bank	10/28	1	^{90}Sr	5.71	0.65	0.77	0.87	5.9	pCi/g	6.56	0.97
Site #4 Meadow Ln. South bank	10/28	1	^{90}Sr	7.39	0.70	0.69	0.87	5.9	pCi/g	8.49	1.25
Site #4 Meadow Ln. Strm Channel	10/28	1	^{90}Sr	5.96	0.65	0.74	0.87	5.9	pCi/g	6.85	1.01
Site #5 Overlook Park South bank	10/28	1	^{90}Sr	4.45	0.58	0.78	0.87	5.9	pCi/g	5.11	0.75
Site #5 Overlook Park South bank	10/28	1	^{90}Sr	5.18	0.55	0.61	0.87	5.9	pCi/g	5.95	0.88

Table 5-13. Detections of Greater-Than-Background Strontium-90 in Sediments for 1999[a] (Cont.)
(LANL's 1999 strontium-90 data are not valid because of analytical laboratory problems; the data appear in this report for documentary purposes only.)

Station Name	Date	Code[b]	Analyte	Value	Uncertainty[c]	Detection Limit	Background	SAL	Units	Ratio of Value to Background	Ratio of Value to SAL
Site #5 Overlook Park South bank	10/28	1	^{90}Sr	6.33	0.66	0.73	0.87	5.9	pCi/g	7.28	1.07
Site #5 Overlook Park South bank	10/28	1	^{90}Sr	7.02	0.66	0.66	0.87	5.9	pCi/g	8.07	1.19
Site #5 Ovrlk Prk Strm Chnl	10/28	1	^{90}Sr	2.88	0.43	0.62	0.87	5.9	pCi/g	3.31	0.49
Site #5 Ovrlk Prk Strm Chnl	10/28	1	^{90}Sr	4.05	0.50	0.64	0.87	5.9	pCi/g	4.66	0.69
Twomile at SR-501	03/31	1	^{90}Sr	3.25	0.56	0.88	0.87	5.9	pCi/g	3.74	0.55
Water at SR-4	03/31	1	^{90}Sr	3.94	0.49	0.64	0.87	5.9	pCi/g	4.53	0.67
Water at SR-501	03/31	1	^{90}Sr	3.24	0.46	0.64	0.87	5.9	pCi/g	3.72	0.55

[a]Above background detection defined as ≥ 3× uncertainty and ≥ detection limit and ≥ background.
[b]Codes: 1–primary analysis; 2–secondary analysis; R–lab replicate; D–lab duplicate.
[c]Radioactivity counting uncertainty (1 std dev).

Table 5-14. Total Recoverable Trace Metals in Sediments for 1999 (mg/kg[a])

Station Name	Date	Code[b]	Ag	Al	As	B	Ba	Be	Cd	Co	Cr	Cu	Fe	Hg
Regional Stations														
Rio Grande at Frijoles (bank)	12/21	1	<0.4	4,812	1.3	2	82.6	0.1	0.6	3.0	6.7	4.6	7,282	<0.010
Rio Grande at Cochiti Spillway	09/23	1	<0.4	6,626	1.8	<1	143.7	0.3	<0.2	4.0	8.1	5.4	9,229	<0.010
Reservoirs on Rio Chama (New Mexico)														
Heron Upper	08/31	1	<0.4	27,406	7.0	7	124.6	0.8	<0.2	8.8	18.2	19.4	24,067	<0.010
Heron Middle	08/31	1	<0.4	29,083	8.0	20	100.6	0.8	1.1	4.1	22.6	10.5	14,293	0.010
Heron Lower	08/31	1	<0.4	39,486	14.0	<10	307.7	1.8	1.3	12.9	36.2	20.8	33,372	0.010
Abiquiu Upper	08/30	1	<0.4	46,050	11.0	24	197.4	1.5	1.2	10.4	37.4	22.0	29,403	<0.010
Abiquiu Middle	10/12	1	<0.4	25,471	4.0	<1	266.9	1.6	<1.0	10.6	27.2	24.5	26,643	<0.100
Abiquiu Lower	10/12	1	<0.4	9,633	2.5	6	103.6	0.8	<0.5	4.1	14.6	9.2	13,681	<0.100
Reservoirs on Rio Grande (New Mexico)														
Cochiti Upper	10/13	1	<0.4	38,033	4.6	6	210.9	0.8	<1.5	7.8	24.4	19.4	26,250	<0.010
Cochiti Middle	10/13	1	<0.4	17,689	5.0	<1	269.0	0.7	0.9	7.9	14.4	16.3	17,814	<0.010
Cochiti Middle	10/13	2	<0.4	29,953	5.0	<1	288.4	0.6	<1.6	8.3	21.5	18.5	24,550	<0.010
Cochiti Lower	10/13	1	<0.4	22,407	5.0	<1	245.6	0.6	<1.3	9.3	17.9	20.2	21,339	<0.010
Other Reservoirs (New Mexico)														
Guaje Reservoir	11/16	1	<0.4	9,475	2.0	<1	83.8	0.1	<1.7	<5.5	19.2	11.6	8,918	<0.010
Acid/Pueblo Canyons:														
Acid Weir	04/27	1	<2.0	1,747	1.0	<3	17.3	0.4	<0.4	<1.0	3.9	<5.7	5,821	<0.030
Pueblo 1	04/27	1	<2.0	1,283	0.3	<3	21.5	0.3	<0.4	<1.0	1.1	<5.1	3,133	<0.030
Pueblo 2	05/24	D	<0.4	1,728	<0.3	<1	22.6	0.3	<0.2	0.7	1.3	2.0	4,585	<0.030
Hamilton Bend Spring	05/24	D	<0.4	3,608	0.5	<1	30.0	0.5	<0.2	1.3	2.6	3.0	5,183	<0.030
Pueblo 3	05/24	D	<0.4	2,432	0.8	<1	17.1	0.2	<0.2	0.4	2.2	22.2	2,999	<0.030
Pueblo at SR-502	08/04	1	<0.4	3,256	7.5	<1	297.7	0.3	<0.2	27.3	2.7	4.1	10,943	<0.010
DP/Los Alamos Canyons:														
Los Alamos at Bridge	04/27	1	<2.0	2,047	0.7	<3	25.1	0.4	<0.4	<1.0	2.2	7.1	3,995	<0.030
Los Alamos at Bridge	04/27	2	<2.0	4,743	<1.0	<3	56.7	0.7	<0.4	<2.6	5.4	9.7	6,323	<0.030
Los Alamos at LAO-1	04/23	1	<0.4	2,624	<0.3	<1	32.2	0.2	<0.2	0.9	3.4	2.5	4,212	<0.030

Table 5-14. Total Recoverable Trace Metals in Sediments for 1999 (mg/kg[a]) (Cont.)

Station Name	Date	Code[b]	Ag	Al	As	B	Ba	Be	Cd	Co	Cr	Cu	Fe	Hg
DP/Los Alamos Canyons: (Cont.)														
DPS-1	04/23	1	<0.4	1,486	0.6	<1	15.1	0.1	<0.2	1.1	2.7	1.7	4,596	<0.030
DPS-4	04/27	1	<2.0	1,678	0.2	<3	20.1	0.5	<0.4	<1.0	2.0	4.1	3,014	<0.030
Los Alamos at Upper GS	04/23	1	<0.4	1,637	0.6	<1	40.1	0.1	<0.2	2.0	3.4	0.9	3,814	<0.030
Los Alamos at LAO-3	04/23	1	<0.4	1,391	<0.3	<1	13.5	0.1	<0.2	0.7	1.8	3.3	4,019	<0.030
Los Alamos at LAO-4.5	04/23	1	<0.4	1,315	<0.3	<1	15.2	<0.1	<0.2	<0.6	1.6	2.0	2,622	<0.030
Los Alamos at SR-4	08/03	1	<0.4	3,308	<0.5	<1	28.3	0.4	<0.2	1.5	2.4	1.3	3,996	<0.010
Sandia Canyon:														
Sandia at SR-4	08/03	1	1.3	1,049	<0.3	<1	22.3	0.2	<0.2	<0.4	<1.1	0.6	1,359	<0.010
Mortandad Canyon:														
Mortandad near CMR Building	04/29	1	<0.4	2,594	0.7	<1	35.3	0.2	<0.2	1.8	3.4	4.5	6,393	<0.004
Mortandad West of GS-1	04/29	1	<0.4	4,988	1.5	<1	68.6	0.4	<0.2	2.2	6.5	4.4	8,774	0.019
Mortandad at GS-1	04/29	1	<0.4	2,294	0.7	<1	18.6	0.3	<0.2	0.9	3.1	6.5	4,720	0.025
Mortandad at MCO-5	04/29	2	<0.4	2,340	<0.3	<1	15.6	0.2	<0.2	1.5	3.7	2.0	14,422	0.009
Mortandad at MCO-5	04/29	1	<0.4	1,075	<0.3	<1	14.7	0.1	<0.2	0.7	2.1	2.3	5,056	0.009
Mortandad at MCO-7	04/29	1	<9.1	<1,957	<0.3	<1	<14.5	<0.1	<0.2	<0.4	<2.2	<0.3	<4,816	<0.004
Mortandad at MCO-9	04/29	1	<0.4	2,566	0.3	<1	19.9	<0.2	<0.2	0.7	2.0	1.4	4,577	<0.004
Mortandad at MCO-13 (A-5)	08/05	2	<0.4	5,735	0.9	<1	39.0	0.4	<0.2	1.5	3.9	2.4	5,813	<0.010
Mortandad at MCO-13 (A-5)	08/05	1	1.2	1,391	0.5	<1	32.1	0.3	<0.2	<1.1	1.1	1.4	1,916	<0.010
Mortandad at SR-4 (A-9)	08/05	1	<0.4	7,738	1.0	<1	57.4	0.5	0.2	2.4	5.8	2.5	7,537	<0.010
Mortandad at SR-4 (A-9)	08/05	2	<0.4	5,023	0.7	<1	42.8	0.4	<0.2	1.7	3.7	1.8	5,268	<0.010
Mortandad at Rio Grande (A-11)	09/20	1	<0.4	2,210	0.4	<1	47.9	0.1	<0.2	<1.7	2.5	2.3	3,954	<0.010
Cañada del Buey:														
Cañada del Buey at SR-4	05/24	D	<0.4	2,117	0.4	3	38.6	0.2	<0.2	1.6	1.3	1.4	3,075	<0.030
CDB_01	07/20	1												<0.030
CDB_02	07/20	2												<0.030
CDB_02	07/20	3												<0.030
CDB_02	07/20	1												<0.030

Table 5-14. Total Recoverable Trace Metals in Sediments for 1999 (mg/kg[a]) (Cont.)

Station Name	Date	Code[b]	Ag	Al	As	B	Ba	Be	Cd	Co	Cr	Cu	Fe	Hg
TA-54, Area G:														
G-0	04/14	1	<0.5	8,300	1.5	3	72.0	0.7	<0.2	1.5	7.6	6.1	9,800	<0.050
G-0	04/14	2	0.4	7,700	1.4	2	72.0	0.7	0.1	1.5	6.5	5.8	9,000	<0.050
G-1	06/09	1												<0.020
G-2	06/09	1												<0.020
G-3	06/09	1												<0.020
G-4 R-1	04/14	1	0.5	5,700	1.0	2	48.0	0.6	<0.2	1.1	6.6	4.0	7,200	<0.050
G-4 R-2	04/14	1	<0.8	2,800	<1.0	<1	52.0	0.6	1,800.0	0.8	4.1	5.5	3,400	<0.050
G-5	06/09	1												<0.020
G-6 R	06/09	1												<0.020
G-7	06/09	1												<0.020
G-8	06/09	1												<0.020
G-9	06/09	1												<0.020
G3_01	07/20	1												<0.030
G3_01	07/20	2												<0.030
G3_02	07/20	1												<0.030
Pajarito Canyon:														
Twomile at SR-501	03/31	D	<2.0	2,436	0.8	<3	26.5	<0.1	<0.9	<1.0	<1.3	2.4	4,354	
Twomile at SR-501	03/31	1												<0.030
Pajarito at SR-501	03/31	D	<2.0	4,073	1.8	<3	43.3	0.1	<0.9	6.7	5.4	<1.0	12,562	
Pajarito at SR-501	03/31	1												<0.030
Pajarito at SR-4	04/15	1	<2.0	4,506	9.0	<3	32.1	0.3	<0.9	1.2	3.2	2.0	6,484	<0.050
Potrillo Canyon:														
Potrillo at SR-4	05/24	D	<0.4	2,964	0.5	<1	39.3	0.3	<0.2	1.6	2.7	2.3	5,438	
Potrillo at SR-4	03/31	1												<0.030
Fence Canyon:														
Fence at SR-4	04/15	1	<2.0	2,122	0.7	<3	16.9	0.1	<0.9	<1.0	<0.9	<1.0	2,559	<0.050
Cañon de Valle:														
Cañon de Valle at SR-501	06/08	1												<0.020

Table 5-14. Total Recoverable Trace Metals in Sediments for 1999 (mg/kg[a]) (Cont.)

Station Name	Date	Code[b]	Ag	Al	As	B	Ba	Be	Cd	Co	Cr	Cu	Fe	Hg
Water Canyon:														
Water at SR-501	06/08	1												<0.020
Water at SR-4	03/31	D	<2.0	2,906	0.6	<3	53.0	0.1	<0.9	<1.0	<1.7	<1.0	5,830	
Water at SR-4	03/31	1												<0.030
Indio Canyon:														
Indio at SR-4	03/31	D	<2.0	3,055	0.6	<3	20.2	0.1	<0.9	<1.0	1.6	<1.0	4,411	
Indio at SR-4	03/31	1												<0.030
Ancho Canyon:														
Ancho at SR-4	03/31	2												<0.030
Ancho at SR-4	03/31	1												<0.030
Ancho at SR-4	03/31	D	<2.0	5,953	1.2	<3	49.5	0.2	<0.9	<1.6	6.7	2.4	6,100	
TA-49, Area AB:														
AB-1	06/08	1												<0.020
AB-1	06/08	2												<0.020
AB-2	06/08	1												<0.020
AB-3	06/08	1												<0.020
AB-4	06/08	1												<0.020
AB-4A	06/08	1												<0.020
AB-5	06/08	1												<0.020
AB-6	06/08	1												<0.020
AB-7	06/08	1												<0.020
AB-8	06/08	1												<0.020
AB-9	06/08	1												<0.020
AB-10	06/08	1												<0.020
AB-11	06/08	1												<0.020
White Rock, Cañada del Buey:														
Site #1 Bonnie View	10/28	1	<0.4	4,400	1.0	<1	77.8	0.5	<0.2	3.5	3.0	3.6	5,178	0.010
Site #2 Rover	10/28	1	<0.4	2,582	0.7	<1	50.9	0.3	<0.2	2.5	2.3	2.4	3,539	0.010
Site #3 Lejano	10/28	1												<0.010
Site #4 Meadow Lane	10/28	1												<0.010

Table 5-14. Total Recoverable Trace Metals in Sediments for 1999 (mg/kg[a]) (Cont.)

Station Name	Date	Code[b]	Ag	Al	As	B	Ba	Be	Cd	Co	Cr	Cu	Fe	Hg
Special EPA Sampling														
Ancho Canyon 1	12/16	1	<0.4	7,103	1.1	<1	69.1	0.5	0.5	2.6	10.4	9.1	8,232	0.227
Ancho Canyon 2	12/16	1	<0.4	7,757	1.0	<1	65.8	0.5	0.5	2.7	6.4	7.0	8,805	0.042
Ancho Canyon 3	12/16	1	<0.4	9,813	1.1	<1	72.8	0.6	0.5	3.0	7.7	6.6	10,041	0.048
Ancho Canyon 4	12/16	1	<0.4	4,138	0.8	<1	47.5	0.4	0.6	2.4	4.1	4.6	6,542	0.042
Ancho Canyon 5	12/16	1	0.6	3,442	0.7	<1	42.5	0.3	<0.4	2.0	3.5	3.7	4,792	0.054
Bayo Canyon 1	12/13	1	<0.4	6,266	1.7	<1	47.5	0.6	<0.2	2.2	5.2	6.5	7,915	0.030
Bayo Canyon 2	12/13	1	<0.4	6,175	1.4	<1	38.5	0.5	<0.4	1.5	4.8	3.3	7,858	0.030
Bayo Canyon 3	12/13	1	<0.4	4,396	1.1	<1	33.6	0.5	<0.2	1.5	3.0	2.7	6,296	0.020
Bayo Canyon 4	12/13	1	<0.4	2,537	1.1	<1	30.1	0.4	0.3	1.5	2.4	2.7	4,673	0.020
Cañada del Buey 1	12/15	1	<0.4	9,805	1.7	<1	97.0	0.7	<0.2	3.9	8.0	4.9	10,264	<0.010
Cañada del Buey 2	12/15	1	<0.4	11,681	2.4	<1	120.5	0.8	<0.4	4.6	10.1	6.0	11,251	<0.010
Cañada del Buey 3	12/16	1	<0.4	3,876	1.2	<1	49.6	0.3	<0.2	3.4	3.8	1.8	6,495	<0.010
Cañada del Buey 4	12/15	1	<0.4	8,758	2.0	<1	90.1	0.6	<0.2	4.1	7.5	3.3	9,027	<0.010
Cañada del Buey 4	12/15	2	<0.4	6,895	1.7	<1	88.6	0.6	<0.2	3.8	5.8	3.2	8,082	<0.010
Cañada del Buey 5A	12/15	1	<0.4	5,249	1.8	<1	79.8	0.5	<0.3	3.0	4.2	3.7	5,933	0.020
Cañada del Buey 5B	12/16	1	<0.4	1,118	0.4	<1	55.5	0.3	<0.2	2.1	1.2	1.8	845	<0.010
Cañada del Buey 6	12/15	1	<0.4	5,791	1.5	<1	94.8	0.6	<0.2	4.3	5.0	3.9	6,613	0.010
Cañada del Buey 7	12/15	1	<0.4	1,517	0.4	<1	66.6	0.4	<0.2	2.5	1.6	2.9	1,066	<0.010
Cañada del Buey 8	12/15	1	<0.4	10,626	1.7	<1	120.4	0.7	0.3	4.4	8.6	4.4	10,585	0.010
Mortandad Canyon 1	12/14	1	<0.4	7,810	1.7	<1	58.6	0.6	<0.2	2.7	5.3	4.3	7,675	0.020
Mortandad Canyon 2	12/14	1	<0.4	3,853	1.3	<1	40.5	0.4	<0.2	1.8	2.5	2.5	5,021	0.030
Mortandad Canyon 3	12/14	1	<0.4	5,938	1.4	<1	44.3	0.4	<0.2	2.1	5.3	2.0	6,620	0.030
Mortandad Canyon 4	12/14	1	<0.4	2,545	0.8	<1	29.1	0.3	<0.2	<2.0	2.6	1.8	6,684	0.030
Mortandad Canyon 5A	12/14	1	<0.4	5,746	1.6	<1	60.4	0.5	<0.2	2.2	4.1	3.4	6,981	0.060
Mortandad Canyon 5B	12/14	1	<0.4	4,719	1.0	<1	34.5	0.4	<0.2	1.3	3.0	1.7	5,599	0.010
Pajarito Canyon 1	12/16	1	<0.4	10,733	1.5	<1	134.9	0.8	0.6	5.7	8.7	9.1	11,658	0.018
Pajarito Canyon 2	12/16	1	<0.4	10,273	1.4	<1	100.8	0.6	<0.2	4.5	7.7	5.1	11,002	0.010
Pajarito Canyon 3	12/16	1	0.7	21,513	3.0	1	152.8	1.1	<0.6	5.4	17.7	11.1	16,563	0.020
Pajarito Canyon 4	12/16	1	<0.4	10,967	2.2	<1	133.3	0.8	<0.4	4.4	8.8	8.2	11,797	0.012
Sandia Canyon 1	12/13	1	<0.4	7,884	1.8	<1	73.9	0.7	<0.3	2.5	5.3	3.6	8,382	0.010
Sandia Canyon 2	12/13	1	<0.4	4,853	1.3	<1	56.3	0.7	<0.2	1.9	5.5	3.4	5,757	<0.010
Sandia Canyon 4	12/13	1	<0.5	6,916	1.7	<1	52.7	0.6	<0.2	2.3	19.4	5.2	8,121	0.020
Sandia Canyon 3	12/13	1	<0.4	6,091	1.3	<1	47.0	0.5	<0.2	2.3	15.5	6.2	7,789	0.020
Sandia Canyon 5	12/13	1	<0.4	9,119	2.1	<1	66.4	0.7	<0.2	2.7	27.9	8.0	9,184	0.060
Sandia Canyon 6	12/13	1	0.7	8,971	1.8	<1	61.4	0.6	<0.2	2.6	16.0	19.1	9,937	0.030

Table 5-14. Total Recoverable Trace Metals in Sediments for 1999 (mg/kg[a]) (Cont.)

Station Name	Date	Code[b]	Ag	Al	As	B	Ba	Be	Cd	Co	Cr	Cu	Fe	Hg
Standardized Comparisons														
Average Detection Limits			2	7	0.2	3	0.2	0.2	0.9	1.0	0.9	1.0	1	0.050
SAL[c]			380	78,000	19	5,900	270		38	4,600	30[d]	28,000		23

Table 5-14. Total Recoverable Trace Metals in Sediments for 1999 (mg/kg[a]) (Cont.)

Station Name	Date	Code[b]	Mn	Mo	Ni	Pb	Sb	Se	Sn	Sr	Ti	V	Zn
Regional Stations													
Rio Grande at Frijoles (bank)	12/21	1	154	<1.0	<6	5.6	<0.5	1.0	<4	40.2	<0.3	14.4	21.6
Rio Grande at Cochiti Spillway	09/23	1	213	<1.0	<14	6.5	<0.5	0.5	<4	77.0	<0.3	15.2	29.5
Reservoirs on Rio Chama (New Mexico)													
Heron Upper	08/31	1	464	<1.0	14	14.0	<0.5	1.3	<4	77.2	0.5	50.1	69.5
Heron Middle	08/31	1	257	<1.0	16	17.0	<0.5	1.2	<4	41.2	1.1	51.2	47.5
Heron Lower	08/31	1	538	<1.0	<31	11.0	<0.5	1.4	<4	209.0	0.3	60.6	97.1
Abiquiu Upper	08/30	1	429	<1.0	28	35.0	<0.5	0.7	<4	114.1	1.9	80.7	93.8
Abiquiu Middle	10/12	1	450	<1.0	14	29.0	<2.0	<3.0	<4	102.0	0.6	39.7	69.5
Abiquiu Lower	10/12	1	157	<1.0	<11	19.0	<0.5	<3.0	<4	38.5	<0.3	22.2	23.9
Reservoirs on Rio Grande (New Mexico)													
Cochiti Upper	10/13	1	711	<1.0	13	22.0	<0.5	<0.8	<4	147.2	0.4	42.1	94.2
Cochiti Middle	10/13	1	708	<1.0	<14	16.0	<0.5	<1.0	<4	185.2	<0.3	22.9	69.0
Cochiti Middle	10/13	2	707	<1.0	<28	19.7	<0.5	<1.0	<4	196.6	0.3	34.6	78.9
Cochiti Lower	10/13	1	822	<1.0	8	18.0	<0.5	440.0	<4	185.5	<0.3	29.0	74.6
Other Reservoirs (New Mexico)													
Guaje Reservoir	11/16	1	304	<1.0	<2	11.9	<0.5	3.0	<4	34.9	<0.3	19.0	56.6
Acid/Pueblo Canyons:													
Acid Weir	04/27	1	227	<5.0	<2	150.0	<0.5	<0.3	<5	3.7	<0.3	5.5	42.7
Pueblo 1	04/27	1	203	<5.0	2	16.8	<0.5	<0.3	<5	2.9	<0.3	3.4	31.1
Pueblo 2	05/24	D	162	<1.0	<2	4.0	1.0	0.3	<4	4.1	<0.3	3.5	28.5
Hamilton Bend Spring	05/24	D	181	<1.0	<2	4.3	1.0	0.3	<4	8.0	<0.3	5.2	26.4
Pueblo 3	05/24	D	51	<1.0	<2	4.0	1.0	0.3	<4	4.6	<0.3	4.0	70.2
Pueblo at SR-502	08/04	1	18,563	7.8	<17	15.0	<0.5	<0.3	<4	72.0	<0.3	15.5	132.6
DP/Los Alamos Canyons:													
Los Alamos at Bridge	04/27	1	122	<5.0	<2	8.9	<0.5	<0.3	<5	7.0	<0.3	4.5	25.9
Los Alamos at Bridge	04/27	2	319	<5.0	<5	16.2	<0.5	<0.3	<5	16.4	<0.3	8.4	44.7
Los Alamos at LAO-1	04/23	1	159	<1.0	<2	12.0	<1.0	<0.3	<4	5.9	0.5	4.5	28.8

Table 5-14. Total Recoverable Trace Metals in Sediments for 1999 (mg/kg[a]) (Cont.)

Station Name	Date	Code[b]	Mn	Mo	Ni	Pb	Sb	Se	Sn	Sr	Ti	V	Zn
DP/Los Alamos Canyons: (Cont.)													
DPS-1	04/23	1	125	<1.0	<2	12.0	<0.5	<0.3	<4	2.9	<0.3	5.4	27.5
DPS-4	04/27	1	113	<5.0	<2	12.7	<0.5	<0.3	<5	4.6	<0.3	3.1	24.6
Los Alamos at Upper GS	04/23	1	218	3.2	<2	14.0	<0.5	<0.3	<4	8.0	<0.3	4.9	19.6
Los Alamos at LAO-3	04/23	1	151	<1.0	<2	7.0	<1.0	<0.3	<4	2.5	0.3	3.8	21.1
Los Alamos at LAO-4.5	04/23	1	92	<1.0	<2	8.0	<1.0	<0.3	<4	3.0	0.3	2.5	18.8
Los Alamos at SR-4	08/03	1	147	<1.0	2	7.7	<0.5	<0.3	<4	8.1	<0.3	4.7	30.0
Sandia Canyon:													
Sandia at SR-4	08/03	1	99	<1.0	<2	5.2	<0.5	<0.3	<4	4.4	<0.3	0.7	9.6
Mortandad Canyon:													
Mortandad near CMR Building	04/29	1	212	1.2	<2	10.4	<1.0	<0.3	<4	8.6	<0.3	6.1	71.9
Mortandad west of GS-1	04/29	1	401	1.0	<2	11.4	<1.0	<0.3	<4	16.9	<0.6	9.6	43.7
Mortandad at GS-1	04/29	1	236	1.1	6	11.4	<1.0	<0.3	<4	6.5	<0.3	3.5	33.4
Mortandad at MCO-5	04/29	2	315	1.6	<2	7.2	<1.0	<0.3	<4	2.7	<0.3	7.1	82.4
Mortandad at MCO-5	04/29	1	163	<1.0	<2	5.5	<1.0	<0.4	<4	1.9	<0.3	3.2	32.7
Mortandad at MCO-7	04/29	1	<153	<1.0	<2	3.9	<1.0	<0.3	<4	<2.0	<0.3	<4.9	<20.7
Mortandad at MCO-9	04/29	1	217	<1.0	<2	6.5	<1.0	<0.3	<4	2.9	<0.3	3.2	27.5
Mortandad at MCO-13 (A-5)	08/05	2	237	<1.0	<2	10.0	<0.5	<0.3	<4	7.6	<0.3	7.3	31.9
Mortandad at MCO-13 (A-5)	08/05	1	167	<1.0	<2	8.0	<0.5	<0.3	<4	5.9	<0.3	2.0	12.1
Mortandad at SR-4 (A-9)	08/05	1	292	<1.0	<2	12.0	<0.5	<0.3	<4	10.6	<0.3	9.6	38.3
Mortandad at SR-4 (A-9)	08/05	2	206	<1.0	<7	13.0	<0.5	<0.3	<4	7.7	<0.3	6.2	26.4
Mortandad at Rio Grande (A-11)	09/20	1	155	<1.0	5	4.2	<0.5	<0.4	<4	8.8	<0.3	6.6	12.8
Cañada del Buey:													
Cañada del Buey at SR-4	05/24	D	189	<1.0	<2	5.0	1.0	0.3	<4	5.2	<0.3	3.6	13.1
CDB_01	07/20	1											
CDB_02	07/20	2											
CDB_02	07/20	3											
CDB_02	07/20	1											

Table 5-14. Total Recoverable Trace Metals in Sediments for 1999 (mg/kg[a]) (Cont.)

Station Name	Date	Code[b]	Mn	Mo	Ni	Pb	Sb	Se	Sn	Sr	Ti	V	Zn
TA-54, Area G:													
G-0	04/14	1	250	<1.0	5	11.0	<0.5	<0.3	<4	19.0	<0.3	12.0	50.0
G-0	04/14	2	230	1.3	5	13.0	<0.5	<0.3	<4	18.0	<0.3	11.0	47.0
G-1	06/09	1											
G-2	06/09	1											
G-3	06/09	1											
G-4 R-1	04/14	1	200	1.0	4.5	14.0	<0.5	<0.3	<4	8.5	<0.3	8.4	31.0
G-4 R-2	04/14	1	200	<2.0	<5	8.7	<0.5	0.3	<4	10.0	<0.3	3.8	37.0
G-5	06/09	1											
G-6 R	06/09	1											
G-7	06/09	1											
G-8	06/09	1											
G-9	06/09	1											
G3_01	07/20	1											
G3_01	07/20	2											
G3_02	07/20	1											
Pajarito Canyon:													
Twomile at SR-501	03/31	D	205	<5.0	5	13.6	<0.5		<5	6.0	<0.3	4.0	19.9
Twomile at SR-501	03/31	1						11.0					
Pajarito at SR-501	03/31	D	461	<5.0	7	12.4	<0.5		<5	6.6	<0.3	16.8	38.8
Pajarito at SR-501	03/31	1						0.3					
Pajarito at SR-4	04/15	1	180	<5.0	<4	24.0	<0.5	0.5	<5	6.1	0.3	8.4	30.2
Potrillo Canyon:													
Potrillo at SR-4	05/24	D	197	<1.0	<2	5.0	1.0		<4	6.1	<0.3	5.3	23.0
Potrillo at SR-4	03/31	1						0.5					
Fence Canyon:													
Fence at SR-4	04/15	1	93	<5.0	<4	8.4	<0.5	<0.3	<5	2.8	<0.3	2.5	15.7
Cañon de Valle:													
Cañon de Valle at SR-501	06/08	1											

Table 5-14. Total Recoverable Trace Metals in Sediments for 1999 (mg/kg[a]) (Cont.)

Station Name	Date	Code[b]	Mn	Mo	Ni	Pb	Sb	Se	Sn	Sr	Ti	V	Zn
Water Canyon:													
Water at SR-501	06/08	1											
Water at SR-4	03/31	D	182	<5.0	5	7.0	<0.5		<5	4.3	<0.3	4.7	23.9
Water at SR-4	03/31	1						0.5					
Indio Canyon:													
Indio at SR-4	03/31	D	134	<5.0	4	7.4	<0.5		<5	3.6	<0.3	3.4	20.9
Indio at SR-4	03/31	1						0.4					
Ancho Canyon:													
Ancho at SR-4	03/31	2						0.6					
Ancho at SR-4	03/31	1						0.6					
Ancho at SR-4	03/31	D	164	<5.0	8	10.5	<0.5		<5	10.3	<0.3	5.6	23.2
TA-49, Area AB:													
AB-1	06/08	1											
AB-1	06/08	2											
AB-2	06/08	1											
AB-3	06/08	1											
AB-4	06/08	1											
AB-4A	06/08	1											
AB-5	06/08	1											
AB-6	06/08	1											
AB-7	06/08	1											
AB-8	06/08	1											
AB-9	06/08	1											
AB-10	06/08	1											
AB-11	06/08	1											
White Rock, Cañada del Buey:													
Site #1 Bonnie View	10/28	1	267	<1.0	7	9.9	<0.5	<0.3	<4	12.1	<0.3	5.9	21.7
Site #2 Rover	10/28	1	211	<1.0	3	6.8	<0.5	0.5	<4	8.2	<0.3	4.4	18.9
Site #3 Lejano	10/28	1											
Site #4 Meadow Lane	10/28	1											

Table 5-14. Total Recoverable Trace Metals in Sediments for 1999 (mg/kg[a]) (Cont.)

Station Name	Date	Code[b]	Mn	Mo	Ni	Pb	Sb	Se	Sn	Sr	Ti	V	Zn
Special EPA Sampling													
Ancho Canyon 1	12/16	1	243	<1.0	5	11.1	<0.5	<0.3	<4	13.9	<0.3	9.9	32.6
Ancho Canyon 2	12/16	1	240	<1.0	5	11.6	<0.5	<0.6	<4	14.8	<0.3	10.6	35.3
Ancho Canyon 3	12/16	1	254	<1.0	<2	11.3	<0.5	0.3	<4	16.4	<0.3	13.1	38.4
Ancho Canyon 4	12/16	1	187	<1.0	<2	9.2	<0.5	<0.3	<4	9.6	<0.3	6.9	33.4
Ancho Canyon 5	12/16	1	159	<1.0	<2	7.2	<0.5	<0.3	<4	8.3	<0.3	5.1	21.6
Bayo Canyon 1	12/13	1	239	<1.0	4	10.5	<0.5	0.5	<4	10.3	<0.3	9.3	35.8
Bayo Canyon 2	12/13	1	223	<1.0	<6	9.6	<0.5	0.4	<4	9.9	<0.3	8.8	38.2
Bayo Canyon 3	12/13	1	211	<1.0	<2	8.5	<0.5	0.4	<4	7.7	<0.3	6.2	30.8
Bayo Canyon 4	12/13	1	180	<1.0	<2	8.9	<0.5	0.3	<4	6.4	<0.3	4.7	20.3
Cañada del Buey 1	12/15	1	273	<1.0	<11	12.1	<0.5	0.8	<4	19.3	<0.3	15.1	37.6
Cañada del Buey 2	12/15	1	305	<1.0	4	22.9	<0.5	0.7	<4	30.6	<0.3	15.0	171.0
Cañada del Buey 3	12/16	1	272	<1.0	3	9.0	<0.5	0.7	<4	6.8	<0.3	8.1	32.1
Cañada del Buey 4	12/15	1	330	<1.0	4	10.4	<0.5	0.7	<4	15.4	<0.3	13.3	30.8
Cañada del Buey 4	12/15	2	314	<1.0	5	9.4	<0.5	0.6	<4	14.9	<0.3	10.7	27.6
Cañada del Buey 5A	12/15	1	255	<1.0	5	20.2	<0.5	0.7	<4	13.4	<0.3	7.2	28.4
Cañada del Buey 5B	12/16	1	181	<1.0	<2	19.1	<0.5	0.5	<4	9.5	<0.3	3.1	14.3
Cañada del Buey 6	12/15	1	302	<1.0	<9	14.0	<0.5	0.8	<4	16.5	<0.3	8.6	24.9
Cañada del Buey 7	12/15	1	202	<1.0	<4	9.3	<0.5	0.5	<4	11.4	<0.3	4.0	9.1
Cañada del Buey 8	12/15	1	337	<1.0	6	10.4	<0.5	0.8	<4	18.7	<0.3	16.2	33.8
Mortandad Canyon 1	12/14	1	260	<1.0	6	8.6	<0.5	0.5	<4	10.7	<0.3	9.8	34.4
Mortandad Canyon 2	12/14	1	223	<1.0	<2	7.8	<0.5	0.4	<4	7.6	<0.3	5.2	25.1
Mortandad Canyon 3	12/14	1	276	<1.0	<2	9.4	<0.5	0.4	<4	8.5	<0.3	8.1	34.0
Mortandad Canyon 4	12/14	1	277	<1.0	<2	6.2	<0.5	<0.3	<4	4.3	<0.3	6.0	38.4
Mortandad Canyon 5A	12/14	1	249	<1.0	<2	13.0	<0.5	0.3	<4	11.0	<0.3	8.0	31.6
Mortandad Canyon 5B	12/14	1	198	<1.0	<9	5.5	<0.5	<0.3	<4	7.0	<0.3	5.8	27.4
Pajarito Canyon 1	12/16	1	332	<1.0	7	17.0	<0.5	0.6	<4	27.1	<0.3	12.3	45.0
Pajarito Canyon 2	12/16	1	309	<1.0	5	10.6	<0.5	0.4	<4	18.2	<0.3	14.5	35.2
Pajarito Canyon 3	12/16	1	354	<1.0	9	21.7	<0.5	0.9	<4	33.0	<0.3	24.1	60.2
Pajarito Canyon 4	12/16	1	290	<1.0	9	20.0	<0.5	0.6	<4	32.3	<0.3	13.9	38.9
Sandia Canyon 1	12/13	1	274	<1.0	4	8.8	<0.5	0.5	<4	14.9	<0.3	9.9	41.9
Sandia Canyon 2	12/13	1	213	<1.0	4	11.0	<0.5	0.5	<4	10.4	<0.3	6.1	28.7
Sandia Canyon 4	12/13	1	296	<1.0	<5	19.0	<0.5	0.4	<4	10.4	<0.3	9.3	47.6
Sandia Canyon 3	12/13	1	276	<1.0	<2	20.3	<0.5	0.4	<4	9.4	<0.3	8.7	46.7
Sandia Canyon 5	12/13	1	298	<1.0	5	19.1	<0.5	0.5	<4	14.2	<0.3	11.7	50.1
Sandia Canyon 6	12/13	1	300	<1.0	<8	19.7	<0.5	0.5	<4	12.4	<0.3	12.2	56.1

Table 5-14. Total Recoverable Trace Metals in Sediments for 1999 (mg/kg[a]) (Cont.)

Station Name	Date	Code[b]	Mn	Mo	Ni	Pb	Sb	Se	Sn	Sr	Ti	V	Zn
Standardized Comparisons													
Average Detection Limits			0.3	5	4	0.3	0.30	0.2	5	0.2	0.3	1.3	0.8
SAL[c]			390	380	1,500	400	31	380		46,000	6	540	23,000

[a]Less than symbol (<) means measurement was below the specified limit of detection of the analytical method.
[b]Codes: 1–primary analysis; 2–secondary analysis; R–lab replicate; D–lab duplicate.
[c]Screening Action Level, Environmental Restoration Project, 1997; see text for details.
[d]SAL value for hexavalent chromium is listed; SAL value for trivalent or total chromium is 210 mg/kg.

Table 5-15. Number of Samples Collected for Each Suite of Organic Compounds in Sediments for 1999

		Organic Suite[a]		
Station Name	**Date**	**HE**	**PCB**	**Semivolatile**
Above Ancho Spring	09/21	1		
Ancho at SR-4	03/31		2	2
Ancho Canyon 1	12/16		1	
Ancho Canyon 2	12/16		1	
Ancho Canyon 3	12/16		1	
Ancho Canyon 4	12/16		1	
Ancho Canyon 5	12/16		1	
Bayo Canyon 1	12/13		1	
Bayo Canyon 2	12/13		1	
Bayo Canyon 3	12/13		1	
Bayo Canyon 4	12/13		1	
G-0	04/14		2	2
G-1	04/14		1	1
G-2	04/14		1	1
G-3	04/14		1	1
G-4 R-1	04/14		1	1
G-4 R-2	04/14		1	1
G-5	04/14		1	1
G-6 R	04/14		1	1
G-7	04/15		2	2
G-8	04/14		1	1
G-9	04/14		1	1
Mortandad Canyon 1	12/14		1	
Mortandad Canyon 2	12/14		1	
Mortandad Canyon 3	12/14		1	
Mortandad Canyon 4	12/14		1	
Mortandad Canyon 5A	12/14		1	
Mortandad Canyon 5B	12/14		1	
Pajarito at SR-4	04/15	1		
Pajarito Canyon 1	12/16		1	
Pajarito Canyon 2	12/16		1	
Pajarito Canyon 3	12/16		1	
Pajarito Canyon 4	12/16		1	
Rio Grande at Frijoles (bank)	12/21		1	1
Rio Grande at Otowi (bank)	08/03		1	1
Sandia at SR-4	08/03		1	1
Sandia Canyon 1	12/13		1	
Sandia Canyon 2	12/13		1	
Sandia Canyon 3	12/13		1	
Sandia Canyon 4	12/13		1	
Sandia Canyon 5	12/13		1	
Sandia Canyon 6	12/13		1	
Water at SR-4	03/31		1	1

[a] High explosives, polychlorinated biphenyls, and semivolatiles.

Table 5-16. Radiochemical Analyses of Groundwater for 1999 (pCi/L[a])

Station Name	Date	Code[b]	F/UF[c]	^{3}H		^{137}Cs		U (μg/L)		^{238}Pu		^{239,240}Pu		^{241}Am		Gross Alpha		Gross Beta		Gross Gamma	
Regional Aquifer Wells																					
Test Wells:																					
Test Well 1	05/27	1	UF	200	610	0.00	10.06	2.85	0.29	0.000	0.000	0.011	0.009	0.040	0.020	4.6	4.2	6.8	5.0	272	52
Test Well 1	05/27	1D	UF					3.10	0.30												
Test Well 2	08/11	1	UF	760	660	0.00	6.09	0.01	0.01	0.007	0.010	0.014	0.010	–0.016	0.012	0.4	0.9	2.9	2.0	41	51
Test Well 2	08/11	1D	UF					0.01	0.05												
Test Well 3	05/27	1	UF	–240	570	0.00	7.27	0.63	0.06	0.016	0.009	0.011	0.007	0.067	0.022	0.5	1.7	3.3	2.2	137	51
Test Well 3	05/27	1D	UF					0.53	0.05												
Test Well 4	05/27	1	UF	50	600	0.00	7.74	0.00	0.01	–0.002	0.006	–0.005	0.011	0.048	0.014	0.2	0.6	2.4	2.2	96	51
Test Well 4	05/27	1D	UF					–0.02	0.05												
Test Well 8	08/03	1	UF	930	670	–0.55	4.25	0.39	0.05	–0.004	0.006	0.010	0.007	0.065	0.024	0.8	1.1	3.3	2.3	23	50
Test Well 8	08/03	2	UF	860	660	–0.29	5.69	0.40	0.20	–0.005	0.004	0.007	0.004	0.011	0.005	0.9	1.1	1.9	2.2	91	51
Test Well DT–5A	08/11	1	UF	700	650	–0.31	6.04	0.37	0.04	–0.006	0.005	0.011	0.008	–0.018	0.014	0.7	1.0	1.8	1.7	107	51
Test Well DT–5A	08/11	1D	UF					0.20	0.05												
Test Well DT–9	06/02	1	UF	130	600	0.00	6.03	0.47	0.06	0.007	0.006	0.006	0.007	0.013	0.008	0.5	1.1	1.8	1.4	160	51
Test Well DT–9	06/02	1D	UF					0.46	0.05												
Test Well DT–10	06/03	1	UF	–120	580	0.00	8.54	0.90	0.10	0.007	0.006	0.011	0.008	0.021	0.013	1.1	1.2	1.6	1.4	58	50
Test Well DT–10	06/03	1D	UF					0.64	0.06												
Water Supply Wells:																					
O–1	06/09	1	UF	260	610	0.54	1.17	1.70	0.30	0.002	0.008	0.014	0.007	–0.007	0.005	1.7	1.4	4.4	2.6	80	50
O–4	03/09	1	UF	–140	610	–0.22	3.74	0.74	0.07	0.002	0.008	0.013	0.008	0.028	0.009	1.0	1.5	4.9	5.7	88	51
O–4	03/09	1D	UF					1.30	0.40												
O–4	12/13	1	UF					0.90	0.20												
PM–1	03/09	1	UF	–90	620	1.01	1.22	1.75	0.18	0.014	0.008	0.009	0.008	0.030	0.010	3.6	2.5	6.5	5.5	103	94
PM–1	12/13	1	UF					1.90	0.10												
PM–2	03/09	1	UF	130	630	1.12	0.95	0.32	0.03	0.006	0.006	0.009	0.008	–0.019	0.031	0.8	0.9	2.3	3.4	73	51
PM–3	03/09	1	UF	–90	620	0.00	7.27	0.88	0.09	0.006	0.007	0.027	0.011	–0.005	0.006	1.4	1.7	4.5	5.9	52	72
PM–4	03/26	1	UF			–0.70	1.05	0.71	0.08	0.001	0.012	0.016	0.008	2.400	5.000	0.6	0.4	1.9	0.5		
PM–4	03/29	1	UF					0.57	0.07												
PM–4	03/30	1	UF					0.52	0.06												
PM–4	06/09	1	UF	90	600	–2.47	11.37	0.44	0.05	0.009	0.007	0.018	0.009	0.000	0.002	0.9	1.1	2.8	2.2	49	50
PM–4	06/09	2	UF	340	620	–1.20	6.25	0.35	0.05	0.005	0.007	0.010	0.006	0.002	0.002	0.6	1.0	2.2	2.2	43	50
PM–5	03/09	1	UF	150	630	0.00	7.12	0.57	0.06	–0.003	0.012	0.013	0.012	0.009	0.006	0.9	1.2	6.2	4.6	17	50
G–1	03/09	1	UF	–150	610	–0.96	7.36	0.51	0.05	0.065	0.051	–0.024	0.027	0.038	0.016	1.3	1.3	3.0	4.0	–15	50
G–1	03/09	1D	UF					1.30	0.40												

Table 5-16. Radiochemical Analyses of Groundwater for 1999 (pCi/L[a]) (Cont.)

Station Name	Date	Code[b]	F/UF[c]	^{3}H		^{137}Cs		U (µg/L)		^{238}Pu		^{239,240}Pu		^{241}Am		Gross Alpha		Gross Beta		Gross Gamma	
Regional Aquifer Wells (Cont.)																					
Water Supply Wells: (Cont.)																					
G–2	03/09	1	UF	10	620	0.00	7.04	1.09	0.11	0.003	0.006	0.005	0.010	0.001	0.001	1.9	1.7	2.2	10.0	23	51
G–6	03/09	1	UF	–10	620	2.79	1.44	0.51	0.05	0.014	0.009	0.028	0.013	0.051	0.015	1.0	1.1	3.2	3.9	131	51
G–1A	03/09	1	UF	–260	600	–1.21	7.20	0.65	0.07	0.000	0.000	0.022	0.012	0.013	0.009	1.6	1.4	2.7	4.2	25	51
G–2A (GR–2)	11/30	1	UF	90	600	–0.85	6.87	0.39	0.05	0.008	0.008	0.006	0.006	–0.001	0.002	1.6	1.7	3.8	2.7	50	49
G–3A (GR–3)	11/30	1	UF	–100	590	–1.39	5.89	0.50	0.10	0.012	0.012	0.021	0.011	0.004	0.003	1.8	1.7	3.4	2.7	33	49
G–4A (GR–4)	06/09	1	UF	110	600	0.00	11.29	0.70	0.10	0.003	0.005	0.013	0.007	0.011	0.005	1.8	1.4	4.3	2.5	97	51
G–5A (GR–1)	11/30	1	UF	30	600	–0.63	5.07	0.59	0.05	0.010	0.012	–0.004	0.004	0.004	0.003	1.5	1.7	3.9	2.7	36	49
Regional Aquifer Springs																					
White Rock Canyon Group I:																					
Sandia Spring	09/20	1	F			–0.57	5.77	0.51	0.06	–0.006	0.007	0.004	0.006	0.020	0.012	0.5	1.6	3.5	2.4	353	50
Sandia Spring	09/20	1	UF	280	630																
Spring 3	09/20	1	F			0.00	3.61	1.52	0.09	0.001	0.009	0.001	0.005	0.008	0.010	2.2	1.7	3.9	2.5	44	48
Spring 3	09/20	1	UF	–80	600																
Spring 3AA	09/20	1	F			0.91	0.90	1.20	0.20	0.016	0.014	0.018	0.010	0.029	0.011	1.5	1.5	2.7	2.3	14	48
Spring 3AA	09/20	1	UF	30	610																
Spring 4A	09/21	1	F			0.00	5.48	0.90	0.10	0.002	0.005	0.003	0.007	0.071	0.032	1.8	1.6	2.9	2.3	70	49
Spring 4A	09/21	1	UF	–230	590																
Spring 5	09/21	1	F			0.00	9.51	0.51	0.05	0.008	0.007	0.015	0.014	–0.042	0.273	0.4	2.3	2.3	2.2	79	49
Spring 5	09/21	1	UF	–120	600																
Ancho Spring	09/21	1	F			0.00	3.16	0.23	0.05	0.006	0.013	–0.008	0.006	0.008	0.009	0.8	1.4	2.9	2.3	55	48
Ancho Spring	09/21	1	UF	–120	600																
White Rock Canyon Group II:																					
Spring 6A	09/21	1	F			–1.16	7.83	2.30	0.10	0.019	0.010	0.011	0.008	0.033	0.010	2.0	1.6	4.0	2.5	48	48
Spring 6A	09/21	1	UF	70	610																
Spring 7	09/21	1	F			0.09	0.80	0.50	0.10	–0.004	0.006	0.011	0.007	–0.012	0.019	0.9	1.4	4.2	2.5	91	49
Spring 7	09/21	1	UF	–50	600																
Spring 7	09/21	2	F			0.00	7.78	0.48	0.05	–0.004	0.006	0.019	0.014	–0.022	0.063	0.8	1.4	2.5	2.3	106	49
Spring 7	09/21	2	UF	–40	600																
Spring 8B	09/22	1	F			–0.42	4.34	0.16	0.05	0.006	0.006	0.013	0.009	–0.021	0.042	0.6	1.4	2.2	2.2	24	48
Spring 8B	09/22	1	UF	–40	610																
Spring 9	09/21	1	F			0.84	0.71			0.009	0.007	0.004	0.006	–0.022	0.179	0.7	1.4	2.0	2.2	93	49
Spring 9	09/22	1	F					0.53	0.08												
Spring 9	09/22	1	UF	–10	610																

Table 5-16. Radiochemical Analyses of Groundwater for 1999 (pCi/L[a]) (Cont.)

Station Name	Date	Code[b]	F/UF[c]	^{3}H		^{137}Cs		U (μg/L)		^{238}Pu		^{239,240}Pu		^{241}Am		Gross Alpha		Gross Beta		Gross Gamma	
Regional Aquifer Springs (Cont.)																							
White Rock Canyon Group III:																							
Spring 1	09/20	1	F			0.76	1.65	0.48	0.09	0.008	0.011	0.026	0.012	0.173	0.108	2.3	1.7	3.8	2.5	120	49
Spring 1	09/20	1	UF	–10	610																
Spring 2	09/20	1	F			1.17	0.91			–0.003	0.008	0.004	0.007	0.012	0.020	0.8	1.4	2.6	2.3	67	49
Spring 2	09/20	1	UF	–140	600			2.00	4.00												
White Rock Canyon Group IV:																							
La Mesita Spring	07/19	1	F			0.00	10.32	13.00	5.00	0.001	0.004	0.020	0.009	0.008	0.004	12.6	5.4	8.8	5.1	105	51
La Mesita Spring	07/19	1	UF	170	650																
Other Springs:																							
Sacred Spring	07/22	1	F			1.40	1.44	1.90	0.20	0.002	0.004	0.007	0.007	–0.007	0.006	1.2	1.0	2.9	2.0	127	51
Sacred Spring	07/22	1	UF	160	650																
Canyon Alluvial Groundwater Systems																							
Acid/Pueblo Canyons:																							
APCO–1	03/25	1	UF	150	600	0.15	0.74	0.28	0.03	0.006	0.009	0.057	0.017	0.026	0.009	2.5	2.8	24.6	8.2	45	51
APCO–1	03/25	1D	UF					0.63	0.05												
Cañada del Buey:																							
CDBO–6	06/30	1	UF	190	650	0.80	0.80	0.37	0.04	0.002	0.008	0.016	0.007	0.000	0.002	14.6	5.8	14.8	6.2	124	51
CDBO–6	06/30	1D	UF					0.30	5.00												
CDBO–7	10/06	1	UF	210	620	–0.49	5.68	0.08	0.05	0.020	0.014	0.017	0.012	0.011	0.013	0.5	0.6	3.3	2.7	40	49
DP/Los Alamos Canyons:																							
LAO–C	04/08	1	UF	260	630	–1.14	10.00	0.01	0.05	0.019	0.019	0.030	0.014	0.036	0.009	0.8	3.5	4.1	3.8	87	51
LAO–0.7	04/08	1	UF	210	630	0.00	12.18	0.09	0.05	–0.008	0.009	0.029	0.015	0.017	0.010	4.1	4.1	12.4	7.0	113	51
LAO–1	04/08	1	UF	260	630	1.66	1.71	0.02	0.05	–0.011	0.005	0.014	0.011	0.024	0.008	1.9	2.8	51.2	14.0	42	51
LAO–2	04/07	1	UF	0	610	–0.91	10.05	–0.01	0.05	0.023	0.015	0.038	0.017	0.054	0.014	1.7	2.5	44.8	12.4	34	51
LAO–3A	04/07	1	UF	130	620	2.83	1.65	0.09	0.05	0.022	0.028	–0.014	0.013	0.012	0.006	1.7	3.0	124.0	28.3	55	51
LAO–3A	04/07	2	UF	160	630	1.17	1.06	0.09	0.05	0.002	0.008	0.001	0.008	0.026	0.013	1.2	2.3	124.0	27.3	60	51
LAO–4	11/29	1	UF	230	610	–0.68	9.75	–0.15	0.05	0.011	0.008	0.029	0.012	0.030	0.015	1.3	1.7	7.1	3.3	111	49
LAO–4.5C	03/25	1	UF	120	600	0.91	0.64	0.10	0.01	0.001	0.006	0.024	0.012	0.023	0.007	0.4	1.8	1.3	1.5	28	51
LAO–4.5C	03/25	1D	UF					0.28	0.05												
LAO–5	03/25	1	UF	190	610	0.79	1.08	0.48	0.05	0.154	0.027	0.037	0.016	0.069	0.019	1.5	1.4	6.1	2.7	60	51

Table 5-16. Radiochemical Analyses of Groundwater for 1999 (pCi/L[a]) (Cont.)

Station Name	Date	Code[b]	F/UF[c]	^{3}H		^{137}Cs		U (μg/L)		^{238}Pu		$^{239,240}Pu$		^{241}Am		Gross Alpha		Gross Beta		Gross Gamma	
Canyon Alluvial Groundwater Systems (Cont.)																					
Mortandad Canyon:																					
MCO–3	04/16	1	UF	6,600	1,000	1.65	1.14	2.71	0.09	0.860	0.061	0.321	0.036	1.504	0.089	6.6	3.9	97.0	22.8	616	62
MCO–5	04/14	1	UF	29,300	1,900	0.00	7.55	3.40	0.20	0.027	0.011	0.031	0.012	0.381	0.047	5.2	4.7	184.0	42.7	818	82
MCO–6B	04/14	1	UF	28,600	1,900	0.57	0.86	3.50	0.30	0.026	0.014	0.024	0.011	0.410	0.037	4.5	4.5	160.0	38.1	136	51
MCO–7	04/13	1	UF	11,000	1,200	0.61	0.67	3.10	0.40	0.047	0.025	0.032	0.021	0.419	0.040	2.0	2.7	34.7	11.5	216	52
MCO–7.5	03/26	1	UF	11,100	1,200	0.16	1.05	1.70	0.05	0.171	0.023	0.020	0.008	0.030	0.009	1.5	1.4	6.7	2.9	51	51
MT–3	11/09	1	UF	80	600	–1.60	7.94	4.10	0.40	0.006	0.013	0.016	0.011	0.004	0.003	0.5	2.8	3.3	2.7	148	49
Pajarito Canyon:																					
PCO–1	03/26	1	UF	160	610	1.14	1.12	0.46	0.05	0.707	0.055	0.039	0.013	0.611	0.045	0.3	0.6	11.8	6.5	240	52
PCO–1	12/09	1	UF			1.30	0.78			0.023	0.014	0.025	0.011							98	49
Intermediate Perched Groundwater Systems																					
Pueblo/Los Alamos Canyon Area:																					
Test Well 2A	05/27	1	UF	1,320	690	–0.63	8.33	0.18	0.02	0.001	0.006	0.003	0.004	0.038	0.020	0.7	5.2	5.7	4.0	258	52
Test Well 2A	05/27	1D	UF					0.10	0.05												
Basalt Spring	07/19	1	F			–1.53	10.07	0.28	5.00	0.016	0.015	0.012	0.011	0.008	0.004	4.0	3.0	13.4	6.1	60	51
Basalt Spring	07/19	1	UF	130	640																
Perched Groundwater System in Volcanics:																					
Water Canyon Gallery	08/03	1	UF	720	660	–0.88	3.26	–0.01	0.06	–0.013	0.007	0.002	0.005	0.011	0.005	0.7	1.1	2.6	2.2	15	50
San Ildefonso Pueblo:																					
LA–5	07/22	1	UF	130	640	1.28	1.07	1.20	0.10	–0.005	0.003	0.000	0.006	0.014	0.006	1.5	1.4	3.6	2.4	33	50
Eastside Artesian Well	07/21	1	UF	860	660	1.12	1.12	–0.09	0.10	0.003	0.009	0.012	0.008	–0.014	0.014	–0.9	1.8	1.5	9.3	55	50
Pajarito Well (Pump 1)	07/20	1	UF	130	640	0.00	9.98	12.00	5.00	–0.004	0.003	0.005	0.004	0.024	0.014	18.9	12.3	17.7	15.7	93	51
Don Juan Playhouse Well	07/21	1	UF	840	660	1.08	0.76	13.40	0.60	–0.002	0.005	–0.005	0.009	0.024	0.009	13.6	5.5	9.4	4.9	63	50
New Community Well	07/20	1	UF	780	660	1.28	0.96	26.90	0.80	–0.003	0.003	0.013	0.007	0.019	0.008	21.2	7.3	13.5	5.9	111	51
Sanchez House Well	07/22	1	UF	–60	630	0.00	29.66	12.60	0.50	–0.008	0.003	0.008	0.005	–0.001	0.003	11.6	6.2	11.6	7.2	118	51
Limits of Detection				700		4		0.10		0.04		0.04		0.04		3		3		120	
Water Quality Standards[d]																					
DOE DCG for Public Dose				2,000,000		3,000		800		40		30		30		30		1,000			
DOE Drinking Water System DCG				80,000		120		30		1.6		1.2		1.2		1.2		40			
EPA Primary Drinking Water Standard				20,000				20								15					
EPA Screening Level																				50	
NMWQCC Groundwater Limit								5,000													

Table 5-16. Radiochemical Analyses of Groundwater for 1999 (pCi/L[a]) (Cont.)

Station Name	Date	Code[b]	F/UF[c]	^{3}H	^{137}Cs	U (µg/L)	^{238}Pu	^{239,240}Pu	^{241}Am	Gross Alpha	Gross Beta	Gross Gamma

[a] Except where noted. Two columns are listed: the first is the analytical result, and the second is the radioactive counting uncertainty (1 std dev). Radioactivity counting uncertainties may be less than the analytical method uncertainty.
[b] Codes: 1–primary analysis; R1–lab replicate; D1–lab duplicate.
[c] F/UF: F–filtered; UF–unfiltered.
[d] Standards given here for comparison only; see Appendix A.

Table 5-17. LANL and NMED Groundwater Strontium-90 Data for 1999
(LANL's 1999 strontium-90 data are not valid because of analytical laboratory problems; the data appear in this report for documentary purposes only.)

				Los Alamos					Los Alamos Low Level					New Mexico Environment Department				
Station Name	Date	Code[a]	F/UF[b]	Value	Uncertainty	Detection Limit	Units	Detect?	Value	Uncertainty	Detection Limit	Units	Detect?	Value	Uncertainty	Detection Limit	Units	Detect?
Regional Aquifer Wells																		
Test Wells:																		
Test Well 1	05/27	1	UF	20.57	1.16	0.31	pCi/L	Detect						0.20	0.30	4.90	pCi/L	ND
Test Well 1	06/03	1	UF						0.03	0.09	0.20	pCi/L	ND					
Test Well 2	08/11	1	F											2.70	1.60	3.00	pCi/L	ND
Test Well 2	08/11	1	UF	–2.63	0.57	1.05	pCi/L	ND[c]	–0.21	0.07	0.14	pCi/L	ND					
Test Well 3	05/27	1	UF	10.58	0.67	0.31	pCi/L	Detect						–0.06	0.29	0.52	pCi/L	ND
Test Well 3	06/03	1	UF						–0.12	0.06	0.12	pCi/L	ND					
Test Well 4	05/27	1	UF	18.59	1.07	0.31	pCi/L	Detect	–0.15	0.06	0.12	pCi/L	ND	–0.07	0.29	0.51	pCi/L	ND
Test Well 8	08/03	1	F											0.66	1.70	2.00	pCi/L	ND
Test Well 8	08/03	1	UF	0.74	0.20	0.36	pCi/L	Detect	0.05	0.04	0.08	pCi/L	ND					
Test Well 8	08/03	2	UF	0.24	0.18	0.37	pCi/L	ND	–0.01	0.04	0.08	pCi/L	ND					
Test Well DT–5A	06/03	1	UF						–0.09	0.06	0.14	pCi/L	ND					
Test Well DT–5A	08/11	1	UF	–0.04	0.21	0.47	pCi/L	ND										
Test Well DT–9	06/02	1	UF	10.18	0.64	0.30	pCi/L	Detect	–0.11	0.06	0.12	pCi/L	ND					
Test Well DT–10	06/03	1	UF	9.99	0.63	0.29	pCi/L	Detect										
Test Well DT–10	08/11	1	UF						–0.18	0.06	0.12	pCi/L	ND					
Water Supply Wells:																		
O–1	06/09	1	UF	0.77	0.17	0.30	pCi/L	Detect	0.08	0.11	0.24	pCi/L	ND	–0.11	0.41	0.75	pCi/L	ND
O–4	03/09	1	UF	0.84	0.24	0.66	pCi/L	Detect						<0.14		0.14	pCi/L	ND
O–4	06/08	1	UF						–0.12	0.08	0.18	pCi/L	ND					
O–4	12/13	1	UF	–0.72	0.23	0.45	pCi/L	ND										
PM–1	03/09	1	UF	0.31	0.25	0.77	pCi/L	ND						1.14	0.23	0.15	pCi/L	Detect
PM–1	06/08	1	UF						0.10	0.05	0.10	pCi/L	ND					
PM–1	12/13	1	UF	–0.75	0.22	0.44	pCi/L	ND										
PM–2	03/09	1	UF	0.31	0.29	0.89	pCi/L	ND						0.19	0.11	0.16	pCi/L	ND
PM–2	06/08	1	UF						0.16	0.07	0.14	pCi/L	ND					
PM–3	03/09	1	UF	0.46	0.25	0.75	pCi/L	ND						<0.14		0.14	pCi/L	ND
PM–3	06/08	1	UF						0.08	0.08	0.17	pCi/L	ND					
PM–4	03/26	1	UF	0.24	0.11	0.36	pCi/L	ND										
PM–4	03/26	1	UF	0.26	0.11	0.36	pCi/L	ND										
PM–4	03/29	1	UF	–0.05	0.09	0.32	pCi/L	ND										
PM–4	03/29	1	UF	0.06	0.10	0.34	pCi/L	ND										
PM–4	03/30	1	UF	0.14	0.10	0.34	pCi/L	ND										
PM–4	06/09	1	UF	1.03	0.18	0.30	pCi/L	Detect	0.08	0.04	0.09	pCi/L	ND	0.30	0.41	0.67	pCi/L	ND
PM–4	06/09	2	UF	2.27	0.23	0.26	pCi/L	Detect	–0.02	0.04	0.09	pCi/L	ND	0.30	0.41	0.67	pCi/L	ND

Table 5-17. LANL and NMED Groundwater Strontium-90 Data for 1999 (Cont.)
(LANL's 1999 strontium-90 data are not valid because of analytical laboratory problems; the data appear in this report for documentary purposes only.)

				Los Alamos					Los Alamos Low Level					New Mexico Environment Department				
Station Name	Date	Code[a]	F/UF[b]	Value	Uncertainty	Detection Limit	Units	Detect?	Value	Uncertainty	Detection Limit	Units	Detect?	Value	Uncertainty	Detection Limit	Units	Detect?
Regional Aquifer Wells (Cont.)																		
Water Supply Wells: (Cont.)																		
PM–5	03/09	1	UF	0.76	0.29	0.83	pCi/L	ND						<0.15		0.15	pCi/L	ND
PM–5	06/09	1	UF						0.12	0.05	0.09	pCi/L	ND					
G–1	03/09	1	UF	1.23	0.33	0.87	pCi/L	Detect						<0.16		0.16	pCi/L	ND
G–2	03/09	1	UF	1.01	0.37	1.06	pCi/L	ND						<0.15		0.15	pCi/L	ND
G–2	06/08	1	UF						–0.04	0.05	0.12	pCi/L	ND					
G–6	03/09	1	UF	0.14	0.34	1.09	pCi/L	ND						<0.14		0.14	pCi/L	ND
G–6	06/08	1	UF						–0.15	0.07	0.15	pCi/L	ND					
G–1A	03/09	1	UF	0.47	0.30	0.89	pCi/L	ND						<0.16		0.16	pCi/L	ND
G–1A	06/08	1	UF						–0.02	0.05	0.10	pCi/L	ND					
G5A	11/30	1	UF						–0.10	0.16	0.35	pCi/L	ND					
G2A	11/30	1	UF	–0.40	0.16	0.33	pCi/L	ND										
G3A	11/30	1	UF	–0.26	0.16	0.33	pCi/L	ND										
G4A	06/09	1	UF	0.88	0.17	0.29	pCi/L	Detect	–0.01	0.06	0.14	pCi/L	ND	0.08	0.38	0.66	pCi/L	ND
G4A	06/09	2	UF						–0.30	0.10	0.21	pCi/L	ND	0.08	0.38	0.66	pCi/L	ND
Regional Aquifer Springs																		
White Rock Canyon Group I:																		
Sandia Spring	08/06	1	F											<0.52		0.52	pCi/L	ND
Sandia Spring	09/20	1	F	0.07	0.17	0.39	pCi/L	ND						–0.48	1.40	2.00	pCi/L	ND
Spring 3	09/20	1	F	–0.76	0.24	0.48	pCi/L	ND										
Spring 3AA	09/20	1	F	0.08	0.21	0.46	pCi/L	ND										
Spring 4A	09/21	1	F	–0.28	0.21	0.44	pCi/L	ND										
Spring 5	05/11	1	UF											<1.00	0.40	0.10	pCi/L	ND
Spring 5	09/21	1	F	–0.14	0.21	0.47	pCi/L	ND										
Ancho Spring	05/13	1	UF											<0.10	0.40	0.10	pCi/L	ND
Ancho Spring	09/21	1	F	0.34	0.28	0.60	pCi/L	ND						0.07	1.30	2.00	pCi/L	ND
White Rock Canyon Group II:																		
Spring 6	05/13	1	UF											<0.10	0.40	0.10	pCi/L	ND
Spring 6A	09/21	1	F	0.35	0.21	0.43	pCi/L	ND						–0.70	1.40	3.00	pCi/L	ND
Spring 7	09/21	1	F	–0.20	0.21	0.46	pCi/L	ND										
Spring 7	09/21	2	F	0.12	0.30	0.66	pCi/L	ND										
Spring 8B	09/22	1	F	0.80	0.20	0.36	pCi/L	Detect										
Spring 9	09/21	1	F	–0.33	0.51	1.13	pCi/L	ND						1.90	1.30	2.00	pCi/L	ND
Spring 9A	05/18	1	UF											<1.00	0.40	1.00	pCi/L	ND

Table 5-17. LANL and NMED Groundwater Strontium-90 Data for 1999 (Cont.)
(LANL's 1999 strontium-90 data are not valid because of analytical laboratory problems; the data appear in this report for documentary purposes only.)

				Los Alamos					Los Alamos Low Level					New Mexico Environment Department				
Station Name	Date	Code[a]	F/UF[b]	Value	Uncertainty	Detection Limit	Units	Detect?	Value	Uncertainty	Detection Limit	Units	Detect?	Value	Uncertainty	Detection Limit	Units	Detect?
Regional Aquifer Springs (Cont.)																		
White Rock Canyon Group III:																		
Spring 1	09/20	1	F	0.46	0.37	0.80	pCi/L	ND						–0.78	1.30	2.00	pCi/L	ND
Spring 2	09/20	1	F	–0.58	0.27	0.56	pCi/L	ND										
White Rock Canyon Group IV:																		
La Mesita Spring	07/19	1	F	0.40	0.18	0.35	pCi/L	ND										
Other Springs:																		
Sacred Spring	07/22	1	F	0.76	0.17	0.31	pCi/L	Detect						1.10	1.60	2.00	pCi/L	ND
Canyon Alluvial Groundwater Systems																		
Acid/Pueblo Canyons:																		
APCO–1	03/25	1	F											0.00	0.80	0.90	pCi/L	ND
APCO–1	03/25	1	UF	0.08	0.16	0.36	pCi/L	ND										
Cañada del Buey:																		
CDBO–6	06/30	1	UF	4.71	0.36	0.28	pCi/L	Detect						–0.12	0.29	0.52	pCi/L	ND
CDBO–7	10/06	1	UF	0.06	0.34	0.77	pCi/L	ND										
DP/Los Alamos Canyons:																		
LAO–C	04/08	1	UF	1.49	0.21	0.31	pCi/L	Detect										
LAO–0.7	04/08	1	UF	7.30	0.53	0.38	pCi/L	Detect										
LAO–1	04/08	1	UF	18.23	1.05	0.31	pCi/L	Detect										
LAO–2	04/07	1	UF	18.61	1.04	0.26	pCi/L	Detect						17.80	1.20	1.00	pCi/L	Detect
LAO–3A	04/07	1	UF	46.48	2.40	0.23	pCi/L	Detect										
LAO–3A	04/07	2	UF	44.95	2.48	0.55	pCi/L	Detect										
LAO–4	11/29	1	UF	2.15	0.42	0.68	pCi/L	Detect										
LAO–4.5C	03/25	1	UF	1.48	0.21	0.32	pCi/L	Detect										
LAO–5	03/25	1	UF	0.98	0.20	0.34	pCi/L	Detect										
Mortandad Canyon:																		
MT–3	11/09	1	UF	–1.00	0.49	1.01	pCi/L	ND										
MCO–3	04/16	1	UF	28.91	1.62	0.38	pCi/L	Detect						15.50	2.90	0.68	pCi/L	Detect
MCO–3	04/16	1	F											16.50	3.00	0.68	pCi/L	Detect
MCO–5	04/14	1	UF	62.58	3.30	0.42	pCi/L	Detect										

Table 5-17. LANL and NMED Groundwater Strontium-90 Data for 1999 (Cont.)
(LANL's 1999 strontium-90 data are not valid because of analytical laboratory problems; the data appear in this report for documentary purposes only.)

				Los Alamos					Los Alamos Low Level					New Mexico Environment Department				
Station Name	Date	Code[a]	F/UF[b]	Value	Uncertainty	Detection Limit	Units	Detect?	Value	Uncertainty	Detection Limit	Units	Detect?	Value	Uncertainty	Detection Limit	Units	Detect?
Canyon Alluvial Groundwater Systems (Cont.)																		
Mortandad Canyon: (Cont.)																		
MCO–5	04/15	1	F											40.10	7.30	0.68	pCi/L	Detect
MCO–6B	04/14	1	UF	51.64	2.74	0.39	pCi/L	Detect										
MCO–7	04/13	1	UF	1.00	0.21	0.34	pCi/L	Detect										
MCO–7.5	03/25	1	F											0.20	0.50	2.00	pCi/L	ND
MCO–7.5	03/26	1	UF	0.19	0.16	0.35	pCi/L	ND						0.00	0.80	0.90	pCi/L	ND
Pajarito Canyon:																		
PCO–1	03/26	1	UF	0.51	0.17	0.32	pCi/L	Detect										
Intermediate Perched Groundwater Systems																		
Pueblo/Los Alamos Canyon Area:																		
Test Well 2A	05/27	1	UF	19.03	1.08	0.30	pCi/L	Detect						0.23	0.33	0.54	pCi/L	ND
Basalt Spring	07/19	1	F	1.23	0.22	0.35	pCi/L	Detect						0.41	0.38	0.61	pCi/L	ND
Perched Groundwater System in Volcanics:																		
Water Canyon Gallery	08/03	1	UF	0.11	0.17	0.37	pCi/L	ND	–0.04	0.07	0.15	pCi/L	ND					
San Ildefonso Pueblo:																		
LA–5	07/22	1	UF	0.54	0.17	0.33	pCi/L	Detect						0.21	0.35	0.57	pCi/L	ND
Eastside Artesian Well	07/21	1	UF	0.98	0.17	0.29	pCi/L	Detect										
Pajarito Well (Pump 1)	07/20	1	UF	0.61	0.19	0.36	pCi/L	Detect										
Don Juan Playhouse Well	07/21	1	UF	1.13	0.18	0.28	pCi/L	Detect										
New Community Well	07/20	1	UF	0.32	0.14	0.28	pCi/L	ND										
Sanchez House Well	07/22	1	UF	24.09	1.37	0.37	pCi/L	Detect						–0.18	0.34	0.61	pCi/L	ND

[a] Codes: 1–primary analysis; 2–secondary analysis; R–lab replicate; D–lab duplicate.
[b] F/UF: F–filtered; UF–unfiltered.
[c] ND = not detected.

Table 5-18. Detections of Radionuclides[a] and Comparison to Department of Energy Derived Concentration Guides[b] in Groundwater for 1999

Station Name	Date	Code[c]	F/UF[d]	Analyte	Value	Uncertainty[e]	Detection Limit	Units	DOE DCG	Ratio of Value to DCG	Ratio of Value to Minimum Standard	Minimum Standard	Minimum Standard Type
APCO-1	03/25	1	UF	^{241}Am	0.026	0.009	0.025	pCi/L					
APCO-1	03/25	1	UF	^{239,240}Pu	0.057	0.017	0.035	pCi/L					
Don Juan Playhouse Well	07/21	1	UF	U	13.40	0.60		µg/L					
G-1A	03/09	1	UF	^{238}Pu	0.000	0.000	0.000	pCi/L					
G-6	03/09	1	UF	^{241}Am	0.051	0.015	0.039	pCi/L					
LAO-1	04/08	1	UF	Beta	51.2	14.0		pCi/L	1,000	0.05	1.02	50	EPA Screening Level
LAO-2	04/07	1	UF	^{241}Am	0.054	0.014	0.030	pCi/L					
LAO-2	04/07	1	UF	Beta	44.8	12.4		pCi/L					
LAO-3A	04/07	1	UF	Beta	124.0	28.3		pCi/L	1,000	0.12	2.48	50	EPA Screening Level
LAO-3A	04/07	1	UF	Beta	124.0	27.3		pCi/L	1,000	0.12	2.48	50	EPA Screening Level
LAO-4.5C	03/25	1	UF	^{241}Am	0.023	0.007	0.019	pCi/L					
LAO-5	03/25	1	UF	^{241}Am	0.069	0.019	0.053	pCi/L					
LAO-5	03/25	1	UF	^{238}Pu	0.154	0.027	0.051	pCi/L					
LAO-C	04/08	1	UF	^{241}Am	0.036	0.009	0.014	pCi/L					
MCO-3	04/16	1	UF	^{241}Am	1.504	0.089	0.048	pCi/L	30	0.05	1.25	1.2	DOE Drinking Water DCG
MCO-3	04/16	1	UF	Beta	97.0	22.8		pCi/L	1,000	0.10	1.94	50	EPA Screening Level
MCO-3	04/16	1	UF	Gamma	616	62	80	pCi/L					
MCO-3	04/16	1	UF	^{3}H	6,600	1,000	400	pCi/L					
MCO-3	04/16	1	UF	^{238}Pu	0.860	0.061	0.043	pCi/L					
MCO-3	04/16	1	UF	^{239,240}Pu	0.321	0.036	0.036	pCi/L					
MCO-5	04/14	1	UF	^{241}Am	0.381	0.047	0.038	pCi/L					
MCO-5	04/14	1	UF	Beta	184.0	42.7		pCi/L	1,000	0.18	3.68	50	EPA Screening Level
MCO-5	04/14	1	UF	Gamma	818	82	80	pCi/L					
MCO-5	04/14	1	UF	^{3}H	29,300	1,900	400	pCi/L	2,000,000	0.01	1.47	20,000	EPA Primary Drinking Water Standard
MCO-6B	04/14	1	UF	^{241}Am	0.410	0.037	0.044	pCi/L					
MCO-6B	04/14	1	UF	Beta	160.0	38.1		pCi/L	1,000	0.16	3.20	50	EPA Screening Level
MCO-6B	04/14	1	UF	^{3}H	28,600	1,900	400	pCi/L	2,000,000	0.01	1.43	20,000	EPA Primary Drinking Water Standard
MCO-7	04/13	1	UF	^{241}Am	0.419	0.040	0.018	pCi/L					
MCO-7	04/13	1	UF	Beta	34.7	11.5		pCi/L					
MCO-7	04/13	1	UF	Gamma	216	52	80	pCi/L					
MCO-7	04/13	1	UF	^{3}H	11,000	1,200	400	pCi/L					
MCO-7.5	03/26	1	UF	^{3}H	11,100	1,200	400	pCi/L					
MCO-7.5	03/26	1	UF	^{238}Pu	0.171	0.023	0.030	pCi/L					
MT-3	11/09	1	UF	Gamma	148	49	80	pCi/L					

Table 5-18. Detections of Radionuclides[a] and Comparison to Department of Energy Derived Concentration Guides[b] in Groundwater for 1999 (Cont.)

Station Name	Date	Code[c]	F/UF[d]	Analyte	Value	Uncertainty[e]	Detection Limit	Units	DOE DCG	Ratio of Value to DCG	Ratio of Value to Minimum Standard	Minimum Standard	Minimum Standard Type
New Community Well	07/20	1	UF	U	26.90	0.80		µg/L	800	0.03	1.34	20	Proposed EPA Primary Drinking Water Standard
PCO-1	03/26	1	UF	^{241}Am	0.611	0.045	0.047	pCi/L					
PCO-1	03/26	1	UF	Gamma	240	52	80	pCi/L					
PCO-1	03/26	1	UF	^{238}Pu	0.707	0.055	0.055	pCi/L					
PM-1	03/09	1	UF	^{241}Am	0.030	0.010	0.024	pCi/L					
Sanchez House Well	07/22	1	UF	U	12.60	0.50		µg/L					
Sandia Spring	09/20	1	F	Gamma	353	50	80	pCi/L					
Spring 6A	09/21	1	F	^{241}Am	0.033	0.010	0.025	pCi/L					
Test Well 1	05/27	1	UF	Gamma	272	52	80	pCi/L					
Test Well 2A	05/27	1	UF	Gamma	258	52	80	pCi/L					
Test Well 3	05/27	1	UF	^{241}Am	0.067	0.022	0.051	pCi/L					
Test Well 4	05/27	1	UF	^{241}Am	0.048	0.014	0.037	pCi/L					
Test Well DT-9	06/02	1	UF	Gamma	160	51	80	pCi/L					

[a] Detection defined as value ≥ 3× uncertainty and ≥ detection limit, except values shown for uranium ≥ 5 µg/L, for gross alpha ≥ 5 pCi/L, and for gross beta ≥ 20 pCi/L.
[b] Values indicated by entries in righthand columns are greater than the minimum standard shown. The minimum standard is either a DOE DCG for DOE-administered drinking water systems or an EPA drinking water standard.
[c] Codes: 1–primary analysis; 2–secondary analysis; R–lab replicate; D–lab duplicate.
[d] F/UF: F–filtered; UF–unfiltered.
[e] One standard deviation radioactivity counting uncertainty.

Table 5-19. Detections of Strontium-90[a] and Comparison to Department of Energy Derived Concentration Guides[b] in Groundwater Samples for 1999
(LANL's 1999 strontium-90 data are not valid because of analytical laboratory problems; the data appear in this report for documentary purposes only.)

Station Name	Date	Code[c]	F/UF[d]	Analyte	Value	Uncertainty[e]	Detection Limit	Units	DOE DCG	Ratio of Value to DCG	Ratio of Value to Minimum Standard	Minimum Standard	Minimum Standard Type
Basalt Spring	07/19	1	F	^{90}Sr	1.23	0.22	0.35	pCi/L					
CDBO-6	06/30	1	UF	^{90}Sr	4.71	0.36	0.28	pCi/L					
Don Juan Playhouse Well	07/21	1	UF	^{90}Sr	1.13	0.18	0.28	pCi/L					
Eastside Artesian Well	07/21	1	UF	^{90}Sr	0.98	0.17	0.29	pCi/L					
G-1	03/09	1	UF	^{90}Sr	1.23	0.33	0.87	pCi/L					
G-4A	06/09	1	UF	^{90}Sr	0.88	0.17	0.29	pCi/L					
LA-5	07/22	1	UF	^{90}Sr	0.54	0.17	0.33	pCi/L					
LAO-0.7	04/08	1	UF	^{90}Sr	7.30	0.53	0.38	pCi/L					
LAO-1	04/08	1	UF	^{90}Sr	18.23	1.05	0.31	pCi/L	1,000	0.02	2.28	8	EPA Primary Drinking Water Standard
LAO-2	04/07	1	UF	^{90}Sr	18.61	1.04	0.26	pCi/L	1,000	0.02	2.33	8	EPA Primary Drinking Water Standard
LAO-3A	04/07	1	UF	^{90}Sr	46.48	2.40	0.23	pCi/L	1,000	0.05	5.81	8	EPA Primary Drinking Water Standard
LAO-3A	04/07	1	UF	^{90}Sr	44.95	2.48	0.55	pCi/L	1,000	0.04	5.62	8	EPA Primary Drinking Water Standard
LAO-4	11/29	1	UF	^{90}Sr	2.15	0.42	0.68	pCi/L					
LAO-4.5C	03/25	1	UF	^{90}Sr	1.48	0.21	0.32	pCi/L					
LAO-5	03/25	1	UF	^{90}Sr	0.98	0.20	0.34	pCi/L					
LAO-C	04/08	1	UF	^{90}Sr	1.49	0.21	0.31	pCi/L					
MCO-3	04/16	1	UF	^{90}Sr	28.91	1.62	0.38	pCi/L	1,000	0.03	3.61	8	EPA Primary Drinking Water Standard
MCO-5	04/14	1	UF	^{90}Sr	62.58	3.30	0.42	pCi/L	1,000	0.06	7.82	8	EPA Primary Drinking Water Standard
MCO-6B	04/14	1	UF	^{90}Sr	51.64	2.74	0.39	pCi/L	1,000	0.05	6.45	8	EPA Primary Drinking Water Standard
MCO-7	04/13	1	UF	^{90}Sr	1.00	0.21	0.34	pCi/L					
O-1	06/09	1	UF	^{90}Sr	0.77	0.17	0.30	pCi/L					
O-4	03/09	1	UF	^{90}Sr	0.84	0.24	0.66	pCi/L					
Pajarito Well (Pump 1)	07/20	1	UF	^{90}Sr	0.61	0.19	0.36	pCi/L					
PCO-1	03/26	1	UF	^{90}Sr	0.51	0.17	0.32	pCi/L					
PM-4	06/09	1	UF	^{90}Sr	1.03	0.18	0.30	pCi/L					
PM-4	06/09	1	UF	^{90}Sr	2.27	0.23	0.26	pCi/L					
Sacred Spring	07/22	1	F	^{90}Sr	0.76	0.17	0.31	pCi/L					

Table 5-19. Detections of Strontium-90[a] and Comparison to Department of Energy Derived Concentration Guides[b] in Groundwater Samples for 1999 (Cont.)
(LANL's 1999 strontium-90 data are not valid because of analytical laboratory problems; the data appear in this report for documentary purposes only.)

Station Name	Date	Code[c]	F/UF[d]	Analyte	Value	Uncertainty[e]	Detection Limit	Units	DOE DCG	Ratio of Value to DCG	Ratio of Value to Minimum Standard	Minimum Standard	Minimum Standard Type
Sanchez House Well	07/22	1	UF	^{90}Sr	24.09	1.37	0.37	pCi/L	1,000	0.02	3.01	8	EPA Primary Drinking Water Standard
Spring 8B	09/22	1	F	^{90}Sr	0.80	0.20	0.36	pCi/L					
Test Well 1	05/27	1	UF	^{90}Sr	20.57	1.16	0.31	pCi/L	1,000	0.02	2.57	8	EPA Primary Drinking Water Standard
Test Well 2A	05/27	1	UF	^{90}Sr	19.03	1.08	0.30	pCi/L	1,000	0.02	2.38	8	EPA Primary Drinking Water Standard
Test Well 3	05/27	1	UF	^{90}Sr	10.58	0.67	0.31	pCi/L	1,000	0.01	1.32	8	EPA Primary Drinking Water Standard
Test Well 4	05/27	1	UF	^{90}Sr	18.59	1.07	0.31	pCi/L	1,000	0.02	2.32	8	EPA Primary Drinking Water Standard
Test Well 8	08/03	1	UF	^{90}Sr	0.74	0.20	0.36	pCi/L					
Test Well DT-10	06/03	1	UF	^{90}Sr	9.99	0.63	0.29	pCi/L	1,000	0.01	1.25	8	EPA Primary Drinking Water Standard
Test Well DT-9	06/02	1	UF	^{90}Sr	10.18	0.64	0.30	pCi/L	1,000	0.01	1.27	8	EPA Primary Drinking Water Standard

[a] Detection defined as value ≥ 3× uncertainty and ≥ detection limit, except values shown for uranium ≥ 5 µg/L, for gross alpha ≥ 5 pCi/L, and for gross beta ≥ 20 pCi/L.
[b] Values indicated by entries in righthand columns are greater than the minimum standard shown. The minimum standard is either a DOE DCG for DOE-administered drinking water systems or an EPA drinking water standard.
[c] Codes: 1–primary analysis; 2–secondary analysis; R–lab replicate; D–lab duplicate.
[d] F/UF: F–filtered; UF–unfiltered.
[e] One standard deviation radioactivity counting uncertainty.

Table 5-20. Chemical Quality of Groundwater for 1999 (mg/L[a])

Station Name	Date	Code[b]	F/UF[c]	SiO_2	Ca	Mg	K	Na	Cl	SO_4	CO_3 Alkalinity	Total Alkalinity	F	PO_4-P	NO_3-N	CN	TDS[d]	TSS[e]	Hardness as $CaCO_3$	pH[f]	Conductance (µS/cm)
Regional Aquifer Wells																					
Test Wells:																					
Test Well 1	05/27	1	UF	47					35.4	21.8	<5[g]	112	0.35	<0.03	5.82	0.01	304	2.8		7.9	419
Test Well 1	05/27	D	UF		50.4	10.0	2.9	16.8											167.0		
Test Well 2	08/11	1	UF	<1					2.0	<1.0	<5	67	0.54	<0.03	0.01	0.01	66	3		7.7	118
Test Well 2	08/11	D	UF		7.2	1.7	2.5	19.0										25.0			
Test Well 3	05/27	1	UF	80					3.0	3.0	<5	78	0.39	<0.03	0.61	0.01	180	<1		7.9	175
Test Well 3	05/27	D	UF		16.7	5.3	1.3	11.6											63.3		
Test Well 4	05/27	1	UF	6					2.1	<1.0	<5	68	0.17	<0.03	0.01	0.01	88	<1		8.2	129
Test Well 4	05/27	D	UF		9.2	5.1	1.2	9.8											44.1		
Test Well 8	08/03	1	UF	71	11.4	3.8	1.7	9.6	2.5	1.8	<5	61	0.20	<0.03	0.21	0.01	114	<1	44.0	7.8	124
Test Well 8	08/03	2	UF	70	11.6	3.8	2.1	9.7	2.9	1.9	<5	71	0.20	<0.03	0.20	0.01	130	<1	44.7	7.6	123
Test Well DT–5A	08/11	1	UF	75					2.0	1.3	<5	51	0.25	<0.03	0.32	0.01	118	<1		7.6	102
Test Well DT–5A	08/11	D	UF		9.1	2.4	2.4	10.0											32.6		
Test Well DT–9	06/02	1	UF	72					1.9	1.9	<5	57	0.28	<0.03	0.34	<0.01	134	1.2		7.9	116
Test Well DT–9	06/02	D	UF		10.3	2.7	<0.7	10.5											37.1		
Test Well DT–10	06/03	1	UF	67					1.8	1.7	<5	58	0.21	<0.03	0.24	<0.01	136	<1		8.1	130
Test Well DT–10	06/03	D	UF		12.2	3.5	<0.7	10.8											44.9		
Water Supply Wells:																					
O–1	06/09	1	UF	60	15.0	2.2	1.9	29.2	5.9	6.6	<5	99	0.35	0.07	1.33	0.03	184	<1	46.2	8.5	226
O–4	03/09	1	UF	93	18.5	7.8	<2.5	20.8	8.4	6.0	<5	114	0.28	0.04	0.45	<0.01	222	<1	78.4	7.3	255
PM–1	03/09	1	UF	77	24.6	6.0	<2.5	19.0	6.1	5.0	<5	115	0.24	0.02	0.54	<0.01	192	<1	86.1	8.1	248
PM–2	03/09	1	UF	90	8.6	2.9	<2.5	10.5	4.1	3.0	<5	54	0.25	0.03	0.34	<0.01	128	<1	33.4	7.9	116
PM–3	03/09	1	UF	94	22.7	7.5	<2.5	17.7	7.0	5.0	<5	109	0.28	0.02	0.47	<0.01	212	<1	87.5	7.8	248
PM–4	06/09	1	UF	84	11.0	3.7	1.7	11.1	2.3	2.6	<5	60	0.24	0.07	0.33	0.02	148	<1	42.7	8.0	135
PM–4	06/09	2	UF	85	10.7	3.6	1.6	11.1	2.3	2.3	<5	66	0.24	0.08	0.33	0.02	146	<1	41.7	8.0	138
PM–5	03/09	1	UF	91	11.8	4.5	<2.5	12.6	3.1	3.0	<5	68	0.26	<0.02	0.30	<0.01	150	<1	48.0	7.8	150
G–1	03/09	1	UF	81	12.3	0.5	<2.5	21.2	2.6	5.0	<5	70	0.40	<0.02	0.44	<0.01	154	<1	32.6	8.4	160
G–2	03/09	1	UF	72	0.9	0.1	<2.5	3.4	3.3	4.0	<5	100	0.97	<0.02	0.42	<0.01	176	<1	2.5	8.5	211
G–6	03/09	1	UF	67	16.4	3.4	<2.5	12.5	3.0	4.0	<5	77	0.24	<0.02	0.52	<0.01	152	<1	54.8	8.2	162
G–1A	03/09	1	UF	75	10.2	0.5	<2.5	30.0	3.6	5.0	<5	83	0.54	<0.02	0.45	<0.01	166	<1	27.3	8.4	181
G–2A (GR–2)	11/30	1	UF	61	10.8	0.8	2.2	24.4	2.1	3.2	<5	79	0.36	<0.03	0.41	0.03	156	<1	30.5	6.9	159
G–3A (GR–3)	11/30	1	UF	61	10.5	0.8	2.1	24.0	2.0	3.1	<5	80	0.36	0.04	0.42	0.03	150	<1	29.7	8.0	157
G–4A (GR–4)	06/09	1	UF	56	17.0	3.3	1.6	13.2	3.7	3.8	<5	77	0.22	0.06	0.50	0.02	120	<1	56.0	8.4	169
G–5A (GR–1)	11/30	1	UF	61	10.7	0.8	2.2	24.0	2.1	3.1	<5	78	0.36	<0.03	0.41	0.03	146	<1	30.1	8.3	155
Regional Aquifer Springs																					
White Rock Canyon Group I:																					
Sandia Spring	09/20	1	F	48	37.1	2.4	2.5	14.4	4.9	3.5	<5	136	0.54	<0.03	0.03		180		102.5	7.9	269
Sandia Spring	09/20	1	UF													0.01		561			

Table 5-20. Chemical Quality of Groundwater for 1999 (mg/L[a]) (Cont.)

Station Name	Date	Code[b]	F/UF[c]	SiO_2	Ca	Mg	K	Na	Cl	SO_4	CO_3 Alkalinity	Total Alkalinity	F	PO_4-P	NO_3-N	CN	TDS[d]	TSS[e]	Hardness as $CaCO_3$	pH[f]	Conductance (µS/cm)
Regional Aquifer Springs (Cont.)																					
White Rock Canyon Group I: (Cont.)																					
Spring 3	09/20	1	F	52	21.6	1.6	2.7	13.7	5.2	5.1	<5	135	0.43	<0.03	1.08		154		60.6	8.2	197
Spring 3	09/20	1	UF													0.01		11			
Spring 3AA	09/20	1	F	43	16.9	0.3	2.5	14.9	3.9	3.2	<5	83	0.39	<0.03	0.40		118		43.4	7.8	167
Spring 3AA	09/20	1	UF													0.01		167			
Spring 4A	09/21	1	F	71	18.4	4.1	1.8	10.6	6.1	5.2	<5	80	0.42	<0.03	0.86		124		62.9	8.1	186
Spring 4A	09/21	1	UF													0.01		<1			
Spring 5	09/21	1	F	70	17.9	4.3	2.1	10.4	5.1	4.5	<5	79	0.38	<0.03	0.65		130		62.2	8.2	179
Spring 5	09/21	1	UF													0.02		7			
Ancho Spring	09/21	1	F	76	12.7	2.9	1.8	9.0	3.5	2.1	<5	62	0.32	<0.03	0.36		98		43.6	7.7	136
Ancho Spring	09/21	1	UF													0.01		13			
White Rock Canyon Group II:																					
Spring 6A	09/21	1	F	68	20.8	3.4	2.6	25.1	4.6	7.5	<5	114	0.43	<0.03	0.33		196		66.1	7.2	245
Spring 6A	09/21	1	UF													0.01		8			
Spring 7	09/21	1	F	79	11.7	2.7	2.0	11.2	1.5	3.0	<5	65	0.29	0.03	0.41		144		40.3	7.4	142
Spring 7	09/21	2	F	79	12.3	2.8	2.0	11.9	2.8	2.9	<5	65	0.30	<0.03	0.59		150		42.5	7.4	143
Spring 7	09/21	1	UF													0.01		37			
Spring 7	09/21	2	UF													<0.01		144			
Spring 8B	09/22	1	F	81	11.1	3.1	1.9	10.8	3.1	1.8	<5	70	0.37	<0.03	0.07		106		40.4	7.6	132
Spring 8B	09/22	1	UF													0.01		<1			
Spring 9	09/22	1	F	79	10.8	2.9	<1.8	10.5	2.3	1.8	<5	61	0.39	<0.03	0.10		124		38.8	7.8	127
Spring 9	09/22	1	UF													0.01		156			
White Rock Canyon Group III:																					
Spring 1	09/20	1	F	34	15.4	0.9	1.8	26.3	4.8	6.5	<5	104	0.53	<0.03	0.35		218		42.0	8.0	217
Spring 1	09/20	1	UF													0.01		549			
Spring 2	09/20	1	F	36	19.3	1.0	1.5	40.7	4.0	5.3	<5	136	0.65	<0.03	0.01		194		38.8	8.4	277
Spring 2	09/20	1	UF															<1			
White Rock Canyon Group IV:																					
La Mesita Spring	07/19	1	F	30	36.2	1.1	2.2	27.7	6.9	13.9	<5	124	0.25	0.03	5.37		212		94.3	8.2	298
La Mesita Spring	07/19	1	UF													<0.01		<1			
Other Springs:																					
Sacred Spring	07/22	1	F	44	30.0	1.4	2.1	19.9	3.9	8.2	<5	109	0.43	<0.03	0.29		162		80.4	8.3	219
Sacred Spring	07/22	1	UF													<0.01		4			
Canyon Alluvial Groundwater Systems																					
Acid/Pueblo Canyons:																					
APCO–1	03/25	1	F	82	20.1	5.6	11.6	66.4	44.7	23.4	<5	142	0.48	4.65	4.07		382		73.1	7.0	502
APCO–1	03/25	1	UF													<0.01		<1			

Table 5-20. Chemical Quality of Groundwater for 1999 (mg/L[a]) (Cont.)

Station Name	Date	Code[b]	F/UF[c]	SiO_2	Ca	Mg	K	Na	Cl	SO_4	CO_3 Alkalinity	Total Alkalinity	F	PO_4-P	NO_3-N	CN	TDS[d]	TSS[e]	Hardness as $CaCO_3$	pH[f]	Conductance (μS/cm)
Canyon Alluvial Groundwater Systems (Cont.)																					
Cañada del Buey:																					
CDBO–6	06/30	1	F	57	15.6	3.4	2.0	18.9	19.0	9.0	<5	<5	0.18	0.20	0.12		200		53.1	1.7	11,600
CDBO–6	06/30	1	UF		15.0	3.5	2.0	20.0								<0.01		69	51.6		
CDBO–7	10/06	1	F	66	19.3	4.0	2.3	21.3	22.7	7.6	<5	74	0.13	0.15	0.01		164		64.8	8.0	233
CDBO–7	10/06	1	UF		19.5	4.1	2.8	21.6								0.02		<3			
DP/Los Alamos Canyons:																					
LAO–C	04/08	1	F	32	19.4	4.5	1.7	54.7	89.3	7.1	<5	60	0.11	0.03	0.06		272		67.0	7.0	418
LAO–C	04/08	1	UF		20.0	4.6	2.0	53.6								<0.01		<1			
LAO–0.7	04/08	1	F	30	19.1	3.8	1.4	50.9	86.8	6.6	<5	46	0.14	0.05	0.09		244		63.3	7.1	398
LAO–0.7	04/08	1	UF		19.6	3.8	1.7	49.6								<0.01		27			
LAO–1	04/08	1	F	38	16.3	3.4	1.7	34.7	53.3	5.7	<5	53	0.21	0.06	0.20		202		54.8	7.0	289
LAO–1	04/08	1	UF		16.7	3.3	2.1	34.6								<0.01		2			
LAO–2	04/07	1	F	41	22.2	5.6	4.5	33.7	70.7	7.2	<5	51	0.51	0.11	0.38		244		78.4	6.9	352
LAO–2	04/07	1	UF		21.4	5.5	4.2	33.9								<0.01		<1			
LAO–3A	04/07	1	F	59	32.4	6.8	5.8	35.5	81.5	10.4	<5	65	0.52	0.13	0.74		306		109.0	7.0	421
LAO–3A	04/07	2	F	59	32.4	6.9	5.6	36.3	82.6	10.4	<5	63	0.51	<0.03	0.74		304		109.3	7.0	421
LAO–3A	04/07	1	UF		31.1	6.6	5.1	35.6								<0.01		<1			
LAO–3A	04/07	2	UF		31.4	6.7	5.2	35.7								<0.01		<1			
LAO–4	11/29	1	F	42	11.5	3.3	4.0	25.4	21.2	9.5	<5	67	0.63	0.04	<0.01		152		42.1	7.0	209
LAO–4	11/29	1	UF													0.03		5			
LAO–4.5C	03/25	1	F	39	10.5	3.3	2.8	27.7	18.3	11.7	<5	63	0.64	0.02	0.01		162		39.8	6.9	208
LAO–4.5C	03/25	1	UF													<0.01		2			
LAO–5	03/25	1	F	42	9.0	3.17	<1.7	29.2	27.5	8.9	<5	54	0.44	0.02	<0.01		146		35.5	7.0	216
LAO–5	03/25	1	UF																		
Mortandad Canyon:																					
MCO–3	04/16	1	F	48	37.0	1.8	7.7	42.0	14.4	18.0	<5	139	2.22	0.19	8.02		308		99.8	7.5	412
MCO–3	04/16	1	UF													0.01		<1			
MCO–5	04/14	1	F	39					27.8	33.0	<5	170	1.07	0.07	32.90		530			7.2	756
MCO–5	04/14	1	UF													0.01		<1			
MCO–5	04/15	1	F		55.4	5.4	19.7	81.4											160.6		
MCO–6B	04/14	1	F	40	50.0	4.9	21.0	81.5	25.9	29.0	<5	166	1.18	0.09	30.90		504		145.2	7.3	712
MCO–6B	04/14	1	UF													0.01		<1			
MCO–7	04/13	1	F	40	19.0	4.9	16.3	71.2	14.8	16.0	<5	155	1.79	0.37	14.90		378		67.5	7.3	495
MCO–7	04/13	1	UF													0.01		11			
MCO–7.5	03/26	1	F	35	18.5	4.7	9.9	83.3	17.8	16.2	<5	160	1.75	0.08	16.00		366		65.5	7.1	527
MCO–7.5	03/26	1	UF													<0.01		2			
MT–3	11/09	1	F	66	17.7	3.8	3.1	20.3	18.8	7.1	<5	75	0.12	0.16	0.11		170		60.0	7.0	205
MT–3	11/09	1	UF		26.6	6.0	5.8	21.7								0.03		<1			

Table 5-20. Chemical Quality of Groundwater for 1999 (mg/L[a]) (Cont.)

Station Name	Date	Code[b]	F/UF[c]	SiO_2	Ca	Mg	K	Na	Cl	SO_4	CO_3 Alkalinity	Total Alkalinity	F	PO_4-P	NO_3-N	CN	TDS[d]	TSS[e]	Hardness as $CaCO_3$	pH[f]	Conductance (µS/cm)
Canyon Alluvial Groundwater Systems (Cont.)																					
Pajarito Canyon:																					
PCO–1	03/26	1	F	34	12.9	4.0	<1.7	18.5	17.5	7.8	<5	57	0.14	<0.02	0.07		142		48.8	6.7	186
PCO–1	03/26	1	UF													<0.01		<1			
Intermediate Perched Groundwater Systems																					
Pueblo/Los Alamos Canyon Area:																					
Test Well 2A	05/27	1	UF	23					46.2	24.8	<5	98	0.17	<0.03	0.38	0.01	254	8.8		8.0	390
Test Well 2A	05/27	D	UF		41.2	7.4	1.7	22.5											133.5		
Basalt Spring	07/19	1	F	64	21.9	5.3	7.7	51.3	35.3	21.0	<5	123	0.43	0.58	2.78		280		76.6	7.0	419
Basalt Spring	07/19	1	UF													<0.01		<1			
Perched Groundwater System in Volcanics:																					
Water Canyon Gallery	08/03	1	UF	46	6.9	3.1	1.7	5.1	<1.0	1.1	<5	44	0.05	<0.03	0.28	0.01	88	<1	30.3	8.0	77
San Ildefonso Pueblo:																					
LA–5	07/22	1	UF	41	22.6	0.8	1.9	15.9	3.2	5.4	<5	79	0.44	<0.03	0.58	0.01	146	<2	59.8	8.0	159
Eastside Artesian Well	07/21	1	UF	1	2.8	0.2	0.5	87.1	3.3	14.4	18	190	0.91	<0.03	0.01	<0.01	204	<1	7.6	9.0	400
Pajarito Well (Pump 1)	07/20	1	UF	36	49.6	4.7	4.0	282.6	182.0	47.7	<5	520	0.55	<0.03	0.30	0.01	920	<1	143.0	7.5	1,520
Don Juan Playhouse Well	07/21	1	UF	26	15.5	1.4	1.1	56.2	4.3	16.7	<5	147	0.49	<0.03	1.61	<0.01	212	<5	44.5	8.6	336
New Community Well	07/20	1	UF	27	17.9	1.0	0.8	80.1	8.1	36.3	<5	175	0.18	<0.03	1.58	<0.01	280	<1	48.8	8.3	443
Sanchez House Well	07/22	1	UF	40	31.9	2.1	<1.6	97.3	43.2	43.9	<5	196	1.20	<0.03	1.24	0.01	382	<2	88.4	8.5	546
Water Quality Standards[h]																					
EPA Primary Drinking Water Standard										500			4		10	0.2					
EPA Secondary Drinking Water Standard									250	250							500			6.8–8.5	
EPA Health Advisory								20													
NMWQCC Groundwater Limit									250	600			1.6		10	0.2	1,000			6–9	

[a] Except where noted.
[b] Codes: 1–primary analysis; 2–secondary analysis; R–lab replicate; D–lab duplicate.
[c] F/UF: F–filtered; UF–unfiltered.
[d] Total dissolved solids.
[e] Total suspended solids.
[f] Standard units.
[g] Less than symbol (<) means measurement was below the specified limit of detection of the analytical method.
[h] Standards given here for comparison only; see Appendix A.

Table 5-21. Trace Metals in Groundwater for 1999 (µg/L)

Station Name	Date	Code[a]	F/UF[b]	Ag	Al	As	B	Ba	Be	Cd	Co	Cr	Cu	Fe	Hg
Regional Aquifer Wells															
Test Wells:															
Test Well 1	05/27	1	UF												<0.1
Test Well 1	05/27	D	UF	<6[c]	<40	<2	80	76	<1	<3	<6	<5	<4	620	
Test Well 2	08/11	1	UF												<0.1
Test Well 2	08/11	D	UF	<6	<40	<3	<160	15	1	<3	7	<5	22	875	
Test Well 3	05/27	1	UF												<0.1
Test Well 3	05/27	D	UF	<6	<40	<2	57	24	<1	<3	<6	<5	<4	202	
Test Well 4	05/27	1	UF												<0.1
Test Well 4	05/27	D	UF	<6	<40	<2	11	41	<1	<3	<6	<5	7	928	
Test Well 8	08/03	1	UF	<6	63	<2	<19	8	1	<3	8	<5	<4	129	<0.1
Test Well 8	08/03	2	UF	<6	<40	<2	<9	7	1	<3	<6	<5	<4	111	<0.1
Test Well DT-5A	08/11	1	UF												<0.1
Test Well DT-5A	08/11	D	UF	<6	<40	<2	<160	22	<1	<3	<6	<5	<20	67	
Test Well DT-9	06/02	1	UF												<0.1
Test Well DT-9	06/02	D	UF	<6	141	<2	41	14	<1	<3	<6	5	<4	<30	
Test Well DT-10	06/03	1	UF												<0.1
Test Well DT-10	06/03	D	UF	<6	138	<2	34	5	<1	<3	<6	5	<4	<30	
Water Supply Wells:															
O-4	12/13	1	UF			<2									
PM-1	12/13	1	UF			<2									
G-2A (GR-2)	11/30	1	UF	<6	72	13	17	10	<1	<3	<6	<8	<4	<30	
G-3A (GR-3)	11/30	1	UF	<6	106	12	40	10	<1	<3	7	6	<4	<30	
G-5A (GR-1)	11/30	1	UF	<7	165	12	51	10	<1	<3	38	<5	<4	<30	
Regional Aquifer Springs															
White Rock Canyon Group I:															
Sandia Spring	09/20	1	F	<11	<72	<2	18	122	<1	<3	<6	<5	<10	<63	
Sandia Spring	09/20	1	UF												<0.1
Spring 3	09/20	1	F	11	<72	2	25	36	<1	<3	<6	<10	<10	<63	
Spring 3	09/20	1	UF												<0.1
Spring 3AA	09/20	1	F	<11	<72	<2	12	8	<1	<3	<6	<5	<10	<72	
Spring 3AA	09/20	1	UF												<0.1
Spring 4A	09/21	1	F	<11	<72	<5	24	41	<1	<3	<6	7	<10	<63	
Spring 4A	09/21	1	UF												<0.1
Spring 5	09/21	1	F	<11	<72	<2	15	25	<1	<3	11	<13	<10	<63	
Spring 5	09/21	1	UF												<0.1
Ancho Spring	09/21	1	F	<11	<72	<3	16	25	<1	<3	6	<5	<10	<63	
Ancho Spring	09/21	1	UF												<0.1

Table 5-21. Trace Metals in Groundwater for 1999 (µg/L) (Cont.) (Cont.)

Station Name	Date	Code[a]	F/UF[b]	Ag	Al	As	B	Ba	Be	Cd	Co	Cr	Cu	Fe	Hg
Regional Aquifer Springs (Cont.)															
White Rock Canyon Group II:															
Spring 6A	09/21	1	F	<11	<72	<2	29	34	<1	<3	<9	<5	<10	<63	
Spring 6A	09/21	1	UF												<0.1
Spring 7	09/21	1	F	<11	<72	<2	25	23	<1	<3	<6	<5	<10	<63	
Spring 7	09/21	2	F	<11	<72	<2	15	24	<1	<3	<6	<5	<10	<63	
Spring 7	09/21	1	UF												<0.1
Spring 7	09/21	2	UF												<0.1
Spring 8B	09/22	1	F	<11	<72	<2	10	24	<1	<3	<12	<5	<10	<63	
Spring 8B	09/22	1	UF												<0.1
Spring 9	09/22	1	F	<11	<72	<2	<18	14	<1	<3	<6	<5	<10	<63	
Spring 9	09/22	1	UF												<0.1
White Rock Canyon Group III:															
Spring 1	09/20	1	F	<11	<72	3	30	24	<1	<3	<6	6	<10	<63	
Spring 1	09/20	1	UF												<0.1
Spring 2	09/20	1	UF												<0.1
White Rock Canyon Group IV:															
La Mesita Spring	07/19	1	F	<6	<1,400	<2	55	103	<1	<3	<6	<5	<4	<570	
La Mesita Spring	07/19	1	UF												<0.1
Other Springs:															
Sacred Spring	07/22	1	F	<6	<200	2	37	76	<1	<3	<20	<5	<4	<20	
Sacred Spring	07/22	1	UF												<0.1
Canyon Alluvial Groundwater Systems															
Acid/Pueblo Canyons:															
APCO-1	03/25	1	F	<6	62	5	302	41	1	<3	<6	<5	11	41	
APCO-1	03/25	1	UF	<6	109	5	321	43	1	<3	<6	<5	6	68	<0.3
Cañada del Buey:															
CDBO-6	06/30	1	F	<6	<1,400	2	39	77	<1	<3	<6	<5	<4	<570	
CDBO-6	06/30	1	UF												<0.1
CDBO-6	06/30	D	UF	<6	4,334	2	35	98	<1	<3	<6	<5	<4	2,427	
CDBO-7	10/06	1	F	<6	110	<2	43	88	1	<3	<6	<5	<8	<30	
CDBO-7	10/06	1	UF	<6	226	<3	52	90	1	<3	<6	<5	9	106	
CDBO-7	10/06	D	UF												<0.1
DP/Los Alamos Canyons:															
LAO-C	04/08	1	F	<6	1,083	<2	<13	62	1	<3	6	<5	<4	554	
LAO-C	04/08	1	UF	<6	1,398	2	<9	62	1	<3	6	<5	<4	704	<0.1

Table 5-21. Trace Metals in Groundwater for 1999 (µg/L) (Cont.)

Station Name	Date	Code[a]	F/UF[b]	Ag	Al	As	B	Ba	Be	Cd	Co	Cr	Cu	Fe	Hg
Canyon Alluvial Groundwater Systems (Cont.)															
DP/Los Alamos Canyons: (Cont.)															
LAO-0.7	04/08	1	F	<6	329	<2	<12	42	1	<3	<6	<5	<4	78	
LAO-0.7	04/08	1	UF	13	982	<2	<9	52	1	<3	<6	<5	<4	430	<0.1
LAO-1	04/08	1	F	<6	634	<2	<9	36	1	<3	<6	14	<4	245	
LAO-1	04/08	1	UF	<6	755	<2	<9	37	1	<3	<6	13	<4	283	<0.1
LAO-2	04/07	1	F	<6	325	<2	11	50	1	<3	<6	<5	<4	89	
LAO-2	04/07	1	UF	<6	550	<2	10	52	1	<3	<6	<5	<4	173	<0.1
LAO-3A	04/07	1	F	<6	117	<2	17	69	1	<3	<6	<5	<4	<30	
LAO-3A	04/07	2	F	<6	147	<2	19	70	1	<3	<6	<5	<4	<30	
LAO-3A	04/07	1	UF	<6	197	2	18	68	1	<3	<6	<5	<4	<30	<0.1
LAO-3A	04/07	2	UF	<6	166	2	21	69	1	<3	<6	<5	<4	<30	<0.1
LAO-4	11/29	1	F	<6	550	<2	31	31	<1	<3	<6	<5	<4	239	
LAO-4	11/29	1	UF	<6	586	<2	36	34	<1	<3	<6	<5	<4	240	<0.1
LAO-4.5C	03/25	1	F	<6	938	<2	31	34	1	<3	<6	<5	<4	381	
LAO-4.5C	03/25	1	UF	<6	905	<2	23	34	1	<3	<6	<5	<10	379	<0.3
LAO-5	03/25	1	F	<6	586	<2	34	23	1	<3	<6	<5	<4	190	
LAO-5	03/25	1	UF	<6	766	<2	26	31	2	<3	<6	<5	<4	292	<0.28
Mortandad Canyon:															
MCO-3	04/16	1	F	<6	145	<2	67	29	1	<3	<6	<5	23	83	
MCO-3	04/16	1	UF	<6	201	<2	63	28	<1	<3	<6	<5	7	123	<0.1
MCO-5	04/14	1	UF	<6	<40	<2	93	160	<1	<3	<6	<5	<4	36	<0.1
MCO-5	04/15	1	F	<6	<40	<2	81	153	<1	<3	<6	<5	<11	<30	
MCO-6B	04/14	1	F	<6	<82	<2	82	134	<1	<10	<6	<5	<4	70	
MCO-6B	04/14	1	UF	<6	117	<2	82	133	<1	<3	<6	<5	<4	41	<0.1
MCO-7	04/13	1	F	29	321	<2	72	157	<1	<3	<6	<5	<4	140	
MCO-7	04/13	1	UF	<6	950	<2	81	162	<1	<3	<6	<5	<4	506	<0.1
MCO-7.5	03/26	1	F	<6	106	<2	69	153	1	<3	<6	5	<4	<30	
MCO-7.5	03/26	1	UF	<6	190	<2	67	155	1	<3	<6	<5	<4	76	<0.3
MT-3	11/09	1	F	<6	200	<2	33	86	1	<3	<6	<5	5	183	
MT-3	11/09	1	UF	<6	7,602	<4	35	1,111	5	<3	12	<5	13	3,836	<0.1
Pajarito Canyon:															
PCO-1	03/26	1	F	<6	2,110	<2	26	70	1	<3	<6	<5	<4	1,050	
PCO-1	03/26	1	UF	<6	1,710	<2	25	71	1	<3	<6	<5	<4	961	<0.3

Table 5-21. Trace Metals in Groundwater for 1999 (µg/L) (Cont.)

Station Name	Date	Code[a]	F/UF[b]	Ag	Al	As	B	Ba	Be	Cd	Co	Cr	Cu	Fe	Hg
Intermediate Perched Groundwater Systems															
Pueblo/Los Alamos Canyon Area:															
Test Well 2A	05/27	1	UF												<0.1
Test Well 2A	05/27	D	UF	<6	81	<2	80	50	<1	<3	<6	<5	<4	1,892	
Basalt Spring	07/19	1	F	<6	<1,400	7	225	71	<1	<3	<6	<5	<4	<570	
Basalt Spring	07/19	1	UF												<0.1
Perched Groundwater System in Volcanics:															
Water Canyon Gallery	08/03	1	UF	<6	172	<2	<15	13	1	<3	<6	<5	<4	58	<0.1
San Ildefonso Pueblo:															
LA-5	07/22	1	UF	<6	<190	2	31	74	<1	<3	<6	7	<4	43	<0.1
Eastside Artesian Well	07/21	1	UF	<6	<200	<2	122	4	<1	<3	<20	<5	<4	126	<0.1
Pajarito Well (Pump 1)	07/20	1	UF	<6	<1,400	8	1,313	78	<1	<3	<6	<5	<4	<570	0.1
Don Juan Playhouse Well	07/21	1	UF	<6	<200	4	85	33	<1	<3	<20	8	<4	<20	<0.1
New Community Well	07/20	1	UF	<6	<200	2	49	16	<1	<3	<20	<5	<4	<20	<0.1
Sanchez House Well	07/22	1	UF	<6	<190	11	250	92	<1	<3	8	<5	7	<30	<0.1
Water Quality Standards[d]															
EPA Primary Drinking Water Standard						50		2,000	4	5		100			2.0
EPA Secondary Drinking Water Standard					50–200									300	
EPA Action Level													1,300		
EPA Health Advisory															
NMWQCC Livestock Watering Standard					5,000	200	5,000			50	1,000	1,000	500		10.0
NMWQCC Groundwater Limit				50	5,000	100	750	1,000		10	50	50	1,000	1,000	2.0

Table 5-21. Trace Metals in Groundwater for 1999 (µg/L) (Cont.)

Station Name	Date	Code[a]	F/UF[b]	Mn	Mo	Ni	Pb	Sb	Se	Sn	Sr	Ti	V	Zn
Regional Aquifer Wells														
Test Wells:														
Test Well 1	05/27	1	UF						<3					
Test Well 1	05/27	D	UF	26	<10	<20	77	6		<60	270	<3	<7	655
Test Well 2	08/11	1	UF						<3					
Test Well 2	08/11	D	UF	28	<22	<20	<60	<4		<60	33	<3	<7	321
Test Well 3	05/27	1	UF						<3					
Test Well 3	05/27	D	UF	14	<10	<20	<60	<4		<60	71	<3	10	51
Test Well 4	05/27	1	UF						<3					
Test Well 4	05/27	D	UF	25	<10	<20	<60	<4		<60	43	<3	<7	1,518
Test Well 8	08/03	1	UF	2	<10	<20	<60	<4	<3	<60	51	<3	<7	559
Test Well 8	08/03	2	UF	2	<10	<20	<60	<4	<3	<60	52	<3	<7	577
Test Well DT-5A	08/11	1	UF						<3					
Test Well DT-5A	08/11	D	UF	8	<10	<20	<60	<4		<60	46	<3	7	254
Test Well DT-9	06/02	1	UF						<3					
Test Well DT-9	06/02	D	UF	1	<10	<20	<60	<4		<60	46	<3	<7	94
Test Well DT-10	06/03	1	UF						<3					
Test Well DT-10	06/03	D	UF	<1	<10	<20	<60	<4		<60	46	<3	<7	59
Water Supply Wells:														
O-4	12/13	1	UF											
PM-1	12/13	1	UF											
G-2A (GR-2)	11/30	1	UF	<1	<10	<20	<60	<4	<3	<60	52	<3	52	<10
G-3A (GR-3)	11/30	1	UF	1	<10	<20	<60	<4	<3	<60	50	<3	51	<10
G-5A (GR-1)	11/30	1		<1	<10	<20	<60	<4	<3	<60	51	<3	52	<10
Regional Aquifer Springs														
White Rock Canyon Group I:														
Sandia Spring	09/20	1	F	78	<10	<20	<60	<4		<60	323	<3	<7	<10
Sandia Spring	09/20	1	UF						<3					
Spring 3	09/20	1	F	2	<10	<20	<60	<4		<60	217	<3	14	<10
Spring 3	09/20	1	UF						<3					
Spring 3AA	09/20	1	F	<1	<10	<20	<60	<4		<60	148	<3	13	<10
Spring 3AA	09/20	1	UF						<3					
Spring 4A	09/21	1	F	<1	<10	<61	<60	<4		<85	90	<3	8	<10
Spring 4A	09/21	1	UF						<3					
Spring 5	09/21	1	F	1	<10	<20	<60	<4		<60	82	<3	<13	10
Spring 5	09/21	1	UF						<3					
Ancho Spring	09/21	1	F	11	<10	<20	<60	<4		<60	58	<3	<7	<10
Ancho Spring	09/21	1	UF						<3					

Table 5-21. Trace Metals in Groundwater for 1999 (μg/L) (Cont.)

Station Name	Date	Code[a]	F/UF[b]	Mn	Mo	Ni	Pb	Sb	Se	Sn	Sr	Ti	V	Zn
Regional Aquifer Springs (Cont.)														
White Rock Canyon Group II:														
Spring 6A	09/21	1	F	4	<10	<20	<60	<4		<83	128	<3	12	12
Spring 6A	09/21	1	UF						<3					
Spring 7	09/21	1	F	2	<10	<20	<60	<4		<60	59	<3	<7	<10
Spring 7	09/21	2	F	2	<10	<69	<60	<4		<60	64	<3	<7	<10
Spring 7	09/21	1	UF						<3					
Spring 7	09/21	2	UF						<3					
Spring 8B	09/22	1	F	24	<10	<20	<60	<4		<60	52	<3	<7	<10
Spring 8B	09/22	1	UF						<3					
Spring 9	09/22	1	F	1	<10	<20	<60	<4		<60	50	<3	<7	<10
Spring 9	09/22	1	UF						6					
White Rock Canyon Group III:														
Spring 1	09/20	1	F	1	<10	<20	<60	<4		<60	183	<3	13	<10
Spring 1	09/20	1	UF						3					
Spring 2	09/20	1	UF						<3					
White Rock Canyon Group IV:														
La Mesita Spring	07/19	1	F	2	<10	<20	<60	<4		<60	799	<3	<7	<10
La Mesita Spring	07/19	1	UF						<3					
Other Springs:														
Sacred Spring	07/22	1	F	4	<10	<20	<60	<4		<60	435	<3	<20	<40
Sacred Spring	07/22	1	UF						<3					
Canyon Alluvial Groundwater Systems														
Acid/Pueblo Canyons:														
APCO-1	03/25	1	F	234	<10	<20	<60	<4		<60	97	<3	<7	26
APCO-1	03/25	1	UF	207	10	<20	<60	<4	<3	<60	98	<3	8	26
Cañada del Buey:														
CDBO-6	06/30	1	F	<1	<10	<63	<60	<4		<60	97	<3	<7	<10
CDBO-6	06/30	1	UF						<3					
CDBO-6	06/30	D	UF	14	<10	<20	<60	<4		<60	94	<3	<7	<10
CDBO-7	10/06	1	F	1	<10	<20	<60	<4		<60	126	<3	<7	<10
CDBO-7	10/06	1	UF	2	<18	<20	<60	<4	<4	<60	128	<3	7	<10
CDBO-7	10/06	D	UF						<3					
DP/Los Alamos Canyons:														
LAO-C	04/08	1	F	5	<10	<20	<60	<4		<60	118	<3	<7	<10
LAO-C	04/08	1	UF	5	<10	202	<60	<4	<3	<60	117	<3	<7	<10

Table 5-21. Trace Metals in Groundwater for 1999 (µg/L) (Cont.)

Station Name	Date	Code[a]	F/UF[b]	Mn	Mo	Ni	Pb	Sb	Se	Sn	Sr	Ti	V	Zn
Canyon Alluvial Groundwater Systems														
DP/Los Alamos Canyons: (Cont.)														
LAO-0.7	04/08	1	F	93	<10	<20	<60	<4		<60	125	<3	<7	<10
LAO-0.7	04/08	1	UF	292	<10	<20	<60	<4	<3	<60	121	<3	<7	<10
LAO-1	04/08	1	F	3	14	<20	<60	<4		<60	108	<3	<7	<10
LAO-1	04/08	1	UF	3	<10	<20	<60	<4	<3	<60	107	<3	<7	<10
LAO-2	04/07	1	F	1	257	<20	<60	<4		<60	134	<3	<7	<10
LAO-2	04/07	1	UF	2	239	<20	<60	<4	<3	<60	131	<3	<7	<10
LAO-3A	04/07	1	F	<1	679	<20	<60	<4		<60	180	<3	<7	<10
LAO-3A	04/07	2	F	1	690	<20	<60	<4		<60	183	<3	<7	<10
LAO-3A	04/07	1	UF	1	665	<20	<60	<4	<3	<60	177	<3	<7	<10
LAO-3A	04/07	2	UF	1	657	<20	<60	<4	<3	<60	176	<3	<7	<10
LAO-4	11/29	1	F	10	<10	<20	<60	<4		<60	74	<3	<7	<10
LAO-4	11/29	1	UF	1	<10	<20	<60	<4	<3	<60	76	<3	<7	<10
LAO-4.5C	03/25	1	F	5	24	<20	<60	<4		<60	75	<3	<7	10
LAO-4.5C	03/25	1	UF	2	17	<20	<60	<4	<3	<60	73	<3	<7	17
LAO-5	03/25	1	F	<1	13	<20	<60	<4		<60	74	<3	<7	<10
LAO-5	03/25	1	UF	1	<10	<20	<60	<4	<3	<60	76	<3	<7	<10
Mortandad Canyon:														
MCO-3	04/16	1	F	1	123	<20	<60	<4		<60	64	<3	<7	<10
MCO-3	04/16	1	UF	6	117	<20	<60	<4	<3	<60	63	<3	<7	<10
MCO-5	04/14	1	UF	6	71	<20	<60	<4	<3	<60	226	<3	<7	<10
MCO-5	04/15	1	F	5	63	<20	<60	<4		<60	216	<3	<7	<10
MCO-6B	04/14	1	F	6	71	<20	<60	<4		<60	198	<3	<7	16
MCO-6B	04/14	1	UF	6	63	<20	<60	<4	<3	<60	200	<3	<7	<10
MCO-7	04/13	1	F	6	98	<20	<60	<4		<60	119	<3	<7	<10
MCO-7	04/13	1	UF	16	116	<20	<60	<4	<3	<60	121	<3	<7	10
MCO-7.5	03/26	1	F	<1	99	<20	<60	<4		<60	127	<3	<7	<10
MCO-7.5	03/26	1	UF	1	101	<20	<60	<4	<3	<60	130	<3	<7	<10
MT-3	11/09	1	F	9	<35	<20	<60	<4		<60	116	<3	<7	<10
MT-3	11/09	1	UF	901	<10	<59	<60	<4	<3	<60	199	<3	17	77
Pajarito Canyon:														
PCO-1	03/26	1	F	35	<10	<20	<60	<4		<60	95	<3	<7	<10
PCO-1	03/26	1	UF	39	<10	<20	<60	<4	<3	<60	94	<3	<7	<10

Table 5-21. Trace Metals in Groundwater for 1999 (µg/L) (Cont.)

Station Name	Date	Code[a]	F/UF[b]	Mn	Mo	Ni	Pb	Sb	Se	Sn	Sr	Ti	V	Zn
Intermediate Perched Groundwater Systems														
Pueblo/Los Alamos Canyon Area:														
Test Well 2A	05/27	1	UF						<3					
Test Well 2A	05/27	D	UF	127	<10	<20	91	<4		<60	219	<3	<7	4,981
Basalt Spring	07/19	1	F	<1	<10	<20	<60	<4		<60	109	<3	<7	<10
Basalt Spring	07/19	1	UF						<3					
Perched Groundwater System in Volcanics:														
Water Canyon Gallery	08/03	1	UF	1	<10	<33	<60	<4	<3	<60	50	<3	<7	<10
San Ildefonso Pueblo:														
LA-5	07/22	1	UF	3	<10	<20	<60	<4	<3	<60	240	<3	15	57
Eastside Artesian Well	07/21	1	UF	9	<10	<20	<60	<4	<3	<60	53	<3	<20	<40
Pajarito Well (Pump 1)	07/20	1	UF	<1	<10	<20	<60	<4	<3	<84	1,118	<3	13	<10
Don Juan Playhouse Well	07/21	1	UF	6	<10	<20	<60	<4	<3	<60	168	<3	<20	<40
New Community Well	07/20	1	UF	<1	<10	<20	<60	<4	<3	<60	208	<3	<20	<40
Sanchez House Well	07/22	1	UF	<1	10	<20	<60	<4	<3	<60	317	<3	16	<10
Water Quality Standards[d]														
EPA Primary Drinking Water Standard						100		6	50			2		
EPA Secondary Drinking Water Standard				50										5,000
EPA Action Level							15							
EPA Health Advisory											25,000–90,000		80–110	
NMWQCC Livestock Watering Standard							100		50				100	25,000
NMWQCC Groundwater Limit				200	1,000	200	50		50					10,00

[a] Codes: 1–primary analysis; 2–secondary analysis; R–lab replicate; D–lab duplicate.
[b] F/UF: F-filtered; UF-unfiltered.
[c] Less than symbol (<) means measurement was below the specified limit of detection of the analytical method.
[d] Standards given here for comparison only; see Appendix A. Note that New Mexico Livestock Watering and Groundwater limits are based on dissolved concentrations, whereas many of these analyses are of unfiltered samples; thus, concentrations may include suspended sediment quantities.

Table 5-22. Number of Samples Collected for Each Suite of Organic Compounds in Groundwater for 1999

		Organic Suite[a]			
Station Name	**Date**	**HE**	**PCB**	**Semivolatile**	**Volatile**
Ancho Spring	09/21	1	1	1	1
APCO-1	03/25				1
Basalt Spring	07/19		1	1	1
CDBO-6	06/30		1	1	1
Don Juan Playhouse Well	07/21		1	1	1
Eastside Artesian Well	07/21		1	1	1
G-1	03/09	1			
G-2	03/09	1			
G-6	03/09	1			
G-1A	03/09	1			
G-2A	11/30	1			
G-3A	11/30	1			
G-4A	06/09	1			
G-5A	11/30	1			
La Mesita Spring	07/19	1	1	1	1
LAO-4.5C	03/25		1	1	1
New Community Well	07/20		1	1	1
O-1	06/09	1			
O-4	03/09	1			
O-4	06/08	1			
Pajarito Well (Pump 1)	07/20		1	1	1
PCO-1	03/26	1			
PM-1	03/09	1			
PM-1	06/08	1			
PM-2	03/09	2			
PM-2	06/08	1			
PM-2	09/28	1			
PM-2	11/04	1			
PM-2	12/13	1			
PM-3	03/09	1			
PM-3	06/08	1			
PM-4	03/26	2	1	1	
PM-4	03/29	2			
PM-4	03/30	1			
PM-4	06/09	2			
PM-5	03/09	1			
PM-5	06/09	1			
PM-5	09/28	1			
PM-5	11/04	1			
PM-5	12/13	1			
Sandia Spring	09/20	1	1	1	
Spring 1	09/20	1	1	1	1
Spring 2	09/20	1			
Spring 3	09/20	1	1	1	1
Spring 3AA	09/20	1	1	1	1
Spring 4A	09/21	1	1	1	1

Table 5-22. Number of Samples Collected for Each Suite of Organic Compounds in Groundwater for 1999 (Cont.)

		Organic Suite[a]			
Station Name	**Date**	**HE**	**PCB**	**Semivolatile**	**Volatile**
Spring 5	09/21	1	1	1	1
Spring 6A	09/21	1			
Spring 7	09/21	2	2	2	2
Spring 8B	09/22	1			
Spring 9	09/22	1			
Test Well 1	06/03	1			
Test Well 2	08/11	1			
Test Well 2A	06/03	1			
Test Well 3	06/03	1			
Test Well 4	06/02	1			
Test Well 8	08/03	2			2
Test Well DT-10	06/03	1			
Test Well DT-5A	08/11	2			
Test Well DT-9	06/02	1			

[a]High explosives, polychlorinated biphenyls, semivolatiles, and volatiles.

Table 5-23. Special Los Alamos Water Supply Sampling during 1999

Location	Date	Analytes	Date	Analytes	Date	Analytes	Date	Analytes	Date	Analytes
G-1	03/09	HE								
G-2	03/09	HE								
G-6	03/09	HE								
G-1A	03/09	HE								
G-2A							11/30	HE		
G-3A							11/30	HE		
G-4A				06/09	HE					
G-5A							11/30	HE		
PM-1	03/09	HE	06/09	HE					12/13	As, U, ^{90}Sr
PM-2	03/09	HE	06/09	HE	09/28	HE	11/04	HE	12/13	HE, ClO_4
PM-3	03/09	HE	06/09	HE						
PM-4	03/25	HE	06/09	HE						
PM-5	03/09	HE	06/09	HE	09/28	HE	11/04	HE	12/13	HE, ClO_4
O-1			06/09	HE						
O-4	03/09	HE	06/09	HE					12/13	As, U, ^{90}Sr

Table 5-24. Quality Assurance Sample Results for Strontium-90 Analysis of Water Samples in 1999[a,b] (pCi/L)

Station Name	Date	Code	^{90}Sr	Uncertainty	Detection Limit	Detect?
DI Blank	03/09	1	0.24	0.16	0.49	ND[c]
DI Blank	04/08	1	2.52	0.25	0.28	Detect
DI Blank	06/09	1	–0.25	0.06	0.11	ND
DI Blank	06/09	1	0.54	0.15	0.29	Detect
DI Blank	07/21	1	0.59	0.17	0.33	Detect
DI Blank	09/20	1	–0.15	0.14	0.29	ND
Average Analytical Detection Limit			0.30			
Average of Blank Values			0.58	0.16		
Standard Deviation of Blank Values			1.01			
Std. Dev. of Blank/Detection Limit (Should be <0.33)			3.39			
Spiked Sample	03/29	1	4.45	0.37	0.34	Detect
Spiked Sample	04/13	1	4.22	0.34	0.27	Detect
Spiked Sample	06/30	1	0.81	0.17	0.29	Detect
Spiked Sample	08/11	1	5.61	0.43	0.34	Detect
Spiked Sample	09/22	1	4.62	0.37	0.31	Detect
Spiked Sample	12/01	1	2.24	0.33	0.48	Detect
Average Analytical Detection Limit			0.34			
Average of Spiked Value			3.66	0.34		
Standard Deviation of Spiked Values			1.78			
Spiked Concentration			5.00	0.50		
Ratio of Result/Spiked Value			0.73			
Calculated Detection Limit (Std. Dev. of spikes × 3)			5.33			
Calculated Detection Limit/Analytical Detection Limit (Should be ≤1)			15.76			

[a] Two columns are listed: the first is the value; the second is the radioactive counting uncertainty (1 std dev). Radioactivity counting uncertainties may be less than analytical method uncertainties.
[b] See Appendix B for an explanation of negative numbers.
[c] ND = not detected.

Table 5–25. Quality Assurance Sample Results for Radiochemical Analysis of Water Samples in 1999[a,b] (pCi/L[c])

Station Name	Date	Code	^{3}H		^{137}Cs		U (μg/L)		^{238}Pu		$^{239,240}Pu$		^{241}Am		Gross Alpha		Gross Beta		Gross Gamma	
DI Blank	03/09	1	–110	610	0.14	1.11	0.11	0.01	–0.006	0.007	0.023	0.011	0.034	0.014	0.85	0.71	0.71	12.30	100.70	51.07
DI Blank	04/08	1	–10	610	–1.13	7.41	0.00	0.05	0.004	0.007	0.010	0.010	0.031	0.009	0.11	0.87	0.56	1.16	23.50	50.80
DI Blank	06/09	1	240	610	0.00	7.43	0.07	0.05	0.010	0.008	0.016	0.009	0.049	0.013	0.27	1.39	–0.17	0.11	107.00	50.60
DI Blank	07/21	1	500	640	0.69	0.83	–0.08	0.10	0.027	0.010	0.035	0.012	0.010	0.005	0.04	0.09	0.08	0.12	46.20	50.10
DI Blank	09/20	1	–30	610	0.00	7.42	0.00	0.05	0.015	0.009	0.005	0.006	–0.025	0.038	0.04	0.05	0.43	1.78	91.10	48.70
DI Blank	12/09	1			0.00	0.33			0.008	0.006	0.004	0.006							47.20	48.50
Analytical Detection Limit			700		4.00		0.10		0.040		0.040		0.040		3.00		3.00		120.00	
Average of Blank Values			118		–0.05	4.09	0.02	0.05	0.010	0.008	0.016	0.009	0.020	0.016	0.26	0.62	0.32	3.09	69.28	49.96
Standard Deviation of Blank Values			251		0.59		0.07		0.011		0.012		0.029		0.34		0.36		34.65	
Std. Dev. Of Blank/Detection Limit (Should be <0.33)			0.36		0.15		0.73		0.272		0.294		0.714		0.11		0.12		0.29	
Spiked Sample	03/29	1	260	610	0.59	1.12	0.16	0.05	0.087	0.021	0.133	0.025	0.132	0.020	0.53	1.37	13.70	4.41	65.80	51.10
Spiked Sample	04/13	1			1.12	0.93			0.087	0.026	0.106	0.027	0.143	0.031	0.27	0.48	9.10	2.73	176.90	51.30
Spiked Sample	04/16	1	0	620			1.63	0.05												
Spiked Sample	06/30	1	310	660	0.46	1.17	0.00	0.01	0.093	0.018	0.096	0.018	0.170	0.023	0.34	0.51	22.70	6.28	209.00	51.40
Spiked Sample	06/30	1D					–0.09	5.00												
Spiked Sample	08/11	1	–130	590	–0.81	5.45	0.00	0.01	0.108	0.022	0.128	0.022	0.108	0.024	0.55	0.91	9.44	3.54	15.40	50.40
Spiked Sample	08/11	1D					–0.06	0.05												
Spiked Sample	09/22	1	10	610	0.00	5.43	–0.01	0.05	0.121	0.025	0.122	0.024	0.110	0.048	0.63	1.41	9.46	3.66	37.60	48.30
Spiked Sample	12/01	1			2.84	1.82	0.20	0.20	0.118	0.022	0.125	0.023	0.119	0.020	0.56	2.62	8.51	3.60	67.50	48.90
Average of Spiked Value			90	618	0.70	2.65	0.23	0.68	0.103	0.022	0.118	0.023	0.130	0.028	0.48	1.22	12.15	4.04	95.37	50.23
Standard Deviation of Spiked Values			187		1.23		0.58		0.015		0.014		0.023		0.14		5.49		78.67	
Spiked Concentration			0		0.00		0.00		0.100	0.010	0.100	0.010	0.100	0.010						
Ratio of Result/Spiked Value									1.026		1.183		1.302							
Calclulated Detection Limit (Standard Deviation of Spikes × 3)					3.70				0.046		0.043		0.070							
Calculated Det. Limit/Analytical Det. Limit (Should be ≤1.00)					0.92				1.160		1.069		1.754							

[a] Two columns are listed: the first is the value; the second is the radioactive counting uncertainty (1 std dev). Radioactivity counting uncertainties may be less than analytical method uncertainties.
[b] See Appendix B for an explanation of negative numbers.
[c] Except where noted.

Table 5-26. Quality Assurance Sample Results for Metals Analysis of Water Samples in 1999 (µg/L)

Station Name	Date	Ag	Al	As	B	Ba	Be	Cd	Co	Cr	Cu	Fe	Hg
DI Blank	04/08	<6	210	<2	<9	<2	1	<3	<6	<5	<4	<30	<0.10
DI Blank	07/21	<6	<200	<2	11	<2	<1	<3	<20	<5	<4	<20	<0.10
DI Blank	09/20	<11	<72	<4	29	<2	<1	<3	8	<5	22	<63	
DI Blank	09/22												<0.10
Spiked Sample	03/29	24	104	<2	<9	512	1	<3	<6	<5	<4	<30	4.20
Spiked Sample	04/16	19	<40	<2	<19	464	<1	<3	<6	<5	<4	31	4.06
Spiked Sample	06/30	14	<1,400	<2	<17	481	<1	<3	<6	<5	<4	<30	3.82
Spiked Sample	08/11	30	<40	<3	<16 0	360	<1	<3	<10	<5	<20	280	4.04
Spiked Sample	09/22	14	<72	<2	<9	469	<1	<3	<6	<5	<10	<63	3.28
Spiked Sample	12/01	8	<70	<2	<9	492	<1	<3	<6	<5	<4	<30	4.18
Average of Results		18				463							3.93
Standard Deviation of Results		8				53							0.35
Spiked Concentration		25				500							5.00
Ratio of Result/Spiked Value		0.73				0.93							0.79

Table 5-26. Quality Assurance Sample Results for Metals Analysis of Water Samples in 1999 (µg/L) (Cont.)

Station Name	Date	Mn	Mo	Ni	Pb	Sb	Se	Sn	Sr	Tl	V	Zn
DI Blank	04/08	1	<10	<20	<60	<4	<3	<60	<1	<3	<7	<10
DI Blank	07/21	<1	<10	<20	<60	<4	<3	<60	<1	<3	<20	<40
DI Blank	09/20	<1	<10	<20	<60	<4		<60	2	<3	<7	36
DI Blank	09/22						<3					
Spiked Sample	03/29	<1	<10	<20	<60	<4	<3	<60	<1	<3	<7	<10
Spiked Sample	04/16	6	<10	<20	<60	<4	<3	<60	<1	<3	<7	<10
Spiked Sample	06/30	<1	<10	<20	<60	<4	<3	<60	<1	<3	<7	<10
Spiked Sample	08/11	8	<10	<20	<60	<4	<3	<60	10	<3	<7	77
Spiked Sample	09/22	<1	<10	<45	<60	<4	<3	<60	<1	<3	<7	<10
Spiked Sample	12/01	<1	<10	<20	<60	<4	<3	<60	<1	<3	<7	10
Average of Results												
Standard Deviation of Results												
Spiked Concentration												
Ratio of Result/Spiked Value												

J. Figures

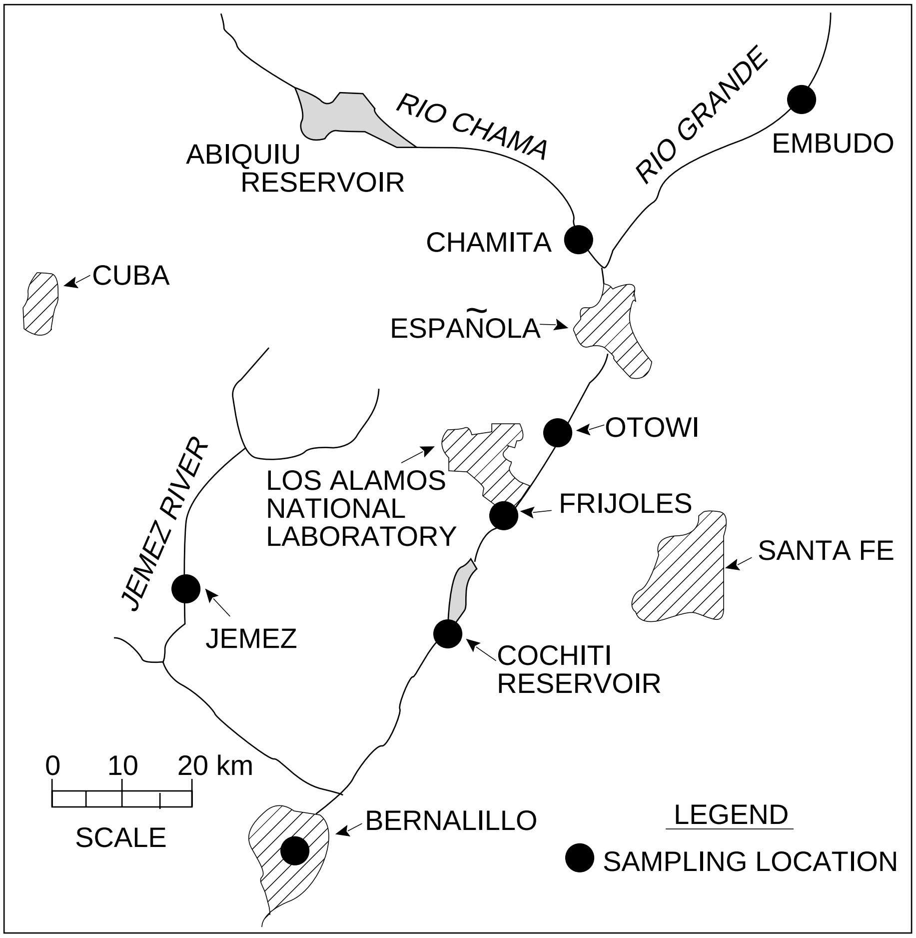


Figure 5-1. Regional surface water and sediment sampling locations.

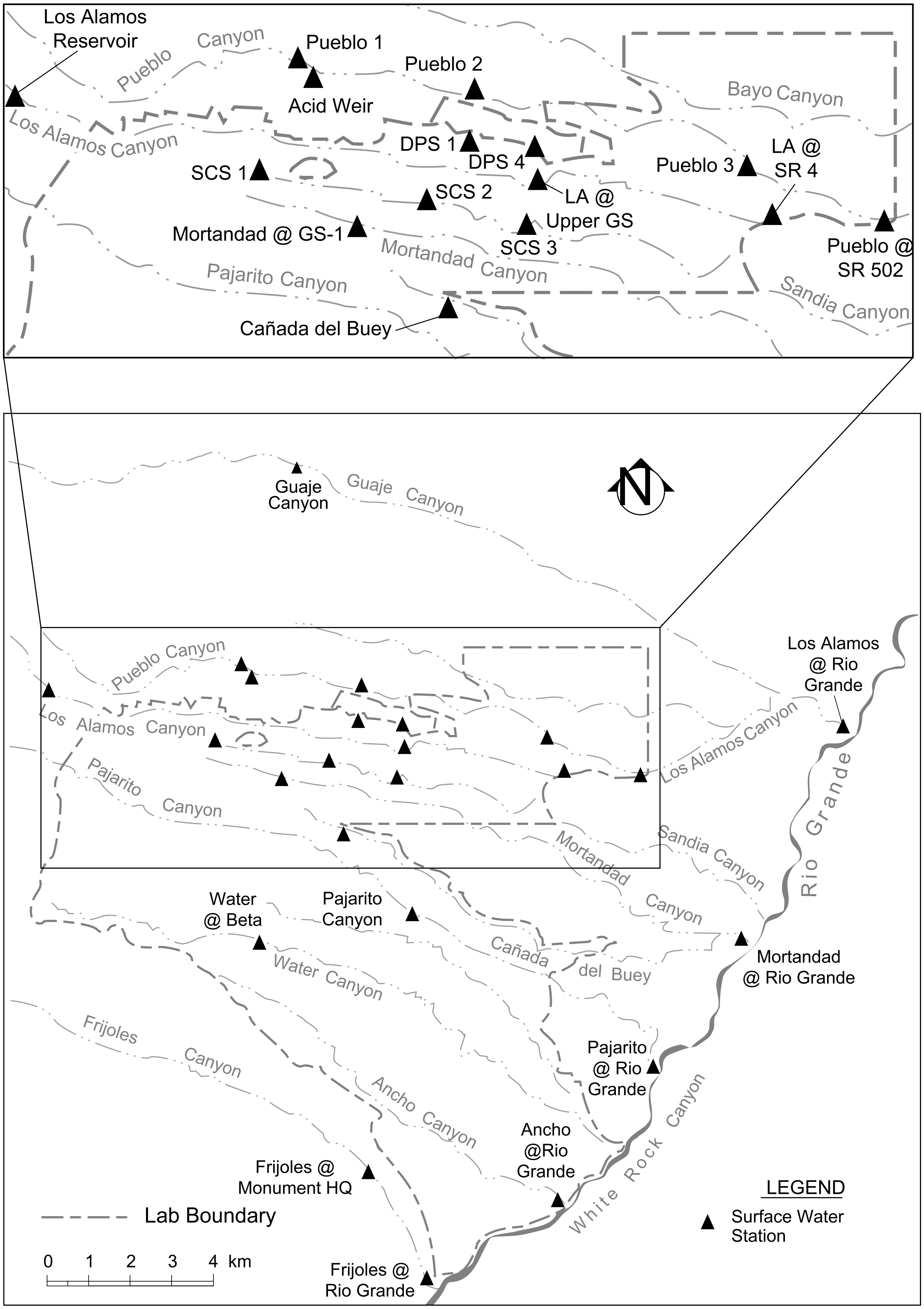


Figure 5-2. Surface water sampling locations in the vicinity of Los Alamos National Laboratory.

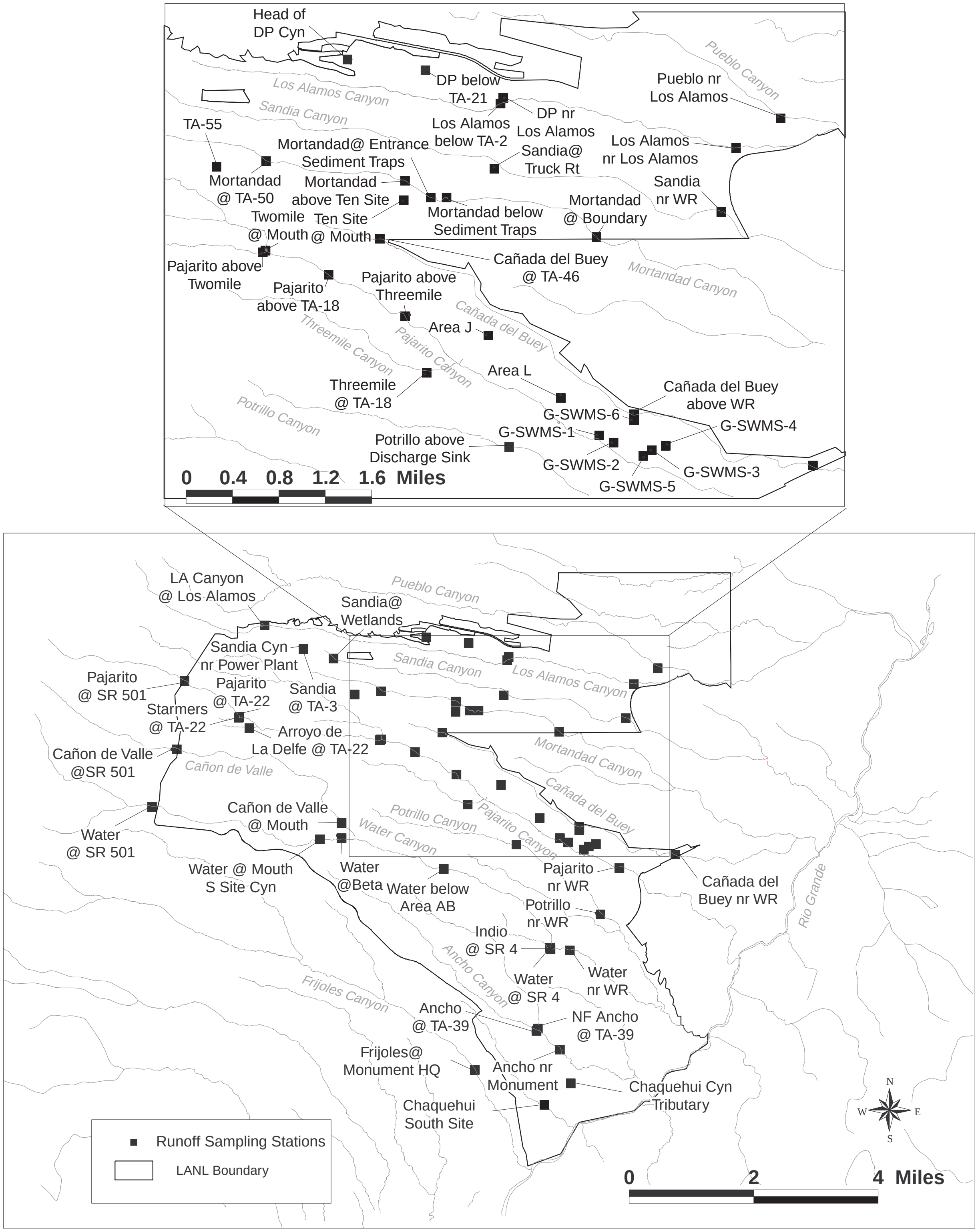


Figure 5-3. Runoff sampling stations in the vicinity of Los Alamos National Laboratory.

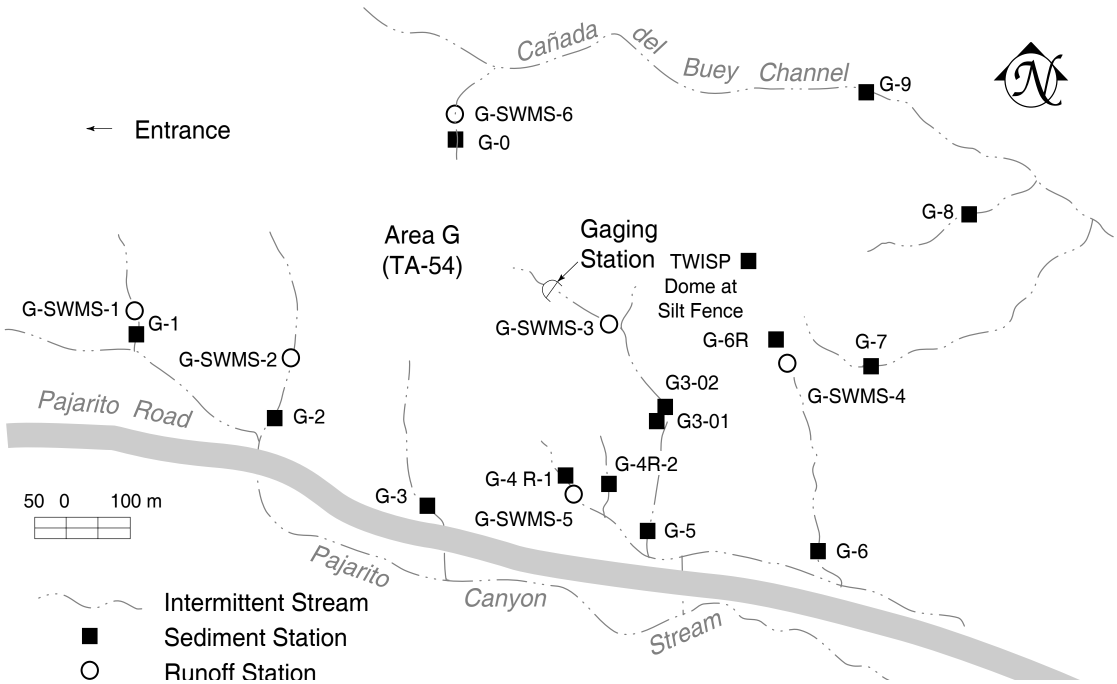


Figure 5-4. Sediment and runoff sampling stations at TA-54, Area G.

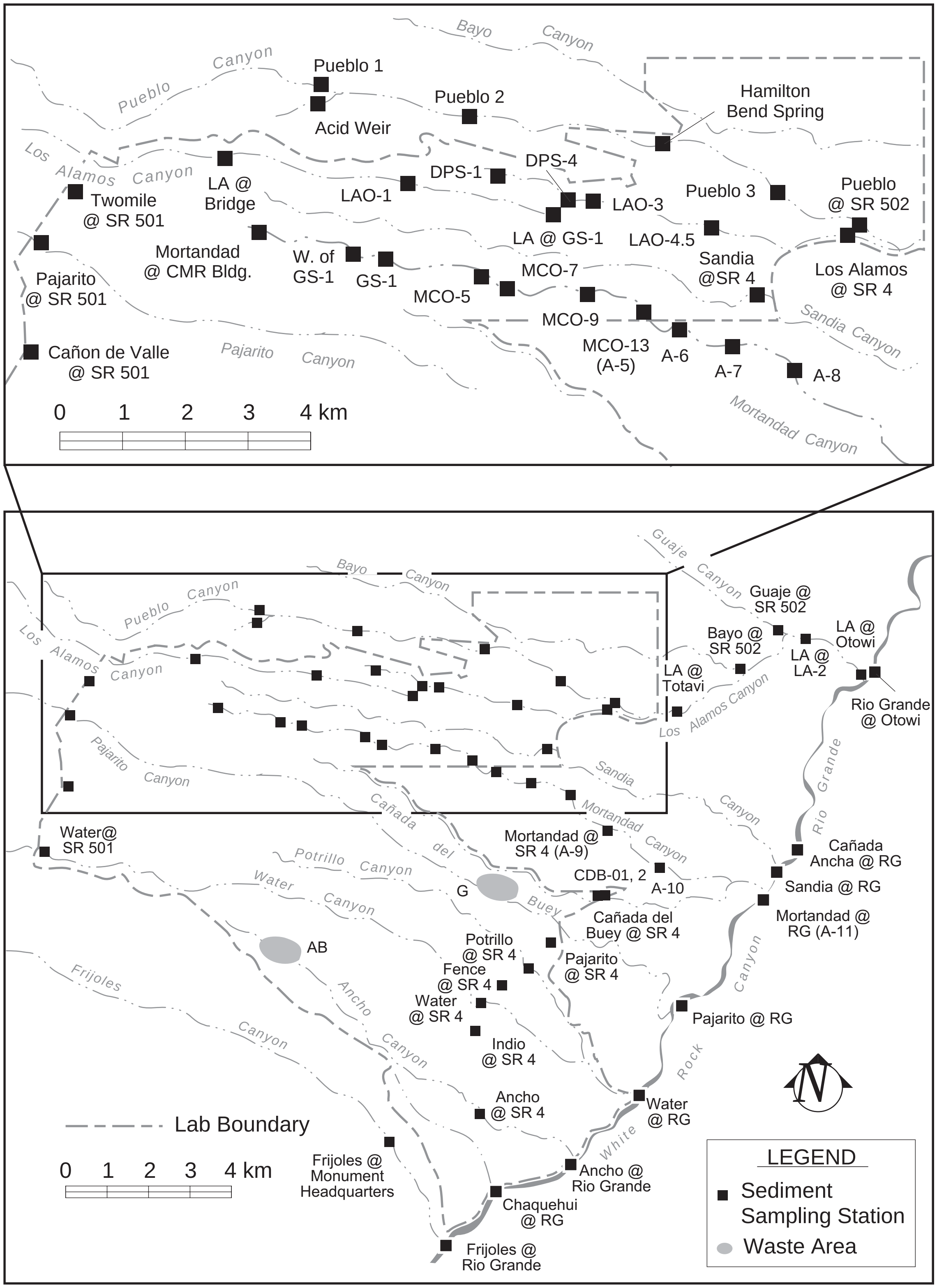


Figure 5-5. Sediment sampling stations on the Pajarito Plateau near Los Alamos National Laboratory.

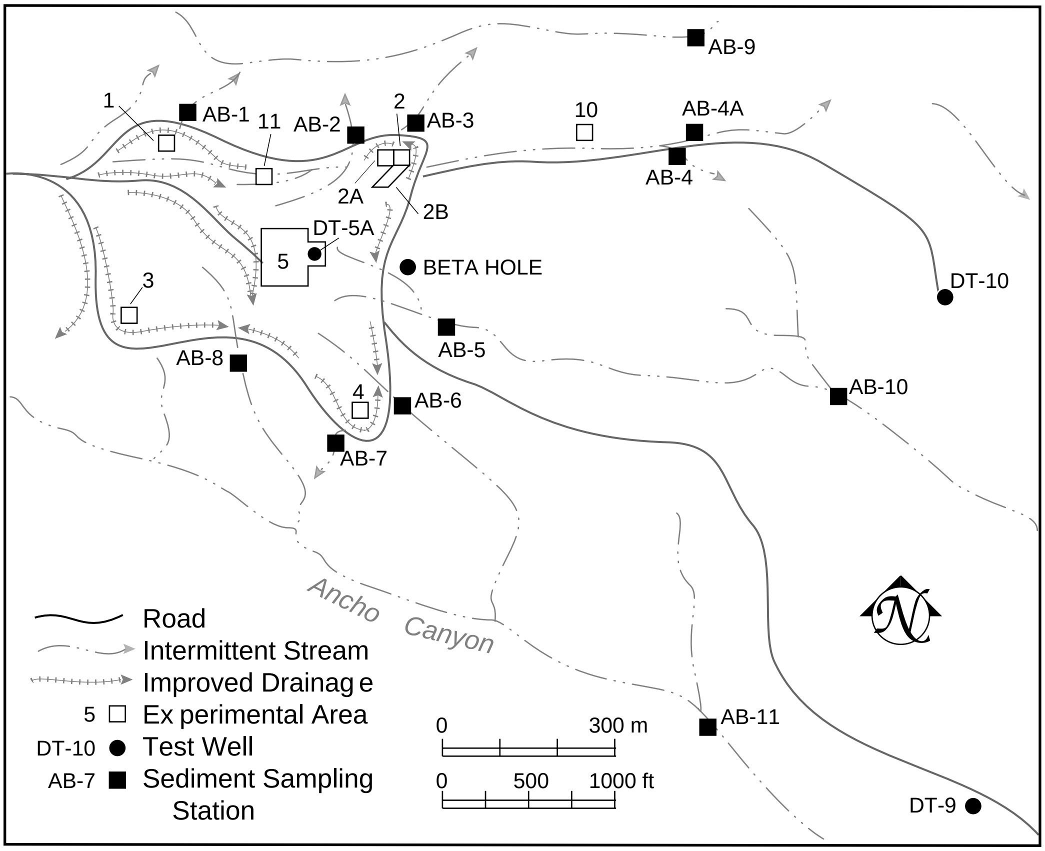


Figure 5-6. Sediment sampling stations at Technical Area 49, Area AB.

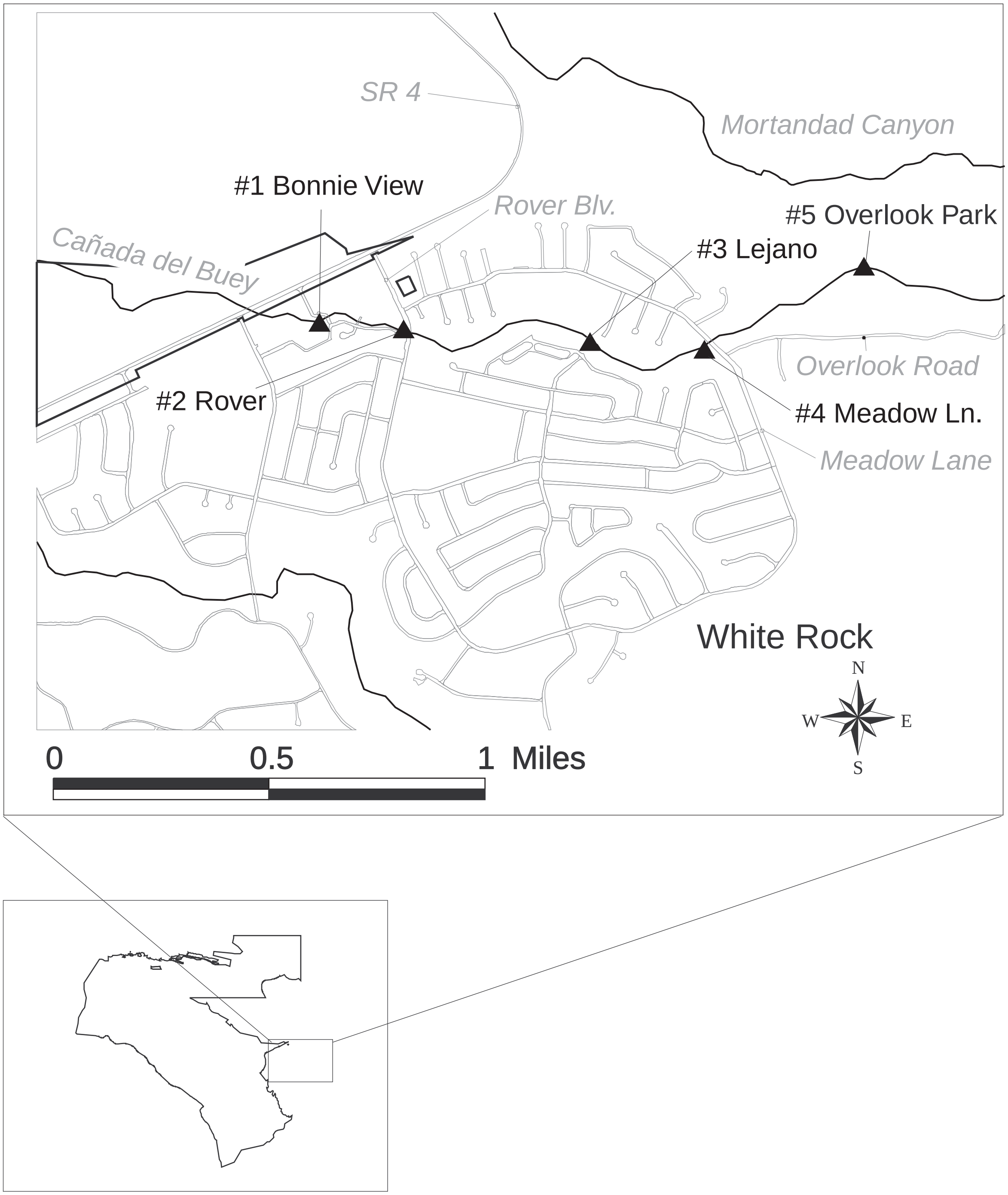


Figure 5-7. Special 1999 sediment sampling locations along Cañada del Buey in White Rock.

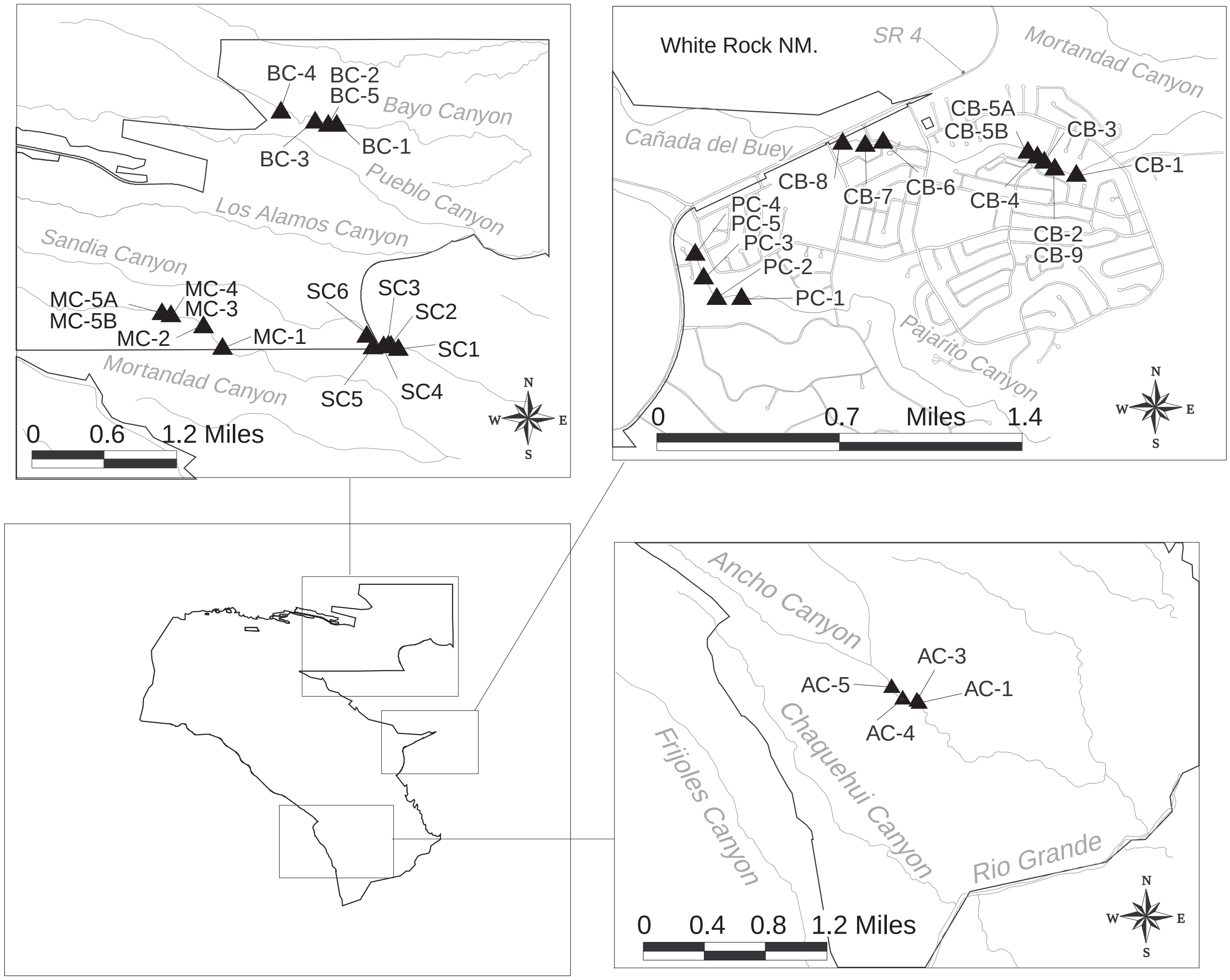
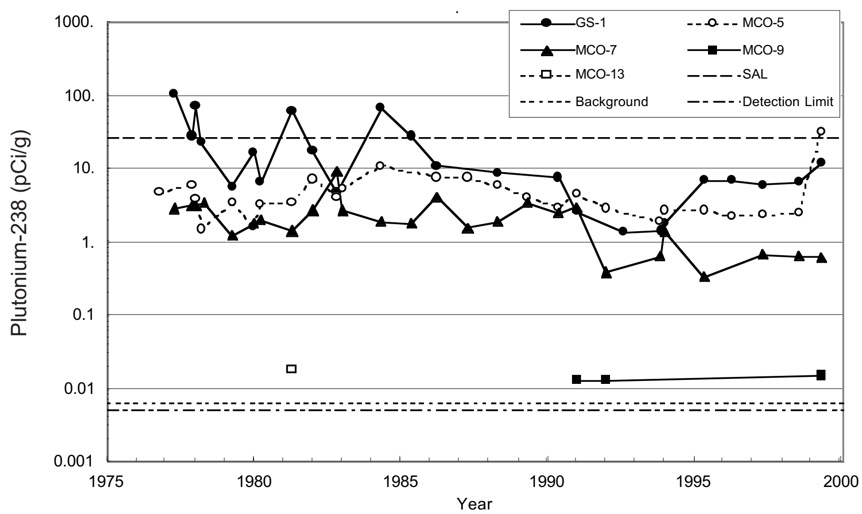
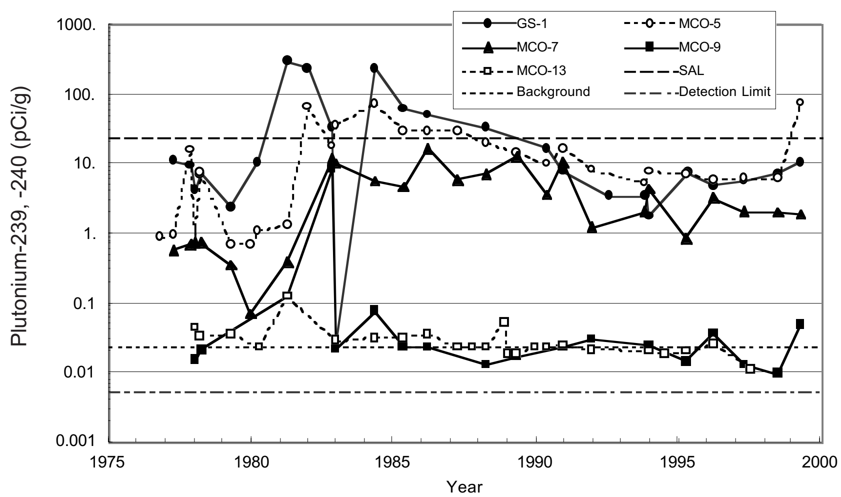


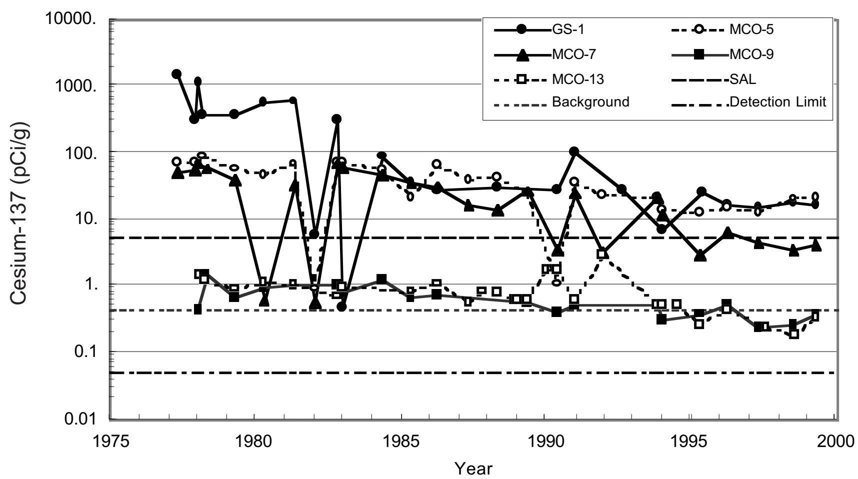
Figure 5-8. Special EPA sediment sampling stations for 1999.



a. Plutonium-238 on Laboratory lands in Mortandad Canyon.



b. Plutonium-239, -240 on Laboratory lands in Mortandad Canyon.



c. Cesium-137 on Laboratory lands in Mortandad Canyon.

Figure 5-9. Sediment radioactivity histories for stations located on Laboratory lands in Mortandad Canyon. Only detections are shown, although data are available for most years.

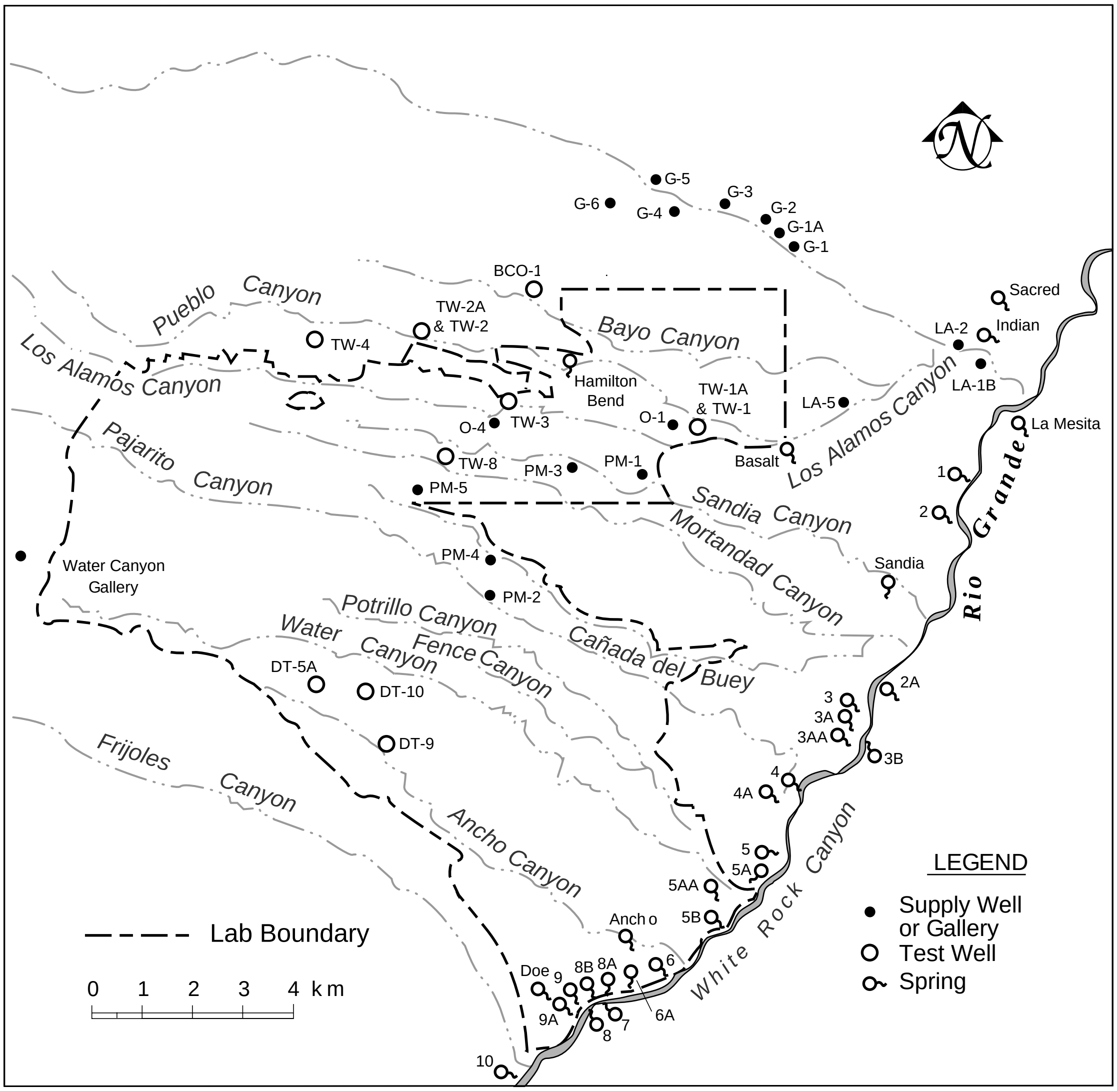


Figure 5-10. Springs and deep and intermediate wells used for groundwater sampling.

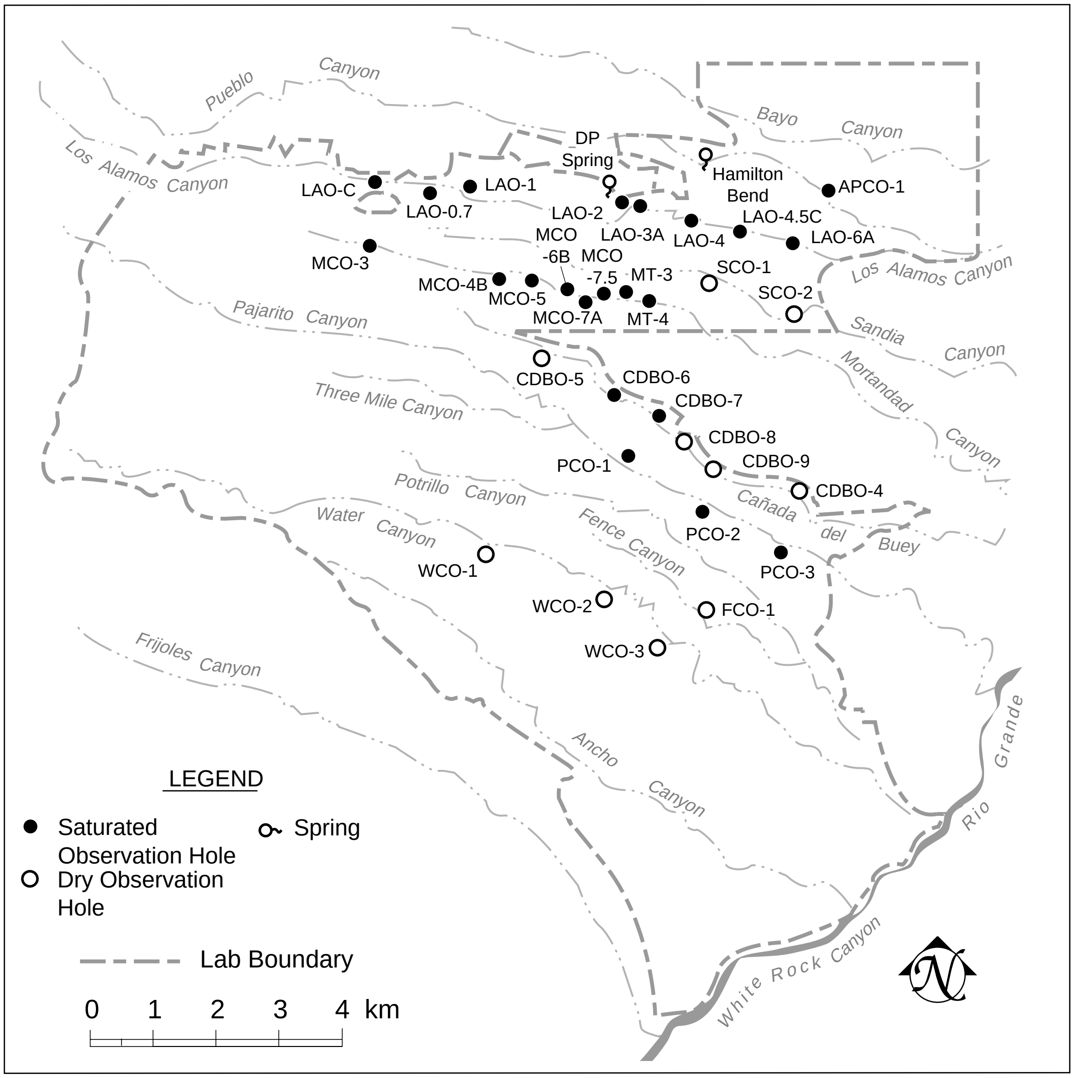
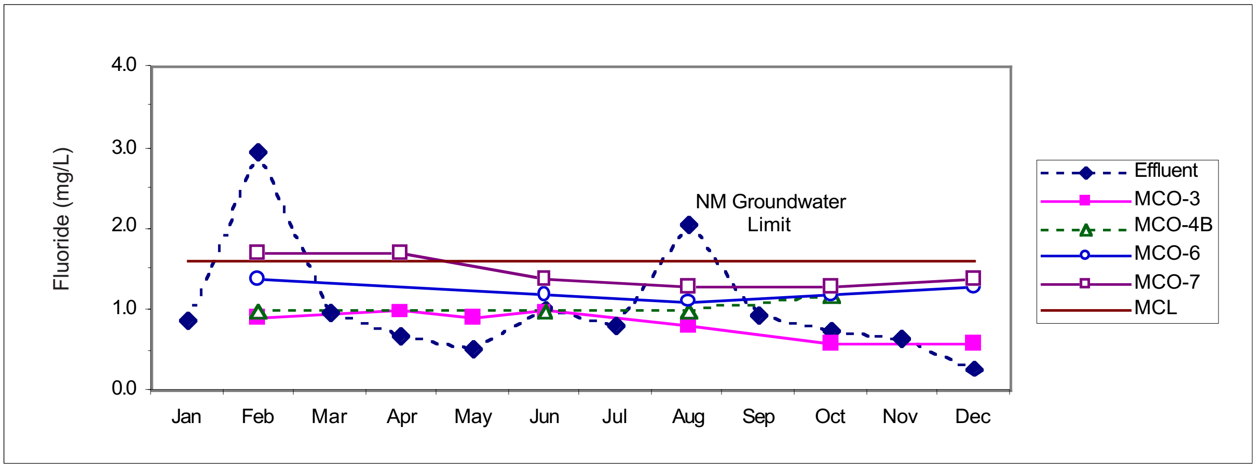
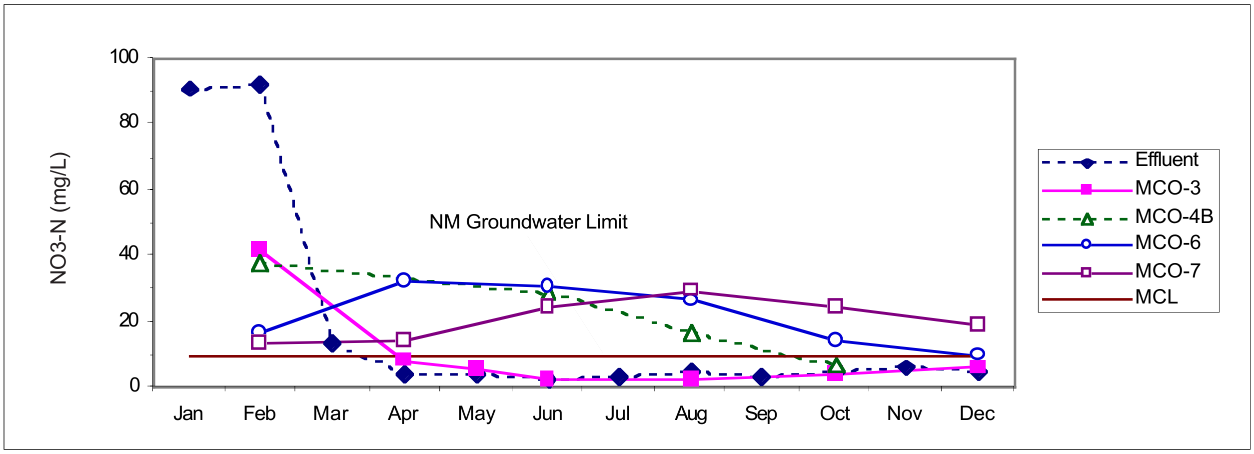


Figure 5-11. Observation wells and springs used for alluvial groundwater sampling.

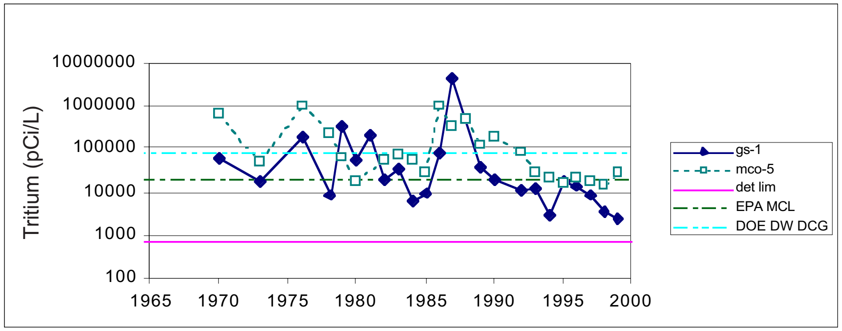


a. Fluoride

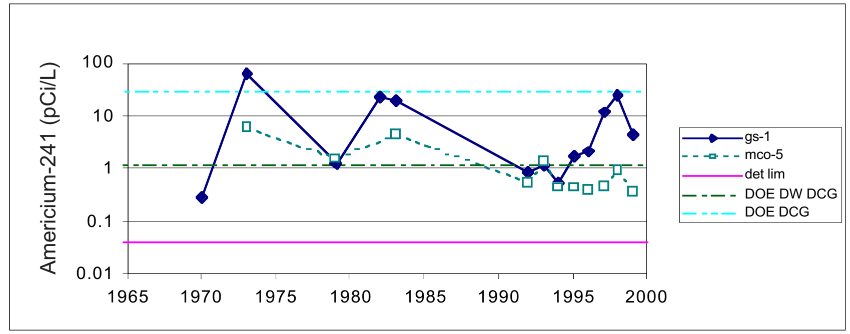


b. Nitrate

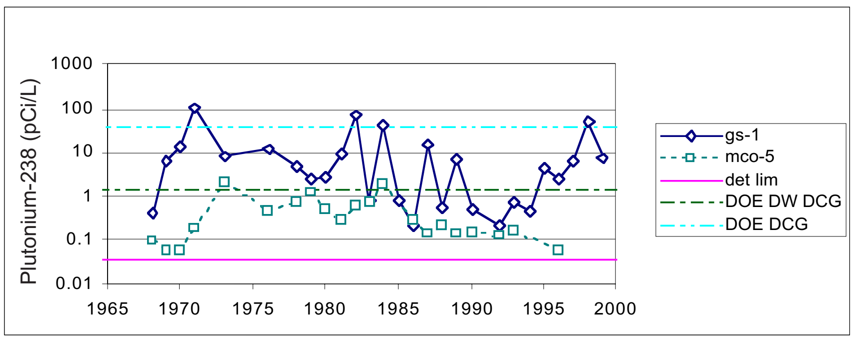
Figure 5-12. Fluoride and nitrate in Mortandad Canyon alluvial groundwater in 1999.



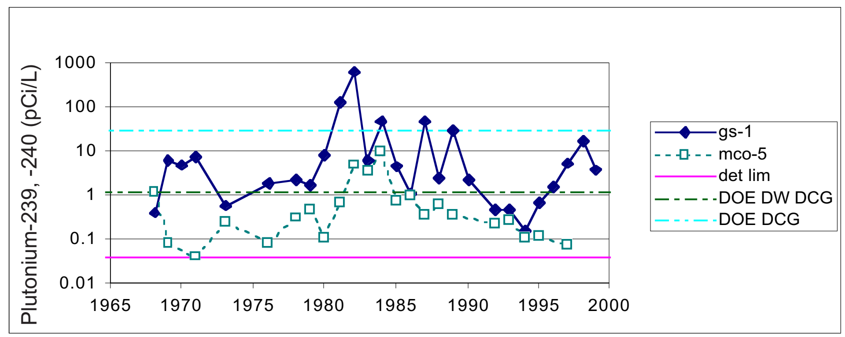
a. Mortandad Canyon tritium



b. Mortandad Canyon americium-241



c. Mortandad Canyon plutonium-238



d. Mortandad Canyon plutonium-239, -240

Figure 5-13. Annual average radioactivity in surface water and groundwater from Mortandad Canyon.

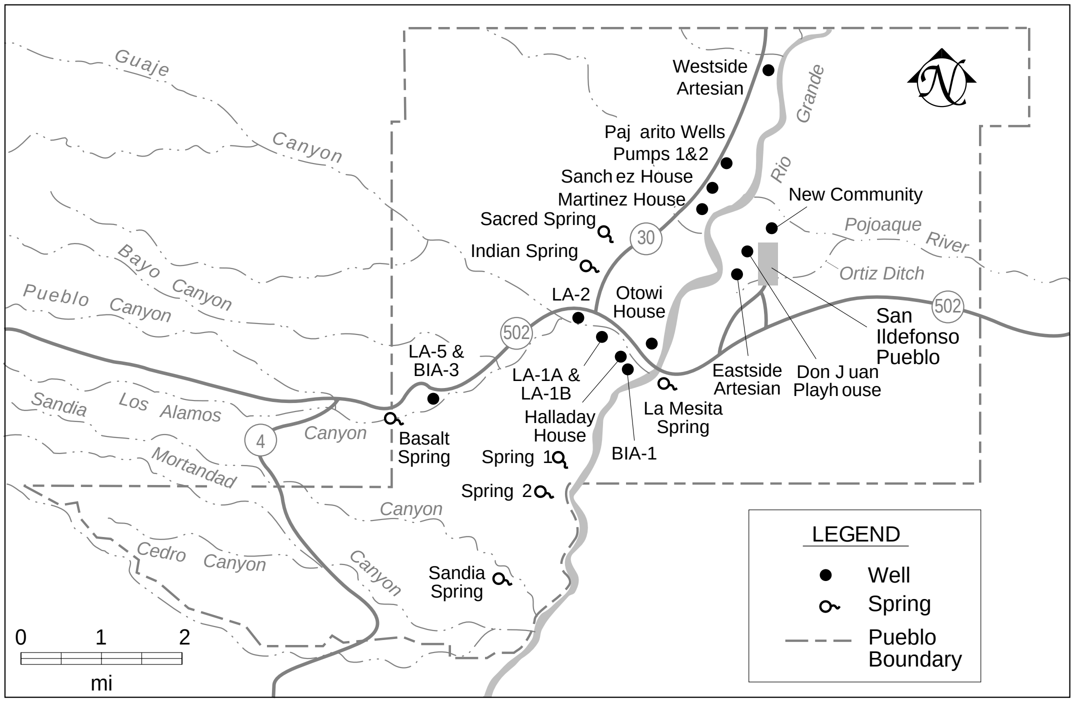


Figure 5-14. Springs and groundwater stations on or adjacent to San Ildefonso Pueblo land.

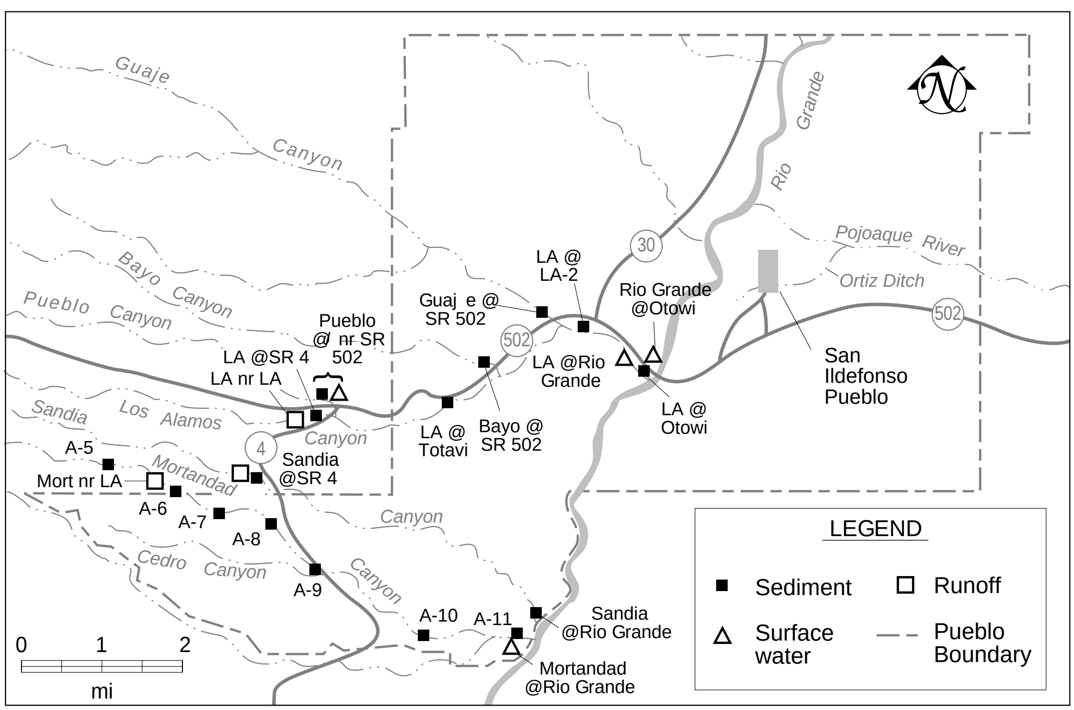


Figure 5-15. Sediment and surface water stations on or adjacent to San Ildefonso Pueblo land.

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6. Soil, Foodstuffs, and Associated Biota

6. Soil, Foodstuffs, and Associated Biota

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Abstract

Soil samples were collected from 12 on-site (Los Alamos National Laboratory [LANL or the Laboratory]) and 10 perimeter areas around the Laboratory, analyzed for radiological and nonradiological constituents, and compared with soils collected from regional background locations in northern New Mexico. Radionuclides in soils collected from regional background areas are presumably from natural sources and/or worldwide fallout. Most radionuclide concentrations in soils collected from on-site and perimeter areas were nondetectable (where the analytical results were less than three counting uncertainties) and/or within the upper range of background concentrations. Soils were also analyzed for trace elements, and most constituents, with the exception of lead in perimeter soils, were within background mean concentrations; lead concentrations, however, were well below LANL screening action levels.

Samples of foodstuffs and associated biota (produce, eggs, milk, fish, elk, deer, beef cattle, herbal tea, piñon, honey, and wild spinach) were collected from Laboratory and/or surrounding perimeter areas, including several Native American Pueblo communities, to determine the impact of LANL operations on the human food chain. In addition, biota (nonfoodstuffs) samples (understory and overstory vegetation and alfalfa forage) were collected. All radionuclides in foodstuffs and biota collected from the Laboratory and perimeter locations were low and, for the most part, were indistinguishable from worldwide fallout and/or natural sources. Plutonium-238 concentrations in produce collected from all perimeter sites, albeit low, were statistically higher than background concentrations and were higher than in past years. All trace elements, including lead, in produce collected from Laboratory and perimeter areas were within background concentrations.

Other environmental surveillance activities and special studies associated with the soils, foodstuffs, and biota programs included the determination of radionuclides and trace elements in soil, vegetation, bees, and small and large game mammals within and around Technical Area (TA) 54, Area G (the Laboratory's primary low-level radioactive waste disposal area) and DARHT (the Laboratory's Dual Axis Radiographic Hydrodynamic Test facility). Special contaminant studies included ecological risk assessments; organics in fish collected from the Rio Grande; depleted uranium effects on aquatic organisms; resource use, activity patterns, and disease analysis of elk; and polychlorinated biphenyl (PCB) concentrations in small mammals around the Laboratory. We also monitored reptiles, amphibians, and forest fire (fuel) risk to the Los Alamos region.

To Read About — **Turn to Page**

A. Soil Monitoring

1. Introduction

A soil sampling and analysis program provides the most direct means of determining the concentration/activity, inventory, and distribution of radionuclides and radioactivity around nuclear facilities (DOE 1991). This program is mandated by Department of Energy (DOE) Orders 5400.1 and 5400.5. Soil provides an integrating medium that can account for contaminants released to the atmosphere, either directly in gaseous effluents (such as air stack emissions) or indirectly from resuspension of on-site contamination (such as firing sites and waste disposal areas) or through liquid effluents released to a stream that is subsequently used for irrigation (Purtymun et al., 1987). The knowledge gained from a soil radiological sampling program is critical for providing information about potential pathways (such as soil ingestion, food crops, resuspension into the air, and contamination of groundwater) that may result in a radiation dose to a person (Fresquez et al., 1998a).

The main objectives of this program include an evaluation of (1) radionuclides, radioactivity, and nonradionuclides (light, heavy, and nonmetal trace elements) in soils collected from regional (background) locations, around the perimeter of Los Alamos National Laboratory (LANL or the Laboratory), and on-site; (2) trends over time (that is, whether radionuclides and nonradionuclides are increasing or decreasing over time); and (3) committed effective dose equivalent (CEDE) to surrounding area residents. We compare on-site and perimeter areas with regional background areas located at such a distance from the Laboratory that their radionuclide and nonradionuclide contents are mostly due to naturally occurring elements and/or to worldwide fallout. See Chapter 3 for potential radiation doses to individuals from exposure to soils.

2. Monitoring Network

Soil surface samples (0- to 2-in. depth) are collected from relatively level, open, and undisturbed areas at regional background locations (3 sites), LANL's perimeter (10 sites), and at LANL (12 sites) (see Figure 6-1). Areas sampled at LANL are not from solid waste management units (SWMUs). Instead, the majority of on-site soil-sampling stations are located on mesa tops close to and downwind from major facilities and/or operations at LANL in an effort to assess radionuclides, radioactivity, and trace elements (light, heavy, and nonmetal) in soils that may have been contaminated as a result of air stack emissions and fugitive dust (the resuspension of dust from SWMUs and active firing sites).

The 10 perimeter stations are located within 4 km (2.5 mi) of the Laboratory. These stations reflect the soil conditions of the inhabited areas to the north (Los Alamos townsite area—four stations) and east (White Rock area and San Ildefonso Pueblo lands—four stations) of the Laboratory. The other two stations, one located on Forest Service land to the west and the other located on Park Service land (Bandelier) to the southwest, provide additional coverage. Soil samples from all these areas are compared with soils collected from regional background locations in northern New Mexico surrounding the Laboratory where radionuclides, radioactivity, and trace elements are from natural and/or worldwide fallout events; these areas are located around Embudo to the north, Cochiti to the south, and Jemez to the southwest. All are more than 32 km (20 mi) from the Laboratory and are beyond the range of potential influence from normal Laboratory operations (DOE 1991).

3. Sampling Procedures, Data Management, and Quality Assurance

Collection of samples for chemical analyses follows a set procedure to ensure proper collection, processing, submittal, and posting of analytical results. Stations and samples have unique identifiers to provide chain-of-custody control from the time of collection through analysis and reporting. All quality assurance/quality control (QA/QC) protocols, chemical analyses, data handling, validation, and tabulation can be found in the Ecology Group (ESH-20) operating procedure (OP) entitled "Soil Sampling for the Soil Monitoring Program," LANL-ESH-20-SF-OP-007, R0, 1997.

4. Radiochemical Analytical Results

Table 6-1 shows data from soils collected in 1999. Most radionuclide concentrations (activity) and radioactivity in soils collected from on-site and perimeter stations were low (pCi), and most were nondetectable (i.e., the analytical result was lower than three times the counting uncertainty = 99% confidence level) (Corely et al., 1981) and/or within regional statistical reference levels (RSRLs). The RSRL is the upper-limit background concentration (mean plus two standard deviations) (Purtymun et al., 1987) from data collected from regional background areas from 1995 through 1999 for worldwide fallout and natural sources of tritium; strontium-90; cesium-137; americium-241; plutonium-238; plutonium-239, -240; total uranium; and gross alpha, beta, and gamma radioactivity.

Strontium-90 concentrations in soils from all locations, including regional background areas, were significantly higher than in past years (ESP 1997, 1998) and appear to be positively biased; the data, therefore, were not given in Table 6-1. The reasons that strontium-90 concentrations appear to be positively biased include (1) the mean strontium-90 concentrations from all locations, including regional background areas, were 15 to 18 times higher than in past years (e.g., 1996); (2) strontium-90, which is principally a beta emitter, was higher than gross (total) beta activity in soils from most sites; (3) split samples from New Mexico Environment Department (NMED) show significantly lower concentrations similar to past years (Table 6-2); and (4) trend analysis using strontium-90 data from 1974 to 1996 shows that strontium-90 concentrations in soils from all sites were in a decreasing mode (Fresquez et al., 1998a). Instead, soil strontium-90 concentrations averaged over the past four years before 1997 for all sites were given in Table 6-1; these data were given for dose assessment purposes. Positively biased strontium-90 data are given in Table 6-2 along with split sample data from NMED for statistical comparison purposes and reference, respectively. (Note: The strontium-90 positive bias was believed to result from a laboratory analysis problem, and actions have since been taken to correct the problem.)

As a group, the average concentrations of strontium-90 (Table 6-2) and total uranium, plutonium, and gross gamma activity in soils collected from on-site and/or perimeter areas were significantly higher ($p<0.05$ = the 95% confidence level) than concentrations in soils from background locations. It should be noted that, although the concentrations of strontium-90 in soils collected from all sites appear to be positively biased, they still can be statistically compared against one another to assess the contribution of Laboratory operations, if any, because all factors associated with sampling, processing, and analysis were the same. Although the mean concentrations of these radionuclides were statistically higher than background, the differences in concentrations, including strontium-90, between the sites were very small. Also, mean concentrations/activity of all radionuclides (strontium-90 was not considered because the data are biased high) were far below LANL screening action levels (SALs). LANL SALs, developed by the Environmental Restoration Project at the Laboratory, identify the presence of contaminants of concern and are derived from a risk assessment pathway based on a 10 mrem/y dose.

The slightly higher strontium, plutonium, and gamma activity in soils from on-site and/or perimeter areas as compared with regional background locations may be, in part, due to Laboratory operations but is probably more related to worldwide fallout. Radionuclides caused by fallout vary from one area to another depending on wind patterns, elevation, and precipitation (Whicker and Schulz 1982). Typically, higher amounts of fallout occur at higher elevations that receive more precipitation. Most of the regional background areas lie at elevations of 5,600 to 6,300 ft and receive approximately 10 in. of precipitation per year (Bowen 1990), whereas the on-site and perimeter areas lie at elevations of 6,500 to 7,500 ft and receive 14 to 19 in. of precipitation per year. The higher levels of uranium detected in the soil samples collected from the on-site and perimeter areas may be a result of differences in the geology or mineralogy of the soils between the areas. Soils in the Los Alamos area are derived from Bandelier (volcanic) tuff and have higher-than-average natural uranium concentrations, ranging from 3 to 11 μg of uranium per gram of soil (Crowe et al., 1978).

5. Nonradiochemical Analytical Results

We analyzed soils for light, heavy, and nonmetal trace elements. The results of the 1999 soil-sampling program can be found in Table 6-3. In general, five out of the 11 trace elements measured in surface soils collected from regional background, perimeter, and on-site stations were below the limits of detection (LOD). Of those elements that were above the LOD, most of those in soils collected from on-site and perimeter areas were within RSRLs and were within the range of metals normally encountered in the Los Alamos area (Ferenbaugh et al., 1990) and the continental United States (Shacklette and Boerngen 1984). The RSRLs were derived from regional background locations averaged over eight years (1992–1999).

As a group, chromium concentrations in soils collected from background areas were significantly higher ($p<0.05$) than chromium in soils from both perimeter and on-site locations, and lead concentrations in soils from perimeter areas were significantly higher than background and on-site soils. The differences in lead in soils between the sites, however, were very low, and they were far below SALs.

6. Long-Term Trends

We performed a Mann-Kendal test for trend analysis on radionuclides and radioactivity in soils collected from on-site and perimeter stations from 1974 through 1996 (Fresquez et al., 1998a). Although some radionuclide and radioactivity levels were generally higher in on-site and perimeter soils when compared with background levels, most radionuclides, with the exception of plutonium-238 in soils from perimeter areas, exhibited decreasing concentrations over time. The statistically significant (but very small) increase of plutonium-238 in perimeter soils over this interval may be related to the resuspension and redistribution of global fallout. Plutonium-238 and plutonium-239, -240 in soils from background areas also exhibited statistically increasing trends; however, the plutonium levels in background soils were still well within worldwide fallout concentrations.

The decreasing concentrations of the other isotopes in soils collected from perimeter and on-site areas over time may be a result of (1) cessation of aboveground nuclear weapons testing in the early 1960s, (2) weathering (water and wind erosion and leaching), (3) radioactive decay (half-life), and (4) reductions in operations and/or better engineering controls employed by LANL. Tritium, which has a half-life of about 12 years, exhibited the greatest decrease in activity over the 20-plus-year period of this study at all three areas: background, perimeter, and on-site. Indeed, by 1996, the majority of radionuclide and radioactivity values in soils collected from both perimeter and on-site areas were statistically similar to values detected in regional background locations. It should be noted that concentrations of most radionuclides in 1999, with the exception of strontium-90 because it is positively biased, are lower or similar to concentrations in 1996.

B. Foodstuffs Monitoring

1. Introduction

A wide variety of wild and domestic edible plant, fruit, and animal products are grown and/or harvested in the area surrounding the Laboratory. Ingestion of foodstuffs constitutes a critical pathway by which radionuclides can be transferred to humans (Whicker and Schultz 1982). For this reason, we collect samples of a wide host of foodstuffs (e.g., milk, eggs, produce [wild and domestic fruits, vegetables, and grains], fish, honey, herbal teas, mushrooms, piñon, domestic animals, and large and small game animals) on a systematic basis from Laboratory property and from the surrounding communities. DOE Orders 5400.1 and 5400.5 mandate this Foodstuffs Monitoring program.

The three main objectives of the program are to determine (1) radioactive and nonradioactive (light, heavy, and nonmetal trace elements) constituents in foodstuffs from on-site LANL, perimeter, and regional background areas; (2) trends; and (3) dose. Chapter 3 presents potential radiation doses to individuals from the ingestion of foodstuffs.

2. Produce

a. Monitoring Network. We collect fruits, vegetables, and grains each year from on-site, perimeter, and regional background locations (Figure 6-2). Samples of produce are also collected from Cochiti and San Ildefonso Pueblos, which are located in the general vicinity of LANL. We compare produce from areas within and around the perimeter of LANL with produce collected from regional background gardens in northern New Mexico; these gardens are located in the Española, Santa Fe, and Jemez Pueblo areas. The regional sampling locations are far enough from the Laboratory that they are unaffected by Laboratory airborne emissions.

b. Sampling Procedures, Data Management, and Quality Assurance. Produce samples are collected from local gardens within and around the perimeter of the Laboratory in the summer and fall of each year. All QA/QC protocols, chemical analyses, data handling, validation, and tabulation can be found in the ESH-20 OP entitled, "Produce Sampling and Processing for the Foodstuffs Monitoring Program," LANL-ESH-20-SF-OP-001, R0, 1997.

c. Radiochemical Analytical Results. See Table 6-4 for concentrations of radionuclides in produce collected from on-site, perimeter, and regional background locations during the 1999 growing season. All radionuclide concentrations in fruits and vegetables collected from on-site and perimeter areas were low, and most, with the exception of plutonium-238, were nondetectable and/or within RSRLs. Tritium data in produce from all sites appear to be negatively biased (over one-half of the samples are negative) and were not reported in Table 6-4. Data for tritium in produce collected during the 1999 growing season, instead, can be found in Table 6-5 and are given for statistical comparison purposes only. It should be noted that, although the concentrations of tritium in produce collected from all sites appear to be negatively biased, they still can be statistically compared against one another to assess contributions from Laboratory operations, if any, because all factors associated with sampling, processing, and analysis were the same.

As a group, most radionuclides, including tritium, in produce collected from on-site and perimeter areas were not significantly higher ($p<0.05$) than produce collected from regional background locations. The only radionuclide in produce that was statistically higher between sites was plutonium-238; concentrations of plutonium-238 were significantly higher in produce from all of the perimeter areas compared with regional background. The differences between sites, however, were low. The mean plutonium-238 concentration in produce from on-site areas was not significantly higher than background and significantly lower than produce from most of the perimeter areas. The fact that on-site produce was significantly lower in plutonium-238 concentrations than produce collected from the perimeter areas, however, may be a reflection of the variety of foodstuffs collected between the two sites; more fruits than vegetables were collected on LANL lands, whereas more vegetables than fruits were collected on perimeter lands. The source of the higher concentrations of plutonium-238 in produce from all of the perimeter areas is not completely known as all of the other radionuclides in produce from the perimeter areas collected this year are similar to background concentrations and are on the same order as in past years.

d. Nonradiochemical Analytical Results. The trace elements silver, arsenic, beryllium, cadmium, chromium, mercury, nickel (for the most part), selenium, and thallium in produce from on-site, perimeter, and regional background locations were below the LOD (Table 6-6). In those cases where produce samples contained trace elements above the LOD (for barium, lead, and zinc), very few individual samples exceeded RSRLs. As a group, the levels of barium, lead, and zinc in produce from on-site and perimeter areas were not significantly higher ($p<0.05$) than in produce collected from regional background areas.

3. Eggs

a. Monitoring Network. We collected fresh eggs from free-ranging chickens in the Los Alamos townsite, the White Rock/Pajarito Acres townsite, and San Ildefonso Pueblo. We compared these eggs with eggs produced from free-range chickens located in the Española area.

b. Sampling Procedures, Data Management, and Quality Assurance. We collected 24 medium-sized eggs from four locations directly from the farmer. All QA/QC protocols, chemical analyses, data handling, validation, and tabulation can be found in the ESH-20 OP entitled, “Egg Sampling and Processing for the Foodstuffs Monitoring Program,” LANL-ESH-20-SF-OP-006, R0, 1997.

c. Radiochemical Analytical Results. Table 6-7 contains the results of radionuclide concentrations in eggs collected from Los Alamos townsite, White Rock/Pajarito Acres townsite, San Ildefonso Pueblo, and Española (background) in 1999. All radionuclide concentrations in eggs collected from all locations were low, similar to past years, and most were nondetectable and/or within upper-level background concentrations. Only plutonium-238 in eggs from White Rock/Pajarito Acres was above RSRLs. The differences in plutonium-238 concentrations in eggs collected from White Rock/Pajarito Acres and background areas, however, were very low—a difference of 0.021 pCi/L.

4. Milk

a. Monitoring Network. We collected goat milk from Los Alamos and White Rock/Pajarito Acres and compared it with goat milk collected from a dairy located near Albuquerque, NM.

b. Sampling Procedures, Data Management, and Quality Assurance. We collected milk directly from the farmers. All QA/QC protocols, chemical analyses, data handling, validation, and tabulation can be found in the ESH-20 OP entitled, “Milk and Tea Sampling and Processing for the Foodstuffs Monitoring Program,” LANL-ESH-20-SF-OP-005, R0, 1997.

c. Radiochemical Analytical Results. Table 6-8 presents the results of the radiochemical analysis performed on goat milk collected from the perimeter areas and Albuquerque (background) in 1999. All radionuclides, including iodine-131, in goat milk from the perimeter areas were low and were nondetectable and/or within upper-level background concentrations. Tritium and strontium-90 levels, in particular, are similar to tritium and strontium-90 levels in milk from other states around the country (Black et al., 1995).

5. Fish

a. Monitoring Network. We collect fish annually upstream and downstream of the Laboratory (Figure 6-2). Cochiti Reservoir, a 10,690-acre flood and sediment control project, is located on the Rio Grande approximately five miles downstream from the Laboratory. We compared radionuclides and nonradionuclides (mostly mercury) in fish collected from Cochiti Reservoir with fish collected from background reservoirs. These background reservoirs are the Abiquiu, Heron, and El Vado Reservoirs, which are located on the Rio Chama, upstream from the confluence of the Rio Grande and intermittent streams that cross Laboratory lands (Fresquez et al., 1994).

The samples include two types of fish: game and nongame (bottom-feeders). Game fish include rainbow trout, brown trout, kokanee salmon, largemouth bass, smallmouth bass, white crappie, and walleye. Nongame fish include the white sucker, channel catfish, carp, and carp sucker.

b. Sampling Procedures, Data Management, and Quality Assurance. Fish were collected by gill nets and transported under ice to the laboratory for preparation. At the laboratory, fish were gutted, had head and tail removed, and were washed. Muscle (plus associated bone) tissue for radiochemical analysis is submitted as ash, and muscle (filet) is submitted in a wet frozen state for mercury analysis. All QA/QC protocols, chemical analyses, data handling, validation and tabulation can be found in the ESH-20 OP entitled, "Fish Sampling and Processing for the Foodstuffs Monitoring Program," LANL-ESH-20-SF-OP-002, R0, 1997.

c. Radiochemical Analytical Results. Table 6-9 presents concentrations of radionuclides in game and nongame fish collected upstream and downstream of the Laboratory in 1999. The data sets for tritium and americium-241 in fish from both reservoirs appear to be negatively biased and were not presented in Table 6-9. Instead, these data are given in Table 6-10 for statistical comparison purposes only.

In general, all radionuclides in game and nongame fish collected from Cochiti Reservoir were low, and most were nondetectable and/or within upper-level background concentrations. These results were similar to radionuclide contents in crappie, trout, and salmon from comparable (background) reservoirs and lakes in Colorado (Whicker et al., 1972; Nelson and Whicker 1969) and, more recently, in fish collected along the length of the Rio Grande from Colorado to Texas (Booher et al., 1998) and from the confluences of some of the major canyons that cross LANL lands with the Rio Grande (Fresquez et al., 1999c).

Although the concentrations of tritium and americium-241 in fish collected from Cochiti and Abiquiu Reservoirs appear to be negatively biased, they still can be statistically compared against one another to assess contributions from Laboratory operations, if any, because all factors associated with sampling, processing, and analysis were the same. Accordingly, both game and nongame fish collected downstream of LANL at Cochiti reservoir were not significantly higher ($p<0.05$) in radionuclide concentrations, including tritium and americium-241, than were fish collected upstream of LANL at Abiquiu Reservoir.

As expected, the nongame fish from both downstream and upstream reservoirs from LANL contained higher average uranium contents (15.2 ng per dry gram) than the surface-feeders (3.8 ng per dry gram). The higher concentration of uranium in bottom-feeding fish compared with surface-feeding fish is attributed to the ingestion of sediments on the bottom of the lake (Gallegos et al., 1971). Radionuclides readily bind to sediments (Whicker and Schultz 1982).

d. Long-Term (Radionuclide) Trends. Fresquez et al. (1994) conducted a summary and trend analysis of radionuclides in game and nongame fish collected from reservoirs upstream (Abiquiu, Heron, and El Vado Reservoirs) and downstream (Cochiti Reservoir) of LANL from 1981 to 1993. In general, the average levels of strontium-90; cesium-137; plutonium-238; and plutonium-239, -240 in game and nongame fish collected from Cochiti Reservoir were not significantly different from concentrations in fish collected from reservoirs upstream of the Laboratory. Total uranium was the only radionuclide that was found to be significantly higher in both game and nongame fish from Cochiti Reservoir when compared with fish from Abiquiu, Heron, and El Vado Reservoirs. Uranium concentrations in fish collected from Cochiti Reservoir, however, significantly ($p<0.05$) decreased from 1981 to 1993, and we found no evidence of depleted uranium in fish samples collected from Cochiti Reservoir in 1993 (Fresquez and Armstrong 1996). Concentrations of most radionuclides in fish collected in 1999 are similar to radionuclides in fish collected in 1993. Other fish studies in the area around LANL for long-term reference include Fresquez et al. (1996) and Fresquez et al. (1998c).

e. Nonradiological Analytical Results. The results of the trace element analysis in fish samples from Cochiti and Abiquiu Reservoirs in past years showed that mercury was the only element to be detected above the minimum level of detection (Table 6-11). All concentrations of mercury in fish from Cochiti Reservoir collected in 1999 were within the RSRL (<0.41μg mercury per wet gram), and fish collected from Abiquiu Reservoir were significantly higher ($p<0.05$) in mercury concentrations than fish collected downstream of the Laboratory at Cochiti Reservoir.

f. Long-Term (Nonradiological) Trends. Fresquez et al. (1999e) conducted a summary and trend analysis of major trace elements, with special reference to mercury, in game and nongame fish collected from Abiquiu, Heron, and El Vado Reservoirs upstream of LANL (hereafter referred to collectively as Abiquiu) and Cochiti Reservoir downstream of LANL from 1991 to present. With the exception of mercury, most trace elements in fish collected from Abiquiu and Cochiti over a nine-year period were below the LOD. Mean mercury concentrations in all years in fish from Abiquiu, upstream of LANL, were generally higher than mercury concentrations in fish from Cochiti, and the statistical analysis of the mean of means showed that mercury in fish from Abiquiu was significantly higher ($p<0.10$) than mercury in fish collected from Cochiti. The highest individual mercury concentrations [1.0 µg/g wet weight] were detected in a single catfish each from Abiquiu and Cochiti in 1994, and the only carnivorous fish collected, brown trout from Abiquiu and white crappie from Cochiti in 1991, contained 0.30 and 0.36 µg/g wet weight of mercury, respectively.

Mean concentrations of mercury in fish from both Abiquiu and Cochiti were within mercury concentrations typical of fish from nonpolluted fresh water systems (Abernathy and Cumbie 1977) and below the US Food and Drug Administration’s ingestion limit of 1 µg mercury/g wet weight (Torres 1998). Concentrations of mercury in catfish from this study were very similar to mercury levels in catfish recently collected from Conchas Lake, which averaged 0.25 µg/g wet weight, and Santa Rosa Lake, which ranged from 0.22 to 0.33 µg/g wet weight (Bousek 1996; Torres 1998). These authors concluded that health risks to the average sport fisherman posed by mercury in fish from Conchas and Santa Rosa Lakes were negligible.

Overall, mean mercury concentrations in fish collected from both reservoirs show significantly decreasing trends over time; Abiquiu ($p = 0.045$) was significant at the 0.05 probability level and Cochiti ($p = 0.066$) was significant at the 0.10 probability level. It is not completely known why concentrations of mercury are decreasing in fish collected from Abiquiu and Cochiti, but the reduction of emissions in coal-burning power plants and/or the reduction of carbon sources within the reservoirs may be part of the reason. Since the early 1980s, for example, coal-burning power plants in the northwest corner of New Mexico have been required to install venturi scrubbers and baghouses to capture particulates and reduce air emissions (Martinez 1999). Additionally, because the conversion of mercury to methyl mercury is primarily a biological process, it has been demonstrated that mercury concentrations in fish tissue rise significantly in impoundments that form behind new dams and then gradually decline to an equilibrium level as the carbon provided by flooded vegetation is depleted (NMED 1999).

6. Game Animals (Elk and Deer)

a. Monitoring Network. Mule deer and Rocky Mountain elk are common inhabitants of LANL. Resident populations of deer number from 50 to 100; elk number from 100 to 200 and increase to as many as 2,000 animals during the winter months (Fresquez et al., 1999d). We collected samples of elk and deer as roadkill on an annual basis from Laboratory areas and analyzed the meat and bone for a host of radionuclides. We compared these data from meat and bone samples with radionuclide concentration in meat and bone samples from elk and deer collected from regional background locations.

b. Sampling Procedures, Data Management, and Quality Assurance. We collected samples of elk and deer meat and bone tissue (1000 g each) from fresh roadkills around and within the Laboratory. The New Mexico Department of Game and Fish collected background samples. All QA/QC protocols, chemical analyses, data handling, validation, and tabulation can be found in the ESH-20 OP entitled, “Game Animal Sampling and Processing for the Foodstuffs Monitoring Program,” LANL-ESH-20-SF-OP-003, R0, 1997.

c. Radiochemical Analytical Results. All radionuclide concentrations in muscle and bone tissue of elk collected from LANL lands were nondetectable and/or below upper-level background concentrations and were within concentrations from past years (Fresquez et al., 1998b) (Table 6-12).

Most radionuclide concentrations in muscle and bone tissue of a deer collected from LANL lands were nondetectable and/or within RSRLs and were within concentrations from past years (Fresquez et al., 1998b) (Table 6-13). Only one element, strontium-90 in bone tissue, was detected in concentrations above the RSRL; the differences in strontium-90 concentrations in bone tissues between the LANL deer and background deer, however, were small.

d. Long-Term Trends. A 1998 report summarized radionuclide concentrations (tritium; strontium-90; cesium-137; plutonium-238 and plutonium-239, -240; americium-241; and uranium) determined in muscle and bone tissue of deer and elk collected from LANL lands from 1991 through 1998 (Fresquez et al., 1998b). Also, we estimated the CEDE to people who ingest muscle and bone from deer and elk collected from LANL lands. Most radionuclide concentrations in muscle and bone from individual deer and elk collected from LANL lands were at less than detectable quantities and/or within upper-level background concentrations. As a group, most radionuclides in muscle and bone of deer and elk from LANL lands were not significantly higher ($p<0.10$ = at the 90% confidence level) than in similar tissues from deer and elk collected from background locations. Also, elk that had worn radio collars and been tracked for two years that spent an average time of 50% on LANL lands were not significantly different in most radionuclide levels from roadkill elk that have been collected on LANL lands as part of the environmental surveillance program. All CEDEs were far below the International Commission on Radiological Protection guideline of 100 mrem/yr.

7. Domestic Animals (Beef Cattle)

a. Monitoring Network. Beef cattle owned by San Ildefonso Pueblo graze the boundaries of LANL on a regular basis and are offered by the Pueblo for sampling and analysis. We compared meat and bone tissue collected from these cattle sampled from San Ildefonso Pueblo with similar tissues from beef cattle collected from regional background locations.

b. Sampling Procedures, Data Management, and Quality Assurance. All QA/QC protocols, chemical analyses, data handling, validation, and tabulation can be found in the ESH-20 OP entitled, "Game Animal Sampling and Processing for the Foodstuffs Monitoring Program," LANL-ESH-20-SF-OP-003, RO, 1997.

c. Radiochemical Analytical Results. Table 6-14 shows radionuclide concentrations in muscle and bone tissue of domestic free-range beef cattle collected from San Ildefonso Pueblo and regional background. Most radionuclides in muscle and bone tissue from these cattle were low and were nondetectable and/or within upper-limit background concentrations. The only radionuclides that were above RSRLs were strontium-90 and plutonium-238 in muscle and bone and plutonium-239 in bone from the San Ildefonso animal. For the most part, concentrations of these (detectable) elements were just above RSRLs, and the differences between these elements in muscle and bone from animals collected from San Ildefonso Pueblo compared with livestock from regional background locations were low.

8. Herbs/Tea

a. Monitoring Network. We collected Navajo Tea (also known as Cota) from three perimeter areas surrounding the Laboratory: Los Alamos townsite on the north, White Rock on the southeast, and San Ildefonso Pueblo lands on the east. We collected tea from the Española, Santa Fe, and Jemez areas as a background comparison.

b. Sampling Procedures, Data Management, and Quality Assurance. Tap water was added to the vegetative (unwashed) portion (stems) of Navajo Tea and brought to a boil. After the tea cooled, it was filtered and poured into a suitable container and submitted to chemistry as a liquid. All QA/QC protocols, chemical analyses, and data handling, validation, and tabulation can be found in the ESH-20 OP entitled, "Milk and Tea Sampling and Processing for the Foodstuffs Monitoring Program," LANL-ESH-20-SF-OP-005, R0, 1997.

c. Radiochemical Analytical Results. See Table 6-15 for results of the liquid tea analysis during 1999. All radionuclides in tea collected from the perimeter areas around LANL were nondetectable and/or within upper-limit background concentrations. Last year (1998), total uranium in Navajo Tea from all of the perimeter and background locations was detected in higher concentrations than the previous year's results. This year, uranium results in teas collected from all of the areas, including the control, are similar to past years, so the uranium results in 1998 were probably a result of chemical bias.

9. Piñon

a. Monitoring Network. Because piñon pine nuts are produced every 7 to 10 years by piñon pine trees in the semiarid Southwest, piñon pine shoot tips (a more conservative medium) have been harvested in the past on an annual basis since 1996 in an effort to estimate the dose from the ingestion of this very popular native product. In 1998, we had a piñon pine nut crop on LANL property and are reporting these results here along with piñon pine shoots we collected in 1999.

For piñon pine shoot tips, we collected samples from three perimeter areas surrounding the Laboratory: Los Alamos townsite on the north, White Rock/ Pajarito Acres on the southeast, and San Ildefonso Pueblo lands on the east. Piñon pine shoot tips collected from the Jemez area provided background comparisons. For piñon pine nuts, we collected samples from two study sites: (1) LANL (Technical Areas [TA]-15, -36, -39, and -49) and (2) regional background locations (Tres Piedras, Jemez, and Coyote, NM).

b. Sampling Procedures, Data Management, and Quality Assurance. Both piñon pine shoot tips and nuts were washed. Piñon pine nuts were also shelled. All QA/QC protocols, chemical analyses, data handling, validation, and tabulation can be found in the ESH-20 OP entitled, "Produce Sampling and Processing for the Foodstuffs Monitoring Program," LANL-ESH-20-SF-OP-001, R0, 1997.

c. Radiochemical Analytical Results. Table 6-16 provides analytical results of the piñon pine shoot tips collected during 1999. Most radionuclides in piñon pine shoot tips from the perimeter areas of LANL were present in very low concentrations and were nondetectable and/or within RSRLs. Cesium-137 detected in piñon pine shoots from White Rock/Pajarito Acres was the only element that was higher than the RSRL. The differences in cesium-137 in piñon pine shoot tips from White Rock/Pajarito Acres and background, however, were very low (0.019 pCi/g dry).

Analytical results of the piñon pine nuts can be found in Table 6-17. All radionuclides in piñon pine nuts collected from LANL lands were nondetectable and/or within RSRLs. Strontium-90 in piñon pine nuts appeared to be negatively biased and was not reported in Table 6-17; instead, the data are given in Table 6-18. Although the concentrations of strontium-90 in piñon pine nuts collected from both LANL and regional background appear to be negatively biased, they still can be statistically compared against one another to assess contributions from Laboratory operations, if any, because all factors associated with sampling, processing, and analysis were the same. Accordingly, as a group, radionuclides, including strontium-90, in piñon pine nuts collected on LANL lands were not significantly higher ($p<0.10$) than radionuclides in nuts from regional background locations (Fresquez et al., 2000).

Comparing radionuclide concentrations in piñon pine nuts collected from LANL lands in 1977 ($n = 6$ sites) (Salazar 1979) with piñon pine nuts collected in the present study shows that most of the radionuclides, with the exception of cesium-137, in piñon pine nuts collected in this study were lower than in piñon pine nuts collected over 20 years ago. It should be noted that Salazar's radionuclide data, with the exception of tritium, were incorrectly presented as being on a dry weight basis. These data were really listed in units per ash weight. We converted the data to a dry weight basis by multiplying the average by the ash/dry weight ratio of piñon pine nuts (0.026) (Fresquez and Ferenbaugh, 1999) for comparison to the present study. Accordingly, the average concentration of tritium decreased slightly from 13 to 10 pCi/mL, strontium-90 from 0.009 to –0.012 pCi/g dry, total uranium from 5.5 to 1.3 ng/g dry, plutonium-238 from –0.0009360 to –0.0000026 pCi/g dry, and plutonium-239 from 0.0009022 to 0.0000312 pCi/g dry. In contrast, the average concentration of cesium-137 in piñon pine nuts from LANL in 1977 slightly increased from 0.0002 to 0.0040 pCi/g dry in 1998.

10. Wild Spinach

a. Monitoring Network. We collected wild spinach from LANL and three perimeter areas: Los Alamos townsite on the north, White Rock/Pajarito Acres on the southeast, and San Ildefonso Pueblo lands on the east. We also collected spinach from the Española, Santa Fe, and Jemez area as a background comparison.

b. Sampling Procedures, Data Management, and Quality Assurance. All QA/QC protocols, chemical analyses, data handling, validation, and tabulation can be found in the ESH-20 OP entitled, "Produce Sampling and Processing for the Foodstuffs Monitoring Program," LANL-ESH-20-SF-OP-001, R0, 1997.

c. Radiochemical Analytical Results. Table 6-19 contains the analytical results of the wild spinach collected during 1999. All radionuclides in wild spinach collected from the perimeter sites were nondetectable and/or within upper-level background concentrations, and most, with the exception of strontium-90, were in similar concentrations to past years (ESP 1996). The concentration of strontium-90 in spinach collected at all of the sites in 1995 was 0.063 pCi/g dry, whereas the concentration of strontium-90 in spinach in 1999 was 0.200 pCi/g dry.

d. Nonradiochemical Analytical Results. Most trace elements in wild spinach from the perimeter areas were below the LODs (Table 6-20). Of the trace elements that were above the LODs, most were similar to trace elements in spinach collected from background locations. Wild spinach collected from the Los Alamos townsite contained nickel and lead concentrations higher than the upper-level background concentrations for general produce; the differences, however, were low.

11. Honey

a. Monitoring Network. Beehives located within perimeter areas—Los Alamos townsite and White Rock/Pajarito Acres—are sampled on a biannual basis for honey and were last sampled during the 1997 year (Figure 6-2). We compared honey from those hives with honey collected from regional background hives located in northern New Mexico.

b. Sampling Procedures, Data Management, and Quality Assurance. We collected honey directly from the producer in their bottles. All QA/QC protocols, chemical analyses, data handling, validation and tabulation can be found in the ESH-20 OP entitled, "Honey Sampling and Processing for the Foodstuffs Monitoring Program," LANL-ESH-20-SF-OP-004, RO, 1997.

c. Radiochemical Analytical Results. See Table 6-21 for the analytical results of the honey collected during 1999. Most radionuclide concentrations in honey collected from perimeter hives were nondetectable and/or within upper-level background concentrations and were in concentrations similar to past years (Fresquez et al., 1997a; Fresquez et al., 1997b). Most of the honey collected from the Los Alamos townsite hive was lost in analysis; apparently, the Los Alamos townsite sample was lost during the tritium distillation process, and the remaining portion may have been (cross) contaminated in the analytical laboratory before the analysis of the other radionuclides (George Brooks, CST-9 Radiochemist, personal communication, April 10, 2000).

Honey from bee hives in the Los Alamos townsite in past years (ESP 1996 and 1997) showed no influence from Laboratory operations, save for tritium (Fresquez et al., 1997b), and honey from the other hive collected during 1999 (White Rock/Pajarito Acres) showed no radionuclide levels of concern. We are currently reanalyzing a sample from the same Los Alamos townsite hive collected during the same period of time, and the results will appear in the next report.

d. Long-Term Trends. Several recent long-term data evaluations have examined radionuclide concentrations, particularly tritium, in bees and honey within the LANL environs. The first study evaluated a host of radionuclides (tritium; cobalt-57; cobalt-60; europium-152; potassium-40; beryllium-7; sodium-22; manganese-54; rubidium-83; cesium-137; plutonium-238 and plutonium-239, -240; strontium-90; americium-241; and uranium) in honey collected from hives located around the perimeter of LANL (Los Alamos and White Rock/Pajarito Acres) over a 17-year period (Fresquez et al., 1997a). All radionuclides, with the exception of tritium, in honey collected from perimeter hives around LANL were not significantly different ($p<0.05$) from background. Overall, the maximum total net positive CEDE—based on the average concentration plus two standard deviations of all the radionuclides measured over the years after the subtraction of background—from consuming 11 lb of honey (maximum consumption rate) collected from Los Alamos and White Rock/Pajarito Acres was 0.031 mrem/yr and 0.006 mrem/yr, respectively. The highest CEDE was <0.04% of the International Commission on Radiological Protection permissible dose limit of 100 mrem/y from all pathways.

The second study examined tritium concentrations in bees and honey collected from within and around LANL over an 18-year period (Fresquez et al., 1997b). Based on the long-term average, bees from nine out of eleven hives and honey from six out of eleven hives on LANL lands contained tritium that was significantly higher ($p<0.05$) than background. The bees with the highest average concentration of tritium (435 pCi/mL) collected over the years were from LANL's TA-54—a low-level radioactive waste disposal site (Area G). Similarly, the honey with the highest average concentration of tritium (709 pCi/mL) was collected from a hive located near three tritium-contaminated storage ponds at LANL TA-53. The average concentrations of tritium in bees and honey from background hives were 1.0 pCi/mL and 1.5 pCi/mL, respectively. Although the concentrations of tritium in bees and honey from most LANL and perimeter (White Rock/Pajarito Acres) areas were significantly higher than background, most areas, with the exception of TA-53 and TA-54, generally exhibited decreasing tritium concentrations over time.

C. Biota Monitoring

1. Introduction

In addition to the biota associated with human foodstuffs, DOE Orders 5400.1 and 5400.5 mandate the monitoring of nonfoodstuff biota for the protection of ecosystems (DOE 1991). Nonfood biota, such as small mammals, amphibians, birds, and vegetation, will be monitored within and around LANL on a systematic basis for radiological and nonradiological constituents. Organic compound analysis, however, will dominate the bulk of the analysis, because it has been determined that the highest risk to nonhuman biota (i.e., animals) at the Laboratory is generally not from radionuclides but rather from organic compounds such as pesticides and polychlorinated biphenyls (PCBs) (Gonzales 1999).

This year, we report on vegetation collected within and around LANL. Vegetation is the foundation of ecosystems because it provides a usable form of energy and nutrients that are transferred through food chains. Because of this function in the food chain, vegetation can serve as a pathway to biological systems. Plants contain radionuclides that settle from "global fallout" (foliar deposition) after resuspension with soil and that are absorbed by plant roots, which occurs on a limited basis (Whicker and Shultz 1982). Consequently, monitoring radionuclide concentrations in vegetation over time is important to understanding the nature of radionuclide transport via food chains and to understanding the dynamics of radioactivity in the environment at nuclear facilities. Knowledge of contaminant levels in vegetation also serves as a "baseline" that becomes important for comparison to post-episodic events or accidents like wildfire that potentially change the baseline condition.

This section will also report work associated with ecological risk assessment at LANL. Ecorisk is becoming an important issue at LANL and other DOE sites; such information is important in establishing site-specific coefficients of contaminant transfer between different feeding levels so that accurate radiation dose estimates can be made (Whicker and Schultz 1982; Calabrese and Baldwin 1993; EPA 1998).

The two main objectives of the biota program are (1) to determine contaminant concentrations in biota at on-site LANL and perimeter areas and compare them with off-site regional background areas and (2) to determine trends over time.

2. Alfalfa Forage

a. Monitoring Network. We collected alfalfa plants—forage that is typically fed to domestic animals—from perimeter and regional background locations (Figure 6-2). Perimeter areas included the Los Alamos townsite, White Rock/Pajarito Acres townsite, and San Ildefonso Pueblo. Alfalfa (unwashed) from areas around the perimeter of LANL was compared with alfalfa collected from regional background fields in northern New Mexico; these fields are located in the Española, Santa Fe, and Jemez areas. The regional sampling locations are far enough from the Laboratory that they are unaffected by Laboratory airborne emissions.

b. Sampling Procedures, Data Management, and Quality Assurance. All QA/QC protocols, chemical analyses, data handling, validation, and tabulation can be found in the ESH-20 OP entitled, "Produce Sampling and Processing for the Foodstuffs Monitoring Program," LANL-ESH-20-SF-OP-001, R0, 1997.

c. Radiochemical Analytical Results. Table 6-22 shows the concentrations of radionuclides in alfalfa forage collected from perimeter and regional background locations during the 1999 growing season. All radionuclide concentrations in alfalfa forage collected from perimeter areas were very low, and most were nondetectable and/or within RSRLs. Only one element, strontium-90, in alfalfa forage from San Ildefonso Pueblo was detected at above upper-level background concentrations. The difference between strontium-90 in alfalfa from San Ildefonso Pueblo and background, however, was low (1.5 pCi/g ash).

d. Nonradiochemical Analytical Results. Most concentrations of trace elements in alfalfa forage collected from perimeter and regional background locations during the 1999 growing season were below the LOD (Table 6-23). Only barium appeared to be higher in alfalfa collected from all of the perimeter areas compared with background. The differences in barium concentrations between perimeter sites and background, however, were low.

3. Native Vegetation

a. Monitoring Network. We collected vegetative overstory (trees) and understory (grass) samples from relatively level, open, and undisturbed areas at the same locations that soil surface samples have been collected over the years: regional background locations (three sites), LANL's perimeter (10 sites), and at LANL (12 sites) (see Figure 6-1). Areas sampled at LANL are not from SWMUs. Instead, the majority of on-site vegetation sampling stations are located on the mesa tops close to and downwind from major facilities and/or operations at LANL in an effort to assess the impact of transport or migration of contaminants on radionuclide levels in vegetation. This sampling focuses on vegetation that may have been contaminated by air stack emissions, fugitive dust (caused by the resuspension of dust from SWMUs and active firing sites), or other transport or migration (such as hydrological) followed by plant uptake. In 1999, the focus was on radionuclides and radioactivity, leaving metal and organic contamination considerations for another year.

The ten perimeter stations are located within 4 km (2.5 mi) of the Laboratory. These stations reflect the soil conditions of the inhabited areas to the north (Los Alamos townsite area—four stations) and east (White Rock area and San Ildefonso Pueblo lands—four stations) of the Laboratory. The other two stations, one located on US Forest Service land to the west and the other located on US Park Service land (Bandelier) to the southwest, provide additional coverage. We compared vegetation samples from all these areas with vegetation collected from regional background locations in northern New Mexico surrounding the Laboratory where radionuclides and radioactivity are from natural and/or worldwide fallout events. The background stations are located close to Embudo to the north, Cochiti Pueblo to the south, and Jemez Pueblo to the southwest. All are more than 32 km (20 mi) from the Laboratory and are beyond the range of potential influence from normal Laboratory operations (DOE 1991).

b. Sampling Procedures, Data Management, and Quality Assurance. Collection of samples for chemical analyses follows a set procedure to ensure consistent and accurate collection, processing, submittal, and posting of analytical results. Stations and samples have unique identifiers to provide chain-of-custody control from the time of collection through analysis and reporting. Overstory samples consisted of conifer (ponderosa pine, one-seed juniper, and piñon pine) tree-shoot tips approximately 2.5–5.0 cm (1 to 2 in.) in length at 1.3 to 1.6 m (4 to 5 ft) above soil level. Understory samples consisted of composited grass subsamples of various species collected from 10 × 10 m (32 × 32 ft) plots. Protocols for QA/QC, data handling, validation, and tabulation can be found in the ESH-20 OP entitled “Sampling and Processing Samples for the Waste-Site Monitoring Program,” LANL-ESH-20-SF-OP-011, R0, 1997. Radionuclide analysis of unwashed samples generally consisted of alpha spectroscopy (plutonium-238, plutonium-239, and americium-241), gamma spectroscopy (cesium-137), and liquid scintillation (strontium-90 and tritium). The specific procedure can be found at *http://cst.lanl.gov/docs* or in hardcopy within the LANL document LA-10300-M, Vol. III, Method ANC325 – 331, R.0 (Gautier 1995).

c. Radiochemical Analytical Results. Tables 6-24 (understory) and Table 6-25 (overstory) show the measured and arithmetic mean concentrations for vegetation collected in 1999 at LANL, perimeter, and regional background stations. Nonparametric descriptive statistics and results of the Kendall’s Tau tests generally indicate no difference in radionuclide concentrations between sites. The exceptions were statistically higher ($p<0.05$) concentrations of tritium in LANL (on-site) understory vegetation than in perimeter understory and in LANL overstory compared with background. The mean tritium concentration in LANL understory vegetation was 501 pCi/L compared with 144 pCi/L in perimeter understory; however, there was overlap between respective interquartiles. The mean tritium concentration in LANL overstory was 463 pCi/L compared with –63 pCi/L in background overstory with no overlap of interquartile ranges.

With generally no differences among the sites, the need to assess the influence of overstory species on radionuclide concentrations between sites (i.e., determine whether species effects confounded the influence of sample locations) is diminished. Nevertheless, this issue is of scientific interest; therefore, we combined data by overstory species across two sites, a LANL site and a perimeter site, and tested for significant differences. We detected no differences in radionuclide concentrations between piñon pine and ponderosa pine.

Maximum on-site understory radionuclide concentrations are as follows: total uranium was 0.0730 μg/g dry; strontium-90 was 0.243; cesium-137 was 0.131; plutonium-238 was 0.197; plutonium-239 was 0.00045; and americium-241 was 0.00056 pCi/g dry. These values are all lower than toxicity reference values that were assumed to represent “safe limits” that protect nonhuman biota. For a more complete description of results of this study, see Gonzales et al., (2000a).

4. Ecological Risk Assessment

a. Approach. Ecological risk assessment is the qualitative or quantitative appraisal of effects, potential or real, of stressors such as contamination on flora, fauna, and/or populations, communities, or ecosystems. The relationship between ecological risk assessment and environmental surveillance is severalfold. First, the Environmental Surveillance Program provides contaminant data for assessing potential effects on ecological entities, including flora, fauna, and/or populations, communities, or ecosystems. The data collected for surveillance programs include concentrations of contaminants in environmental abiotic and biotic media, both of which are useful in ecological risk assessments. The biocontaminant data can also validate ecological risk models by comparing the accuracy of model predictions with real data. Second, the results of ecological risk assessments can help identify gaps in the Environmental Surveillance

Program (Gonzales et al., 1998; Gonzales 1999). For example, ecological risk assessments on threatened and endangered (T&E) species at LANL established the need to develop an organic-contaminant focus area as a component of the LANL Environmental Surveillance Program. Another example is the need for knowledge of contaminant levels in amphibians native to the LANL environment and related potential risk.

The monitoring of organics in the Environmental Surveillance Program will undoubtedly help to focus additional ecological risk assessments. Thus, the relationship between Environmental Surveillance Program and ecological risk assessment is mutualistic and iterative. As does the Environmental Surveillance Program, ecological risk assessments also help identify special studies that enhance the basis on which environmental compliance is founded. For example, Ferenbaugh et al. (1999) studied the potential effects of radionuclides on deer and elk that forage around the perimeter of Area G at LANL and measured radionuclide concentrations in deer and elk muscle tissue. The results of this study validated dose modeling in accord with predictions of uptake using equations in NCRP Report 76 (NCRP 1984).

b. History. The Laboratory is in the early stages of an ecological risk assessment program. This void is due in part to the infancy of this field worldwide and/or to emphasis on related pieces or components of ecological risk assessment such as monitoring and modeling of contaminant release, fate, and transport. In 1996, the Environmental Impact Statement Record of Decision on the Dual Axis Radiographic Hydrodynamic Test facility (DARHT) at LANL specified, among other things, the requirement for closer observance of the federal Endangered Species Act of 1973. As a result of this requirement, between 1996 and 1999, we completed risk assessments on four T&E species and initiated at least two related field studies. Previous Environmental Surveillance Reports have contained summaries of the T&E assessments. In late 1999, a similar approach was begun for application to non-T&E species, and summaries of these results will appear in future Environmental Surveillance Reports.

c. Results. The 1998 Environmental Surveillance Report contained a summary of the assessment of the last of four T&E species (southwestern willow flycatcher). In 1999, we documented the FORTRAN computer model ECORSK.5. A summary of the ECORSK.5 documentation appears later in the Special Studies section of Chapter 6.

D. Other Environmental Surveillance Program Activities and Special Studies around Los Alamos National Laboratory

1. MDA G, TA-54, Environmental Surveillance and Studies

a. "Radionuclide Concentrations in Soils and Vegetation at Low-Level Radioactive Waste Disposal Area G During the 1998 Growing Season (with a cumulative summary of tritium and plutonium-239 over time)." Soils and unwashed overstory and understory vegetation were collected at eight locations within and around MDA G, a disposal facility for low-level radioactive solid waste at the Laboratory. We analyzed the samples for tritium, plutonium-238, plutonium-239, strontium-90, americium-241, cesium-137, and total uranium. Most of the radionuclide concentrations in soils and vegetation were within the upper 95% level of background concentrations except for tritium and plutonium-239. Tritium concentrations in vegetation from most sites were greater than background concentrations of about 2 pCi/mL. The concentrations of plutonium-239 in soils and understory vegetation were largest in samples collected several meters north of the transuranic waste pad area and were consistent with previous results. Based on tritium and plutonium-239 data through 1998, we saw that (1) concentrations were significantly greater than background concentrations ($p<0.05$) in soils and vegetation collected from most locations at MDA G, and (2) the data showed no systematic increase or decrease in concentrations with time (Fresquez et al., 1999b).

b. "Sampling of Perimeter Surface Soils at Technical Area 54, MDA G." During fiscal year (FY) 1998, 39 surface soil samples were collected from the perimeter of MDA G, TA-54. The locations we sampled depended on historical data collected at MDA G between 1993 and 1997. We chose the locations for the FY98 surface soil samples to best indicate whether contaminants, under the influence of surface water runoff, were moving outside the MDA G, TA-54, perimeter. Each sampling point was located in small but obvious drainage channels just outside the perimeter fence. These sampling locations thus offered the best opportunity to determine whether contaminated soil was being carried by surface water runoff from within the confines of MDA G to beyond the MDA G fence. The radioactive constituents measured in these surface soil samples included americium-214, cesium-137, isotopic plutonium, and tritium.

The analytical results of the surface soil sampling indicate that some perimeter soils at MDA G continue to be elevated above background levels for tritium and plutonium. The most elevated concentrations of tritium in soils are prevalent in locations that are adjacent to the active tritium disposal shafts and next to a series of inactive tritium shafts and the transuranic waste storage pads. Isotopic plutonium and americium-241 are slightly elevated in perimeter surface soils located adjacent to the transuranic pads. Cesium-137 is uniformly distributed in the perimeter soils. The perimeter soil samples were not analyzed for total uranium, but previous years' uranium data have shown a uniform distribution in surface soils with no evidence of elevated levels over background. We observed no gross changes in radioactivity in surface soil samples, and the samples collected in FY98 contain radioactivity similar to samples collected in previous years. Our sampling did not define any new locations where surface soils were elevated with radioactivity. These findings are consistent with analogous measurements taken in FY93 through FY97. The MDA G perimeter surface soil data indicate that very little radioactivity moves outside of MDA G under the influence of surface water runoff (Childs 1999).

c. "Radionuclide in Honey Bees from Area at TA-54 during 1998." We collected honey bees from two colonies located at the Laboratory's MDA G, TA-54, and from one control (background) colony located near Jemez Springs, NM. Samples were analyzed for various radionuclides. MDA G sample results from both colonies were higher than the upper (95%) level background concentration for plutonium-239, tritium, and total uranium. Sample results from one colony were higher than the upper (95%) level background concentration for plutonium-238 (Haarmann and Fresquez, 1999).

d. "Elk and Deer Study, Material Disposal Area, Technical Area 54." MDA G is the primary low-level radioactive waste disposal site at the Laboratory and occupies 26 ha on the eastern side of LANL adjacent to San Ildefonso Pueblo lands. Analyses of soil and vegetation collected from the perimeter of MDA G show concentrations of radionuclides greater than background concentrations established for northern New Mexico. As a result, pueblo residents have become concerned that contaminants from MDA G could enter tribal lands through various pathways. The residents have specifically questioned the safety of consuming meat from elk and deer that forage near MDA G and then migrate on to tribal lands.

This study addresses the uptake of a host of radionuclides by elk (*Cervus elaphus*) and deer (*Odocoileus hemionus*) that forage around the perimeter of MDA G, the health risks to the animals from this uptake, and the health risks to humans that consume meat from these elk and deer. Uptake by and internal dose to animals were estimated using equations from the National Council on Radiation Protection and Measurements Report 76 coded into a Microsoft Excel spreadsheet. The RESRAD computer code estimated the external dose to animals and the dose to humans consuming elk or deer meat. Soil and water concentrations from the perimeter of MDA G and from background regions in northern New Mexico were averaged over four years (1993–1996) and used as input data for the models. Concentration estimates the spreadsheet model generated correspond to the concentration range measured in actual tissue samples taken from elk and deer collected as part of the Environmental Surveillance Program at LANL. The highest dose estimates for both animals (17 mrad/yr) and humans (0.072 mrem/yr) were well below guidelines established to protect the environment (100 mrad/day) and the public (100 mrem/yr) from radiological health risks (Ferenbaugh et al., 1998; Ferenbaugh et al., 1999).

e. "The Relationship Between Pocket Gophers (*Thomomys bottae*) and the Distribution of Buried Radioactive Waste at the Los Alamos National Laboratory." MDA G at the Laboratory is a low-level radioactive waste storage facility. The noticeable presence of pocket gopher mounds and cast soil on closed waste burial sites of various types resulted in the need to understand possible interactions between gophers and radioactive waste at MDA G. In our study, we collected pocket gophers, mound soil, off-mound surface soil, and vegetation at MDA G and at off-site background locations. The samples were analyzed for four radionuclides (americium-241, plutonium-238, plutonium-239, and tritium) and total uranium.

A comparison of radionuclide concentrations in mound soil with surface soil and in gophers with soil and vegetation suggests that gopher activity is generally not resulting in the upward transport of radionuclides. Concentrations of americium-241, plutonium-238, plutonium-239, and tritium in some of the gopher, soil, and vegetation samples were higher than background at some of the sites. Gophers at one site within MDA G had tritium concentrations that resulted in an estimated dose that could impact the gophers' health. We conducted correlation tests to examine relationships in radionuclide concentrations among the four media (pocket gophers, mound soil, off-mound surface soil, and vegetation). Correlations were highest for americium-241 and plutonium-238; however, only the plutonium-238 relationship may be accurate enough for use in predicting concentrations. Data this study generated are valuable for ecological risk assessments. Further investigation through modeling and monitoring may be necessary to determine if the tritium shafts are a source of environmental tritium levels that are of ecological concern. Future research should include modeling the transport of radionuclides through ecological receptors within and around MDA G. This modeling should investigate transfer to high-level carnivores, especially raptors (Gonzales et al., 2000b).

2. DARHT, TA-15, Environmental Surveillance Programs

a. "Baseline Concentrations of Radionuclides and Trace Elements in Soils and Vegetation Around the DARHT Facility: Construction Phase (1998)." The Mitigation Action Plan for the DARHT facility at the Laboratory mandates the establishment of baseline concentrations for potential environmental contaminants. To this end, we determined concentrations of tritium, cesium-137, strontium-90, plutonium-238, plutonium-239, americium-241, and total uranium and silver, arsenic, barium, beryllium, cadmium, chromium, copper, mercury, nickel, lead, antimony, selenium, and thallium in surface and subsurface soils, sediments, and vegetation (overstory and understory) around the DARHT facility during the construction phase in 1998 (this is the third year of a four-year baseline study). We also measured volatile and semivolatile organic compounds in soils and sediments.

In 1999, most radionuclides and trace metals in soil, sediment, and vegetation were similar to past years at DARHT and were within regional background concentrations. Exceptions were concentrations of strontium-90, beryllium, barium, and total uranium in some samples; these concentrations exceeded upper-limit regional background concentrations (i.e., they exceeded the mean plus two standard deviations). We detected no volatile organic compounds and very few semivolatile organic compounds in soils and sediments at DARHT. We summarized mean (± std dev) radionuclide and trace element concentrations measured in soil, sediment, and vegetation over a three-year period (construction phase) (Fresquez et al., 1999a).

b. "Concentrations of Radionuclides and Heavy Metals in Honey Bee Samples Collected Near DARHT and a Control Site (1998)." We collected honey bees from two colonies located at the Laboratory's DARHT facility and from one control (background) colony located near Jemez Springs, NM. Samples were analyzed for various radionuclides and heavy metals. DARHT facility sample results from both colonies were higher than the upper (95%) level background concentration for cesium-137, thalium-208, total uranium, and barium. Sample results from one colony were higher than the upper (95%) level background concentration for manganese-54, plutonium-239, and copper (Haarmann 1999).

3. Ecological Risk Assessment Studies

"Documentation of the Ecological Risk Assessment Computer Model ECORSK.5." This study summarizes the documentation of ECORSK.5, an ecological risk computer model used to estimate the potential toxicity of radioactive and nonradioactive contaminants to several T&E species at the Laboratory. These analyses to date include preliminary toxicity estimates for the Mexican spotted owl, the American peregrine falcon, the bald eagle, and the southwestern willow flycatcher. The Record of Decision for the construction of the DARHT facility at LANL required this work as part of the Environmental Impact Statement. The model is dependent on the use of the geographic information system and associated software—ARC/INFO—and has been used in conjunction with LANL's Facility for Information Management and Display (FIMAD) contaminant database. The integration of FIMAD data and ARC/INFO using ECORSK.5 allowed the generation of spatial information from a gridded area of potential exposure called an Ecological Exposure Unit. ECORSK.5 simulated exposures using a modified Environmental Protection Agency Quotient Method. The model can handle a large number of contaminants within the home range of species. This integration results in the production of hazard indices which, when compared with risk evaluation criteria, estimate the potential for impact from the consumption of contaminated food and ingestion of soil.The full report (Gallegos and Gonzales, 1999) summarizes and documents the ECORSK.5 code, the mathematical models used to develop ECORSK.5, and the input and other requirements for its operation. Other auxiliary FORTRAN77 codes that process and graph output from ECORSK.5 are also discussed. The reader may refer to other LANL reports to obtain greater detail on past applications of ECORSK.5 and assumptions used in deriving model parameters. A FORTRAN90 version of the code is under development.

4. Fire Ecology Studies

a. “Fuels Inventories and Spatial Modeling of Fire Hazards in the Los Alamos Region.” Several land management agencies, including Los Alamos National Laboratory, Los Alamos County, Santa Fe National Forest, and Bandelier National Monument, are working collaboratively toward reducing the fire hazard in the Los Alamos wildland-urban interface. As part of this multiyear project, we have been inventorying fuels, determining the spatial patterns of the fuel levels, assessing the values at risk in the wildland-urban interface, and designing optimal mitigation action strategies. Here we review the preliminary results of the initial two years of fuels inventories and related analyses. The first year, 1997, we conducted a preliminary survey of fuel levels along the elevation gradient from piñon-juniper woodlands to ponderosa pine forests and mixed conifer forests and on selected topographic positions: canyons, mesas, and mountains. The surface fuels were greatest in mixed conifer forests, whereas the overstory fuels were greatest in mixed conifer forests and in ponderosa pine forests on mesas. These results provided direction for the surveys conducted during the second year, 1998. We selected a random sample of sites above 2100 m to emphasize the portion of the study region that supported the highest fuel loads. During 1998, we found that the surface fuels and overstory fuels are greatest at higher elevations in the study region and on north-facing aspects or on relatively steep slopes. Conversely, the variability among the overstory fuels is the greatest at lower elevations in the ponderosa pine zone.

The results of this preliminary survey have several consequences. First, the surveyed fuel loads are consistent with predicted and actual patterns of fire behavior in the study region. Second, the highly variable fuels at lower elevations present a dilemma to land managers who wish to protect federal facilities and residential areas in the wildland-urban interface. Third, these results are useful for mapping the fuel loads in the Los Alamos wildland-urban interface. Fourth, the data this project generated are serving as inputs to predictive wildfire behavior models and as the basis for optimal mitigation action strategies (Balice et al., 1999).

b. “Mapping Fuel Risk at the Los Alamos Urban-Wildland Interface.” Remote sensing and geographic information system (GIS) technologies support the goals of Los Alamos to use current technology in expanding information to reduce fire hazard within its wildland-urban interface. The forests and woodlands on the east slopes of the Jemez Mountains are generally overstocked and have the potential to produce intense wildfires that could threaten lives, property, and natural resources. Overall overstory fuel classification accuracy was 96.10 %, with a kappa coefficient of 0.95. Average modeled understory fuel loads increase from 4.89 tons/acre in grass, to 28.29 tons/acre in ponderosa pine, 31.53 tons/acre in aspen, and 52.05 tons/acre in mixed conifer. The coefficient of variation, which measures the reliability of the means, is almost the same for the mixed conifer and ponderosa pine data, at around 0.34 (Yool et al., 2000).

5. Aquatic Studies

a. “Radionuclides and Trace Elements in Fish Upstream and Downstream of Los Alamos National Laboratory and the Doses to Humans from the Consumption of Muscle and Bone.” The purpose of this study was to determine radionuclide and trace element concentrations in bottom-feeding fish (catfish, carp, and suckers) collected from the confluences of some of the major canyons that cross Laboratory lands with the Rio Grande and the potential radiological doses from the ingestion of these fish. We analyzed samples of muscle and bone (and viscera in some cases) for tritium; strontium-90; cesium-137; total uranium; plutonium-238 and plutonium-239, 240; and americium-241 and silver, arsenic, barium, beryllium, chromium, cadmium, copper, mercury, nickel, lead, antimony, selenium, and thallium. Most radionuclides, with the exception of strontium-90, in the muscle plus bone portions of fish collected from LANL canyons/Rio Grande were not significantly ($p<0.05$) higher than those from fish collected upstream (San Ildefonso/background) of LANL. Strontium-90 in fish muscle plus bone tissue significantly ($p<0.05$) increases in concentration starting from Los Alamos Canyon, the most upstream confluence (fish contained 3.4E-02 pCi/g), to Frijoles Canyon, the most downstream confluence (fish contained 14E-02 pCi/g). The differences in strontium-90 concentrations in fish collected downstream and upstream (background) of LANL, however, were very small.

Based on the average concentrations (±2SD) of radionuclides in fish tissue from the four LANL confluences, the committed effective dose equivalent from the ingestion of 46 lb (maximum ingestion rate per person per year) of fish muscle plus bone, after the subtraction of background, was 0.1 ± 0.1 mrem/yr and was far below the International Commission on Radiological Protection (all pathway) permissible dose limit of 100 mrem/yr. Of the trace elements that were found above the limits of detection (barium, copper, and mercury) in fish muscle collected from the confluences of canyons that cross LANL and the Rio Grande, none were in significantly higher ($p<0.05$) concentrations than in muscle of fish collected from background locations (Fresquez et al., 1999c).

b. "Organic Contaminant Levels in Three Fish Species Down Channel from the Los Alamos National Laboratory." We analyzed three species of fish from sites upriver and downriver of the LANL in the Rio Grande for pesticides and PCBs. Data were used to implicate potential sources of the contaminants and to discuss potential risk to fish, the bald eagle, and humans. Eight of 28 contaminants were measurable in at least one sample of fish muscle tissue. Of 18 samples total, there were 18 detections of dichlorodiphenylethylene (DDE), eight of Aroclor-1254, five of dichloroethane, two of dichlorodiphenyltrichloroethane (DDT), two of endosulfan sulfate, two of gamma-chlordane, and one of Aroclor-1260. The Laboratory contribution, if any, to pesticide levels in the common carp (*Carpiodes carpio*), the channel catfish (*Ictalurus punctatus*), and the white sucker (*Catostomus commersoni*) in the Rio Grande appears to be small. The source of the DDT-related compounds was probably a pest control event in 1963 in which approximately 500,000 acres of forest west of the Rio Grande in the Santa Fe and Carson National Forests were sprayed with approximately one pound per acre of DDT (~141,000 ppm–weight/weight). DDE concentration among fish species was significantly different: the white sucker had significantly lower levels of 4,4' – DDE than the common carp and the channel catfish. This difference may have affected location treatment means of 4,4' – DDE because equal numbers of each species at each sampling site were not used; therefore, studies that attempt to discern effects related to location should consider species, feeding habits, and other factors.

Maximum DDE concentrations in all three fish species (0.03 to 0.15 mg/kg) were slightly below the minimum range in concentration (0.2 to 1.0 mg/kg) that has been associated with reproductive effects of sensitive bird species.

Assuming a maximum total fish ingestion of 21 kg/yr and a 70-kg human consumer body weight, the maximum DDT consumption by humans would be 6.7×10^{-5} mg/kg/d, which is lower than the EPA human risk value of 5×10^{-4} mg/kg/d. The mean total DDT concentration of 82 µg/kg results in an EPA recommendation of no consumption restrictions for chronic systemic health endpoints for the general human population. At the largest meal size and most protective criteria, the EPA recommends minor consumption restrictions for chronic systemic health endpoints for children and for carcinogenic health endpoints for the general population.

Maximum Aroclor-1254 concentrations in all three fish species (0.05 to 0.66 mg/kg) were well below the minimum range in concentration (50 to 100 mg/kg) that may adversely affect growth and reproduction of fish. Assuming a maximum total fish ingestion of 21 kg/yr and a 70-kg consumer body weight, the maximum Aroclor-1254 consumption would be 1.1×10^{-4} mg/kg/d. This level is above the EPA human risk value of 2×10^{-5} mg/kg/d. Regarding the mean Aroclor-1254 concentration in fish, 0.13 mg/kg, the EPA recommends minor consumption restrictions on the basis of chronic systemic health endpoints for the general population and on developmental health endpoints for women of reproductive age (Gonzales et al., 1999).

c. "Effects of Depleted Uranium on the Survival and Reproduction of *Ceriodaphnia dubia*." Depleted uranium (DU) released to the environment during military weapons testing is generally alloyed with other heavy metals (e.g. beryllium, cadmium, lead) and found in the soil of impact test fields as three uranium oxides. The low solubility of the alloyed heavy metals and the uranium oxides has led researchers to consider DU in the soil as more of a terrestrial hazard than an aquatic one. However, research has indicated DU present in soil is not stationary and has the potential to move into aquatic systems. The primary focus of previous research on terrestrial systems has left an information gap in the chemical and biological effects of DU on aquatic organisms. This study addressed the effects of DU-contaminated soil on the health of the water flea (*Ceriodaphnia* *dubia)*. We conducted a 96-hour acute assay and a seven-day chronic assay to measure the contaminant effect on survival and reproduction of *Ceriodaphnia dubia* exposed to dilutions of test water overlying and aged with DU soil and a reference soil (relatively contaminant free). Statistical analysis indicated a significant difference in survival and reproduction in test dilutions (12.5% and 50%) compared with control (0.0) and reference groups. We analyzed test water collected from treatment, control, and reference samples throughout the acute and chronic assays by mass spectrophotometry to identify the concentrations of uranium-238, uranium-235, beryllium, cadmium, and lead. Information this study generated will enable researchers to determine the potential impact of long-term sublethal concentrations of DU on aquatic systems (Kuhne et al., 1999).

6. Elk Studies

"Resource Use, Activity Patterns, and Disease Analysis of Rocky Mountain Elk (*Cervus elaphus nelsoni*) at the Los Alamos National Laboratory." To form the basis for developing management strategies for elk and other large herbivores, it is necessary to understand how, when, where, and why animals move with respect to the landscape and availability of essential habitats for foraging and watering. From 1996 to 1998, we evaluated daily/seasonal movements, habitat use, and activity patterns of elk on and near Laboratory property through the use of global positioning system collars and the Geographic Information System. We have identified primary travel corridors on and immediately adjacent to LANL property and identified travel routes for collared animals moving west off LANL property in the vicinity of Pajarito Mountain. Daily use of different land cover types and terrain was evaluated seasonally by comparing six four-hour periods to one another: 0000–0400, 0400–0800, 0800–1200, 1200–1600, 1600–2000, and 2000–2400.

Significantly more locational fixes of elk took place in piñon/juniper cover (Pearson's x test, $p<0.05$) compared with all other cover types between the hours of 0400–1200 and significantly more than all other cover types, except ponderosa pine, through the 2000 hour period. In general, use of piñon/juniper increased during daylight hours and decreased during evening hours. Use of grasslands decreased during day hours while increasing during evening hours. Generally, the elk used northeast slopes more than expected and west and northwest slopes less than expected. We found significantly greater fixes on 0°–5° slopes compared to all other slope classes between the evening and early morning hours of 1600–0400 and significantly greater than slopes above 10° for all hourly subperiods except 0800–1200. During spring, use of 0°–5° slopes decreased during midday and increased during evening and early morning hours, and animals tended to increase their proportion of use on steeper slopes in most subperiods during summer. We also examined diseases of animals by analyzing blood samples drawn from all collared elk. Vesicular stomatitis was the most commonly observed disease among tested elk. By understanding movement and activity patterns of elk on LANL property, management strategies can be developed and applied to reduce adverse impacts, such as automobile accidents and overuse of sensitive habitats associated with this species (Biggs et al., 1998).

7. Small Mammal Studies

a. "Development and Application of a Habitat Suitability Ranking Model for the New Mexico Meadow Jumping Mouse (*Zapus hudsonius luteus*)." The New Mexico meadow jumping mouse (*Zapus hudsonius luteus*) is currently listed as a state threatened species in New Mexico and has been identified as potentially occurring within the Laboratory boundary. We describe the development of a model to identify and rank habitat at LANL that may be suitable for occupation by this species. The model calculates a habitat suitability ranking (HSR) based on total plant cover, plant species composition, total number of plant species, and plant height. Input data for the model are based on the measurement of these variables at locations where this species has been found within the Jemez Mountains. Model development included selecting habitat variables (HV), developing a probability distribution for each variable, and applying weights to each variable based on their overall importance in defining the suitability of the habitat.

The HVs include plant cover (HV1), grass/forb cover (HV2), plant height (HV3), number of forbs (HV4), number of grasses (HV5), and sedge/rush cover (HV6). Once we selected the HVs, we calculated probability values for each. Each variable was then assigned a "weighting factor" to reflect the variables' importance relative to one another with respect to contribution to quality of habitat. The least important variable, sedge/rush cover, received a weight factor of "1," with increasing values assigned to each remaining variable as follows: number of forbs

= 3, number of grasses = 3, plant height = 5, grass/forb cover = 6, and total plant cover = 7. Based on the probability values and weighting factors, a HSR is calculated as follows: HSR = (PHV1(7) + PHV2(6) + PHV3(5) + PHV4(3) + PHV5(3) + PHV6(1)). Once calculated, the HSR values are placed into one of four habitat categorical groupings by which management strategies are applied (Biggs et al., 1999).

b. "Evaluation of PCB Concentrations in Archived Small Mammal Samples from Sandia Canyon." During the summer of 1996, concerns developed about PCBs within the Laboratory's Sandia Canyon. We submitted archived small mammal samples (voles, *Microtus* spp.; harvest mouse, *Reithrodontomys megalotis*; vagrant shrews, *Sorex vagrans*; and deer mouse, *Peromyscus maniculatus*) comprising adipose tissue and internal organs from 1995 (thirty samples) and 1996 (thirty-four samples) to determine PCB levels. During the summer of 1998, we selected a reference site in South Fork Canyon of the Jemez Mountains and collected thirty samples of small mammal adipose tissue and internal organs from this site to be analyzed for PCBs. Nine samples from 1995 and 19 samples from 1996 had detectable or estimated concentrations of PCBs, whereas no samples from the reference site (background) had detectable PCB levels. PCB concentrations ranged from 49 to 19,000 mg/kg in the samples collected from Sandia Canyon. Preliminary evaluation of the data indicates that maximum levels of Arochlor-1260 approach minimum levels for which effects have been noted (Bennett et al., 1999).

8. Other Studies

a. "Moisture Conversion Ratios for the Foodstuffs and Biota Environmental Surveillance Programs at Los Alamos National Laboratory: 1999 (Revision 1)." This paper reports the mean ash to dry weight and dry to wet weight moisture ratios for a variety of foodstuffs and biota commonly collected as part of the Environmental Surveillance Programs at the Laboratory (Fresquez and Ferenbaugh, 1999).

b. "Amphibians and Reptiles of Los Alamos County." Recent studies have shown that amphibians and reptiles are good indicators of environmental health. They live in terrestrial and aquatic environments and are often the first animals affected by environmental change. This publication provides baseline information about amphibians and reptiles on the Pajarito Plateau. The report contains ten years of data collection and observations by researchers at the Laboratory, the University of New Mexico, the New Mexico Department of Game and Fish, and hobbyists (Foxx et. al, 1999).

c. "Quantitative Habitat Evaluation of the Conveyance and Transfer Project." The transfer of federally controlled, ecologically sensitive land has become the focus of recent controversy. It has become increasingly important to assess quantitatively the potential impacts of transferring such lands and the associated natural resources. As part of natural resources planning for the Conveyance and Transfer (C&T) Project, we conducted a quantitative field evaluation to assess and rank various habitats in or near the proposed transfer tracts. Field data were collected and analyzed. These data were coupled with an integrated Geographical Information System spatial analysis to assign an overall habitat ranking to both Rendija and Pueblo Canyons. We also ranked plots within the transfer tracts. The results of this study indicate that the overall habitat rankings of the proposed C&T tracts do not differ from the habitat ranking of the canyons in which they are located. Therefore, it is likely that the transfer of these tracts would not result in a decrease in the overall habitat rankings of the canyons. This quantitative habitat evaluation process successfully addressed potential impacts of transferring these tracts (Haarmann and Haagenstad 1999).

Table 6-1. Radionuclides in Surface Soils Collected from Regional Background, Perimeter, and On-Site Locations during 1999

Location	^{3}H (pCi/mL)	^{90}Sr (pCi/g dry)	^{137}Cs (pCi/g dry)	^{tot}U (µg/g dry)	^{238}Pu (pCi/g dry)	^{239,240}Pu (pCi/g dry)	^{241}Am (pCi/g dry)	Gross Alpha (pCi/g dry)	Gross Beta (pCi/g dry)	Gross Gamma (pCi/g dry)
Regional Background Stations:										
Embudo	0.21 (0.64)[a]	[g]	0.23 (0.06)	1.78 (0.18)	0.001 (0.001)	0.012 (0.002)	0.011 (0.003)	3.1 (0.6)	2.8 (0.3)	2.1 (0.2)
Cochiti	0.27 (0.64)	[g]	0.24 (0.07)	1.81 (0.18)	0.000 (0.000)	0.008 (0.002)	0.013 (0.003)	3.6 (0.7)	2.7 (0.3)	2.2 (0.2)
Jemez	0.27 (0.64)	[g]	0.38 (0.08)	3.23 (0.32)	0.004 (0.001)	0.010 (0.002)	0.010 (0.002)	9.3 (2.1)	8.0 (1.3)	2.9 (0.3)
Mean (std dev)	0.25 (0.03)A[b]	0.30 (0.07)[h]	0.28 (0.08)A	2.27 (0.83)B	0.002 (0.002)B	0.010 (0.002)B	0.011 (0.002)A	5.3 (3.4)A	4.5 (3.0)A	2.4 (0.4)B
RSRL[c]	0.61	0.71	0.51	3.30	0.008	0.019	0.013	8.4	7.2	4.1
SAL[d]	1,900.00[e]	4.40	5.10	29.00	27.000	24.000	22.000	– – –	– – –	– – –
Perimeter Stations:										
Otowi	0.27 (0.64)	[g]	0.26 (0.15)	2.85 (0.29)	0.013 (0.003)	0.145 (0.009)	0.009 (0.003)	2.9 (0.6)	2.6 (0.2)	3.3 (0.3)
TA-8 (GT Site)	0.42 (0.65)	[g]	0.72 (0.14)	2.98 (0.30)	0.009 (0.002)	0.029 (0.003)	0.006 (0.002)	6.0 (1.2)	6.0 (0.4)	6.7 (0.7)
Near TA-49 (BNP)	0.24 (0.64)	[g]	0.82 (0.16)	3.73 (0.37)	0.001 (0.001)	0.024 (0.003)	0.010 (0.004)	6.1 (1.2)	5.4 (0.4)	6.7 (0.7)
East Airport	0.19 (0.64)	[g]	0.31 (0.08)	2.60 (0.26)	0.011 (0.003)	0.025 (0.004)	0.007 (0.002)	4.2 (0.8)	3.3 (0.3)	5.8 (0.6)
West Airport	0.34 (0.64)	[g]	0.24 (0.07)	2.74 (0.27)	0.010 (0.002)	0.047 (0.004)	0.009 (0.003)	5.1 (1.0)	5.0 (0.4)	5.4 (0.5)
North Mesa	0.32 (0.65)	[g]	0.31 (0.15)	2.98 (0.30)	–0.000 (0.001)[f]	0.012 (0.002)	0.003 (0.001)	5.4 (1.1)	4.1 (0.3)	2.8 (0.3)
Sportsman's Club	0.36 (0.65)	[g]	0.93 (0.18)	3.75 (0.38)	0.014 (0.002)	0.051 (0.004)	0.015 (0.003)	6.2 (1.2)	5.6 (0.4)	3.3 (0.3)
Tsankawi/PM-1	0.20 (0.64)	[g]	0.18 (0.08)	3.40 (0.34)	0.001 (0.001)	0.006 (0.001)	0.003 (0.001)	3.7 (0.7)	3.0 (0.3)	4.4 (0.4)
White Rock (East)	0.39 (0.65)	[g]	0.13 (0.06)	2.10 (0.21)	–0.000 (0.001)	0.003 (0.001)	0.001 (0.001)	5.2 (1.2)	4.0 (0.3)	3.0 (0.3)
San Ildefonso	0.43 (0.65)	[g]	0.63 (0.13)	2.15 (0.22)	0.010 (0.002)	0.044 (0.003)	0.009 (0.002)	4.9 (0.9)	3.8 (0.3)	3.0 (0.3)
Mean (std dev)	0.32 (0.09)A	0.34 (0.18)[h]	0.45 (0.29)A	2.93 (0.58)B	0.007 (0.006)A	0.039 (0.040)A	0.007 (0.004)A	5.0 (1.1)A	4.3 (1.2)A	4.4 (1.6)A
On-Site Stations:										
TA-16 (S-Site)	0.09 (0.64)	[g]	0.52 (0.11)	5.21 (0.52)	0.006 0.002	0.025 0.003	0.010 0.002	8.2 (1.6)	5.9 (0.4)	4.5 (0.4)
TA-21 (DP-Site)	0.26 (0.65)	[g]	0.11 (0.04)	2.61 (0.26)	0.004 0.002	0.045 0.005	0.008 0.003	4.8 (0.9)	2.5 (0.2)	2.7 (0.3)
Near TA-33	2.15 (0.77)	[g]	0.37 (0.08)	2.94 (0.29)	0.002 0.001	0.021 0.003	0.012 0.004	4.2 (0.8)	4.3 (0.3)	3.8 (0.4)
TA-50	0.06 (0.64)	[g]	0.72 (0.14)	9.06 (0.91)	0.010 0.002	[g]	0.060 0.013	7.5 (1.3)	5.7 (0.4)	4.0 (0.4)
TA-51	0.15 (0.64)	[g]	0.27 (0.07)	3.33 (0.33)	0.003 0.001	0.012 0.002	0.010 0.003	5.9 (1.1)	4.0 (0.3)	3.0 (0.3)
West of TA-53	0.45 (0.66)	[g]	0.27 (0.06)	3.69 (0.37)	0.003 0.001	0.021 0.002	0.009 0.003	5.4 (1.0)	3.5 (0.3)	2.6 (0.3)
East of TA-53	0.35 (0.66)	[g]	0.41 (0.10)	3.82 (0.38)	0.002 0.001	0.040 0.004	0.010 0.003	7.5 (1.4)	4.9 (0.4)	3.5 (0.3)
East of TA-54	0.72 (0.68)	[g]	0.41 (0.09)	3.04 (0.30)	0.021 0.005	0.054 0.004	0.020 0.004	3.7 (0.7)	2.4 (0.2)	3.3 (0.3)
Potrillo Drive/TA-36	0.16 (0.64)	[g]	0.22 (0.06)	3.18 (0.32)	0.001 0.001	0.009 0.002	0.004 0.001	4.9 (0.9)	3.0 (0.3)	2.8 (0.3)
Near Test Well DT-9	0.08 (0.64)	[g]	0.39 (0.09)	3.73 (0.37)	0.002 0.001	0.021 0.003	0.008 0.003	6.1 (1.1)	4.4 (0.3)	4.3 (0.4)
R-Site Road East	0.03 (0.63)	[g]	0.37 (0.08)	5.19 (0.52)	0.001 0.001	0.017 0.003	0.015 0.003	7.3 (1.4)	5.7 (0.4)	3.2 (0.3)
Two-Mile Mesa	0.20 (0.65)	[g]	0.24 (0.06)	3.59 (0.36)	0.000 0.001	0.010 0.002	0.006 0.002	5.3 (1.0)	3.2 (0.3)	2.7 (0.3)
Mean (std dev)	0.39 (0.59)A	0.42 (0.18)[h]	0.36 (0.16)A	4.12 (1.75)A	0.005 (0.006)B	0.025 (0.015)A	0.014 (0.015)A	5.9 (1.4)A	4.1 (1.2)A	3.4 (0.7)A

[a] (±1 counting uncertainty); values are the uncertainty of the analytical results at the 65% confidence level.
[b] Means within the same column followed by the same upper-case letter are not significantly different from one another using a Wilcoxon Rank Sum Test at the 0.05 probability level.
[c] Regional Statistical Reference Level; this is the upper (95%) limit background concentration (mean + 2 std dev) based on data from 1995 to 1999.
[d] Los Alamos National Laboratory Screening Action Level from Fresquez et al. (1996).
[e] Equivalent to the SAL of 260 pCi/g dry soil at 12% moisture.
[f] See Appendix B for an explanation of the presence of negative values.
[g] Sample lost in analysis, not analyzed, or outliers omitted.
[h] Average of 1993 to 1996 data (Fresquez et al., 1998).

Table 6-2. Strontium-90 (Positively Biased) Concentrations (pCi/g dry) in Surface Soils Collected from Regional Background, Perimeter, and On-Site Locations during 1999[a]

Location	LANL[a]		NMED[b]	
Regional Background Stations:				
Embudo	2.93	(0.44)[c]		
Cochiti	3.25	(0.45)		
Jemez	4.47	(0.52)		
Mean (std dev)	3.55	(0.81)B[d]		
Perimeter Stations:				
Otowi	4.55	(0.56)		
TA-8 (GT Site)	4.04	(0.53)		
Near TA-49 (BNP)	4.88	(0.61)	0.28	(0.21)
East Airport	3.92	(0.51)		
West Airport	3.79	(0.53)	0.03	(0.19)
North Mesa	5.07	(0.64)		
Sportsman’s Club	4.94	(0.57)	0.24	(0.21)
Tsankawi/PM-1	5.20	(0.57)	–0.01	(0.22)
White Rock (East)	3.47	(0.50)		
San Ildefonso	4.70	(0.57)		
Mean (std dev)	4.46	(0.60)B	0.14	(0.15)A
On-Site Stations:				
TA-16 (S-Site)	5.24	(0.60)		
TA-21 (DP-Site)	4.95	(0.64)	0.04	(0.21)
Near TA-33	4.81	(0.60)	0.36	(0.20)
TA-50	5.27	(0.58)	0.40	(0.24)
TA-51	4.66	(0.55)		
West of TA-53	5.35	(0.67)		
East of TA-53	5.33	(0.60)	0.30	(0.20)
East of TA-54	4.47	(0.53)	0.20	(0.21)
Potrillo Drive/TA-36	4.54	(0.59)		
New Test Well DT-9	7.21	(0.68)		
R-Site Road East	5.42	(0.90)	0.27	(0.21)
Two Mile Mesa	4.45	(0.55)		
Mean (std dev)	5.14	(0.75)A	0.26	(0.13)A

[a]Positively biased data refer to LANL data that are considered invalid because of analytical laboratory problems; the data appear in this report for documentary purposes.
[b]NMED split sample data (Dave Englert, NMED, April 11, 2000).
[c](±1 counting uncertainty); values are the uncertainty of the analytical results at the 65% confidence level.
[d]Means within the same column followed by the same upper-case letter are not significantly different from one another using a Wilcoxon Rank Sum Test at the 0.05 probability level.

Table 6-3. Total Recoverable Light, Heavy, and Nonmetal Trace Elements (μg/g dry) in Surface Soils Collected from Regional Background, Perimeter, and On-Site Locations during 1999[a]

Location	Ag	As	Ba	Be	Cd	Cr	Hg	Ni	Pb	Sb	Se	Tl[c]
Regional Background Stations:												
Embudo	1.00[b]	1.00	[d]	0.62	0.20[b]	12.00	0.01[b]	6.40	11.90	0.10[b]	0.20[b]	0.10[b]
Cochiti	1.00[b]	3.00	[d]	0.75	0.20[b]	13.00	0.01[b]	6.80	9.20	0.10[b]	0.20[b]	0.10[b]
Jemez	1.00[b]	2.50	[d]	0.97	0.20[b]	19.00	0.01[b]	11.00	16.40	0.10[b]	0.40	0.10[b]
Mean	1.00A[c]	2.17A	[d]	0.78A	0.20A	14.67A	0.01A	8.06A	12.50B	0.10A	0.27A	0.10B
(std dev)	(0.00)	(1.04)		(0.18)	(0.00)	(3.78)	(0.00)	(2.55)	(3.64)	(0.00)	(0.12)	(0.00)
RSRL[e]	2.09	6.05	194.0	0.73	0.20	14.73	0.02	10.50	14.10	0.20	0.62	0.46
SAL[f]	400.00	6.00	5,600.0	0.90	80.00	400.00	24.00	1,600.00	500.00		400.00	
Perimeter Stations:												
Otowi	1.00[b]	0.70	[d]	0.30	0.20[b]	2.80	0.01	2.00[b]	8.00	0.25[b]	0.20[b]	0.25[b]
TA-8 (GT Site)	1.00[b]	1.20	[d]	0.87	0.20[b]	6.00	0.02	2.00[b]	22.80	0.01[b]	0.20[b]	0.10[b]
TA-49 (BNP)	1.00[b]	2.40	[d]	0.87	0.47	8.30	0.01	6.20	24.50	0.10[b]	0.20[b]	0.30
East Airport	1.00[b]	1.50	[d]	0.71	0.20[b]	7.20	0.01	4.40	18.30	0.10	0.20[b]	0.10[b]
West Airport	1.00[b]	2.70	[d]	1.20	0.20[b]	10.00	0.02	6.50	36.00	0.01[b]	0.20[b]	0.30
North Mesa	1.00[b]	2.70	[d]	1.00	0.20[b]	13.00	0.01	7.10	21.30	0.10[b]	0.20[b]	0.20
Sportsman's Club	1.00[b]	2.50	[d]	0.90	0.20[b]	9.40	0.01[b]	6.50	26.00	0.10[b]	0.20[b]	0.20
Tsankawi/PM-1	1.00[b]	0.70	[d]	0.86	0.20[b]	3.70	0.01	2.00[b]	14.00	0.10[b]	0.20[b]	0.10[b]
White Rock (East)	1.00[b]	2.20	[d]	1.10	0.20[b]	10.00	0.03	7.10	15.80	0.10[b]	0.20[b]	0.20
San Ildefonso	1.00[b]	2.00	[d]	0.63	0.20[b]	11.00	0.03	4.50	15.40	0.10[b]	0.20[b]	0.10[b]
Mean	1.00A	1.86A	[d]	0.84A	0.23A	8.14B	0.02A	4.83A	20.21A	0.10A	0.20A	0.19A
(std dev)	(0.00)	(0.78)		(0.25)	(0.09)	(3.23)	(0.01)	(2.16)	(7.77)	(0.07)	(0.00)	(0.08)
On-Site Stations:												
TA-16 (S-Site)	1.00[b]	2.20	[d]	1.10	0.20[b]	8.90	0.02	8.00	12.70	0.20[b]	0.20[b]	0.20[b]
TA-21 (DP-Site)	1.00[b]	2.70	[d]	0.83	0.20[b]	8.20	0.01	5.90	20.90	0.20[b]	0.20[b]	0.20[b]
Near TA-33	1.00[b]	1.50	[d]	0.71	0.20[b]	5.50	0.01[b]	4.60	13.00	0.20[b]	0.20[b]	0.20[b]
TA-50	1.00[b]	1.50	[d]	0.70	0.51	3.10	0.01	2.00[b]	10.30	0.20[b]	0.20[b]	0.20[b]
TA-51	1.00[b]	2.50	[d]	0.89	0.20[b]	8.20	0.01	6.00	14.40	0.20[b]	0.20[b]	0.20[b]
West of TA-53	1.00[b]	3.20	[d]	0.88	0.20[b]	8.60	0.01	5.80	14.00	0.20[b]	0.20[b]	0.20[b]
East of TA-53	1.00[b]	2.40	[d]	1.10	0.20[b]	5.90	0.02	4.90	14.00	0.20[b]	0.20[b]	0.20[b]
Potrillo Drive/TA-36	1.00[b]	2.80	[d]	0.66	0.20[b]	8.90	0.46	4.80	13.30	0.20[b]	0.20[b]	0.20[b]
East of TA-54	1.00[b]	1.50	[d]	0.74	0.20[b]	4.50	0.01	2.00[b]	10.00	0.20[b]	0.20[b]	0.20[b]
Near Test Well DT-9	1.00[b]	1.70	[d]	0.85	0.20[b]	8.50	0.01	5.90	15.00	0.20[b]	0.20[b]	0.20[b]
R-Site Road	1.00[b]	3.70	[d]	1.10	0.20[b]	12.00	0.02	5.90	15.70	0.20[b]	0.20[b]	0.20[b]
Two-Mile Mesa	1.00[b]	2.80	[d]	0.87	0.20[b]	10.00	0.02	6.60	13.00	0.20[b]	0.20[b]	0.40
Mean	1.00A	2.38A	[d]	0.87A	0.23A	7.69B	0.05A	5.20A	13.86B	0.20A	0.20A	0.22A
(std dev)	(0.00)	(0.72)		(0.16)	(0.09)	(2.48)	(0.13)	(1.74)	(2.78)	(0.00)	(0.00)	(0.06)

[a] Analysis by EPA Method 3051 for total recoverable metals.
[b] All less-than values were converted to one-half the concentration.
[c] Means within the same column followed by the same upper-case letter are not significantly different from one another using a Wilcoxon Rank Sum Test at the 0.05 probability level.
[d] Sample lost in analysis, not analyzed, or outlier omitted.
[e] Regional Statistical Reference Level; this is the upper (95%) limit background concentration (mean + 2 std dev) based on data from 1992 to 1999.
[f] Los Alamos National Laboratory Screening Action Level.

Table 6-4. Radionuclides in Produce Collected from Regional Background, Perimeter, and On-Site Locations during 1999[a]

Location	^{3}H (pCi/mL)		^{137}Cs (10^{-3} pCi/g dry)		^{90}Sr (10^{-3} pCi/g dry)		^{234}U (10^{-3} pCi/g dry)		^{235}U (10^{-4} pCi/g dry)		^{238}U (10^{-3} pCi/g dry)		^{238}Pu (10^{-5} pCi/g dry)		^{239}Pu (10^{-5} pCi/g dry)		^{241}Am (10^{-5} pCi/g dry)	
Regional Background Stations																		
Española/Santa Fe/Jemez:																		
Cherries	[e]		0.00	(200.90)[c]	351.8	(139.2)	9.54	(0.91)	4.21	(2.74)	9.81	(0.90)	–49.00	(25.48)[b]	5.88	(19.60)	–29.40	(56.84)
Squash	[e]		16.64	(29.74)	352.4	(70.7)	5.20	(0.90)	0.00	(0.00)	3.07	(0.59)	–61.57	(37.99)	–44.54	(41.92)	–13.10	(10.48)
Corn	[e]		12.16	(10.50)	49.3	(26.9)	1.02	(0.32)	–0.58	(1.15)	0.65	(0.21)	5.76	(11.52)	17.92	(10.24)	–7.68	(4.48)
Apple	[e]		15.08	(14.76)	23.8	(8.64)	2.61	(0.28)	0.97	(0.72)	2.71	(0.28)	7.92	(6.84)	–5.04	(6.84)	–1.80	(1.44)
Cucumber	[e]		3.33	(14.76)	276.6	(67.8)	6.57	(0.93)	3.19	(3.59)	4.56	(0.73)	5.32	(19.95)	26.60	(19.95)	15.96	(6.65)
Tomatoes	[e]		3.70	(7.30)	–3.0	(37.0)	1.90	(0.48)	2.10	(2.00)	0.97	(0.33)	–11.00	(8.00)	24.00	(16.00)	–13.00	(8.00)
Mean (SD)	–0.03	(0.22)[f]	8.49	(7.00)	175.2	(169.4)	4.47	(3.24)	1.65	(1.86)	3.63	(3.35)	–17.10	(30.61)B[a]	4.14	(26.63)	–8.17	(14.98)
RSRL[d]	0.39		73.8		81.6		6.5		2.6		5.6		11.2		16.2		20.5	
Perimeter Stations																		
Los Alamos:																		
Squash	[e]		8.25	(17.82)	125.8	(44.5)	0.69	(0.38)	0.26	(2.49)	1.01	(0.43)	89.09	(28.82)	32.75	(24.89)	–9.17	(5.24)
Apples	[e]		5.15	(4.86)	–0.7	(6.8)	–0.12	(0.13)	0.36	(0.86)	0.10	(0.10)	16.56	(7.56)	–7.20	(3.96)	–3.60	(2.16)
Plums	[e]		11.07	(5.90)	–32.0	(22.1)	0.64	(0.43)	2.34	(2.58)	0.68	(0.38)	43.05	(25.83)	7.38	(23.37)	7.38	(4.92)
Tomatoes	[e]		4.40	(10.10)	19.0	(18.0)	–0.05	(0.47)	–0.20	(1.60)	0.21	(0.20)	79.00	(20.00)	–9.00	(14.00)	–9.00	(7.00)
Peaches	[e]		–6.38	(62.09)	16.7	(16.0)	1.35	(0.33)	–0.23	(1.44)	1.02	(0.27)	148.20	(21.28)	2.28	(8.36)	–10.64	(6.84)
Mean (SD)	0.19	(0.36)[f]	4.50	(6.63)	25.8	(59.5)	0.50	(0.61)	0.51	(1.06)	0.60	(0.43)	75.18	(50.02)A	5.24	(16.79)	–5.01	(7.42)
White Rock/Pajarito Acres:																		
Squash	[e]		12.71	(26.72)	221.4	(62.9)	1.51	(0.79)	1.83	(5.63)	0.56	(0.34)	403.48	(44.54)	3.93	(18.34)	–7.86	(5.24)
Squash	[e]		43.75	(28.95)	233.2	(59.0)	1.41	(0.47)	–2.49	(2.75)	1.70	(0.59)	153.27	(47.16)	5.24	(28.82)	–2.62	(3.93)
Tomatoes	[e]		5.90	(12.50)	60.0	(43.0)	0.27	(0.42)	–1.40	(3.70)	0.27	(0.20)	6.00	(18.00)	–9.00	(13.00)	7.00	(4.00)
Corn	[e]		19.14	(17.98)	46.7	(25.0)	0.24	(0.21)	0.32	(1.09)	0.01	(0.06)	45.44	(16.00)	–10.24	(10.24)	9.60	(3.84)
Apples	[e]		10.22	(6.88)	159.9	(56.2)	0.14	(0.16)	–0.76	(0.65)	0.11	(0.07)	3.60	(5.76)	6.48	(5.76)	1.08	(1.08)
Rhubarb	[e]		11.39	(6.24)	[e]		2.00	(0.71)	–1.09	(3.43)	1.86	(0.54)	187.98	(24.18)	15.60	(10.14)	–3.90	(3.12)
Mean (SD)	–0.03	(0.26)[f]	17.19	(13.70)	144.2	(87.6)	0.93	(0.81)	0.60	(1.50)	0.75	(0.82)	133.30	(153.06)A	2.00	(9.90)	0.55	(6.70)

Table 6-4. Radionuclides in Produce Collected from Regional Background, Perimeter, and On-Site Locations during 1999[a] (Cont.)

Location	^{3}H (pCi/mL)	^{137}Cs (10^{-3} pCi/g dry)	^{90}Sr (10^{-3} pCi/g dry)	^{234}U (10^{-3} pCi/g dry)	^{235}U (10^{-4} pCi/g dry)	^{238}U (10^{-3} pCi/g dry)	^{238}Pu (10^{-5} pCi/g dry)	^{239}Pu (10^{-5} pCi/g dry)	^{241}Am (10^{-5} pCi/g dry)
Cochiti:									
Corn	e	7.55 (10.62)	16.0 (20.5)	0.31 (0.46)	–0.26 (3.71)	0.38 (0.18)	48.64 (21.12)	–23.04 (16.00)	–3.84 (3.20)
Tomatoes	e	28.70 (18.80)	67.0 (36.0)	–0.22 (0.97)	–3.00 (6.50)	0.18 (0.28)	212.00 (38.00)	–37.00 (22.00)	–23.00 (27.00)
Apples	e	–4.75 (61.49)	40.3 (11.9)	0.28 (0.21)	–0.76 (1.37)	0.19 (0.12)	0.36 (5.76)	1.44 (5.40)	–4.68 (2.88)
Cucumbers	e	29.79 (34.45)	99.8 (49.2)	1.78 (0.58)	–0.40 (2.40)	2.30 (0.51)	236.74 (39.90)	–13.30 (25.27)	6.65 (5.32)
Chile	e	4.75 (14.97)	45.3 (27.0)	0.84 (0.68)	–2.41 (3.80)	0.47 (0.25)	–10.95 (7.30)	9.49 (9.49)	–5.84 (3.65)
Mean (SD)	0.04 (0.29)[f]	13.21 (15.34)	53.7 (31.5)	0.60 (0.76)	–1.37 (1.25)	0.70 (0.90)	97.36 (118.41)A	–12.48 (18.64)	–6.14 (10.67)
San Ildefonso Pueblo:									
Corn	e	–6.78 (114.69)	–9.0 (12.8)	0.45 (0.27)	–0.32 (0.83)	0.42 (0.18)	28.16 (16.64)	–24.96 (15.36)	–24.32 (414.08)
Squash	e	0.00 (213.79)	91.7 (38.0)	6.68 (1.07)	4.32 (3.67)	5.92 (0.81)	–20.96 (37.99)	–10.48 (37.99)	–18.34 (13.10)
Choke Cherry	e	–10.00 (43.81)	55.9 (23.5)	4.38 (0.65)	2.45 (2.45)	4.04 (0.60)	28.42 (17.64)	1.96 (12.74)	–15.68 (9.80)
Cucumbers	e	28.33 (31.92)	168.9 (41.2)	15.77 (1.37)	2.00 (2.40)	12.15 (1.20)	172.90 (30.59)	–15.96 (15.96)	–29.26 (19.95)
Tomatoes	e	–28.00 (101.00)	17.0 (19.0)	2.81 (0.58)	–0.20 (2.10)	2.32 (0.50)	80.00 (20.00)	–10.00 (9.00)	7.00 (4.00)
Mean (SD)	–0.12 (0.31)[f]	–3.29 (20.48)	64.9 (69.6)	6.02 (5.91)	1.65 (1.95)	4.97 (4.50)	57.70 (73.63)AC	–11.88 (9.81)	–16.12 (13.96)
On-Site Stations									
LANL (Mesa):									
Nectarines	e	3.82 (3.35)	4.7 (14.0)	0.28 (0.25)	–0.54 (0.93)	0.32 (0.16)	–0.78 (15.60)	10.14 (14.82)	14.04 (4.68)
Peaches	e	19.38 (8.59)	26.6 (16.0)	0.36 (0.36)	–0.53 (1.37)	0.26 (0.16)	30.40 (13.68)	4.56 (11.40)	1.52 (2.28)
Apples	e	0.00 (55.44)	27.4 (8.3)	0.50 (0.16)	–0.07 (0.82)	0.32 (0.11)	–0.36 (4.32)	6.12 (4.68)	1.08 (1.08)
Crab Apples	e	7.92 (5.88)	38.8 (10.4)	1.33 (0.26)	0.28 (0.60)	0.87 (0.20)	5.60 (7.20)	22.00 (10.40)	–0.40 (0.80)
Apples	e	5.58 (2.99)	4.7 (7.2)	0.15 (0.10)	0.43 (0.61)	0.22 (0.10)	4.32 (5.76)	5.04 (5.40)	–1.80 (1.44)
Mean (SD)	1.49 (1.11)[f]	7.34 (7.33)	20.4 (15.2)	0.52 (0.47)	–0.09 (0.45)	0.40 (0.27)	7.84 (12.92)BC	9.57 (7.29)	2.89 (6.37)

[a] There are no concentration guides for produce, and with the exception of ^{238}Pu, there were no statistical differences in any of the mean values from perimeter and on-site locations when compared with regional background at the 0.05 probability level using a Wilcoxon Rank Sum Test. Means within the same column for ^{238}Pu followed by the same upper-case letter are not significantly different from one another using a Wilcoxon Rank Sum Test at the 0.05 probability level.

[b] See Appendix B for an explanation of the presence of negative values.

[c] (±1 counting uncertainty); values are the uncertainty of the analytical results at the 65% confidence level.

[d] Regional Statistical Reference Level; this is the upper (95%) limit background concentration (mean + 2 std dev) based on data from 1993 to 1997.

[e] Sample lost in analysis, not analyzed, or outlier omitted.

[f] Average of 1994 to 1998 data.

Table 6-5. Tritium (Negatively Biased) Concentrations in Produce Collected from Regional Background, Perimeter, and On-Site Locations during 1999[a]

Location	^3H (pCi/mL)[b]	
Regional Background Stations		
Española/Santa Fe/Jemez:		
Cherries	0.06	(0.63)[c]
Squash	–0.10	(0.61)
Corn	0.01	(0.62)
Apple	–0.28	(0.60)
Cucumbers	–0.03	(0.62)
Tomatoes	–0.01	(0.62)
Mean (std dev)	–0.06	(0.12)A[d]
Perimeter Stations		
Los Alamos:		
Squash	–0.26	(0.60)
Apples	0.50	(0.66)
Plums	–0.10	(0.61)
Tomatoes	–0.05	(0.62)
Peaches	–0.28	(0.60)
Mean (std dev)	0.04	(0.32)A
White Rock/Pajarito Acres:		
Squash	–0.10	(0.61)
Squash	–0.11	(0.61)
Tomatoes	–0.30	(0.60)
Corn	–0.06	(0.62)
Apples	–0.12	(0.61)
Rhubarb	–0.20	(0.61)
Mean (std dev)	–0.15	(0.09)A
Cochiti:		
Corn	–0.21	(0.60)
Tomatoes	–0.12	(0.61)
Apples	–0.18	(0.61)
Cucumbers	–0.24	0.60)
Chile	–0.38	(0.59)
Mean (std dev)	–0.23	(0.08)A
San Ildefonso Pueblo:		
Corn	–0.11	(0.61)
Squash	–0.18	(0.61)
Choke Cherry	–0.25	(0.60)
Cucumbers	–0.16	(0.61)
Tomatoes	0.04	(0.62)
Mean (std dev)	–0.13	(0.11)A

Table 6-5. Tritium (Negatively Biased) Concentrations in Produce Collected from Regional Background, Perimeter, and On-Site Locations during 1999[a] (Cont.)

Location	^3H (pCi/mL)[b]	
On Site Stations		
LANL (Mesa):		
Nectarines	0.04	(0.62)
Peaches	2.56	(0.79)
Apples	0.94	(0.69)
Crab Apples	0.59	(0.66)
Apples	0.02	(0.62)
Mean (std dev)	0.81	(1.06)A

[a] Negatively biased data are defined as a data set that contains over 50% negative numbers and are considered invalid because of analytical laboratory problems; the data appear in this report for documentary purposes.
[b] pCi/mL of tissue moisure.
[c] (±1 counting uncertainty); values are the uncertainty of the analytical results at the 65% confidence level.
[d] Means within the column followed by the same upper-case letter are not significantly different from one another using a Wilcoxon Rank Sum Test at the 0.05 probability level.

Table 6-6. Total Recoverable Trace Elements (μg/g dry) in Produce Collected from Regional Background, Perimeter, and On-Site Locations during 1999[a]

Location	Ag	As	Ba	Be	Cd	Cr	Hg	Ni	Pb	Se	Tl	Zn
Regional Background Stations												
Española/Santa Fe/Jemez:												
Cherry	1.00[b]	0.25[b]	5.30	0.10[b]	0.50[b]	0.50[b]	0.03[b]	1.00[b]	7.3	0.20[b]	0.20[b]	5.50
Squash	1.00[b]	0.25[b]	14.00	0.10[b]	0.50[b]	0.50[b]	0.03[b]	1.00[b]	2.2	0.20[b]	0.20[b]	33.00
Corn	1.00[b]	0.25[b]	0.42	0.10[b]	0.50[b]	0.50[b]	0.03[b]	20.00	34.3	0.20[b]	0.20[b]	33.00
Apple	1.00[b]	0.25[b]	0.65	0.10[b]	0.50[b]	0.50[b]	0.03[b]	1.00[b]	2.1	0.20[b]	0.20[b]	1.20
Cucumber	1.00[b]	0.25[b]	13.00	0.10[b]	0.50[b]	2.30	0.03[b]	2.10	2.6	0.20[b]	0.20[b]	29.00
Tomato	1.00[b]	0.25[b]	12.00	0.10[b]	0.50[b]	0.50[b]	0.03[b]	1.00[b]	2.9	0.20[b]	0.20[b]	15.00
Mean	1.00	0.25	7.56	0.10	0.50	0.80	0.03	4.35	8.6	0.20	0.20	19.45
(std dev)	(0.00)	(0.00)	(6.24)	(0.00)	(0.00)	(0.73)	(0.00)	(7.68)	(12.8)	(0.00)	(0.00)	(14.18)
RSRL[c]	1.38	0.66	27.43	0.53	0.46	3.98	0.06	23.50	22.0	0.3	0.20	30.3
Perimeter Stations												
Los Alamos:												
Squash	1.00[b]	0.25[b]	9.80	0.10[b]	0.50[b]	0.50[b]	0.03[b]	15.00	24.0	0.20[b]	0.20[b]	48.00
Apple	1.00[b]	0.25[b]	5.00	0.10[b]	0.50[b]	0.50[b]	0.03[b]	0.10[b]	4.1	0.20[b]	0.20[b]	2.50
Plum	1.00[b]	0.25[b]	2.10	0.10[b]	0.50[b]	0.50[b]	0.03[b]	0.10[b]	8.0	0.20[b]	0.20[b]	7.20
Tomato	1.00[b]	0.25[b]	2.30	0.10[b]	0.50[b]	0.50[b]	0.03[b]	1.00[b]	9.0	0.20[b]	0.20[b]	15.00
Peach	1.00[b]	0.25[b]	4.40	0.10[b]	0.50[b]	0.50[b]	0.03[b]	1.00[b]	0.8	0.20[b]	0.20[b]	8.10
Mean	1.00	0.25	4.72	0.10	0.50	0.50	0.03	3.44	9.2	0.20	0.20	16.16
(std dev)	(0.00)	(0.00)	(3.11)	(0.00)	(0.00)	(0.00)	(0.00)	(6.48)	(8.9)	(0.00)	(0.00)	(18.35)
White Rock /Pajarito Acres:												
Squash	1.00[b]	0.25[b]	5.40	0.10[b]	0.50[b]	0.50[b]	0.03[b]	16.00	11.1	0.20[b]	0.20[b]	27.00
Squash	1.00[b]	0.25[b]	6.30	0.10[b]	0.50[b]	1.00	0.03[b]	1.00[b]	1.9	0.20[b]	0.20[b]	32.00
Tomato	1.00[b]	0.25[b]	1.80	0.10[b]	0.50[b]	0.50[b]	0.03[b]	1.00[b]	2.9	0.20[b]	0.20[b]	22.00
Corn	1.00[b]	0.25[b]	0.24	0.10[b]	0.50[b]	0.50[b]	0.03[b]	1.00[b]	19.0	0.20[b]	0.20[b]	27.00
Apple	1.00[b]	0.25[b]	2.50	0.10[b]	0.50[b]	0.50[b]	0.03[b]	1.00[b]	7.0	0.20[b]	0.20[b]	1.90
Rhubarb	1.00[b]	0.25[b]	27.00	0.10[b]	0.50[b]	0.50[b]	0.03[b]	1.00[b]	3.0	0.20[b]	0.20[b]	10.00
Mean	1.00	0.25	7.21	0.10	0.50	0.58	0.03	3.50	7.5	0.20	0.20	19.98
(std dev)	(0.00)	(0.00)	(9.96)	(0.00)	(0.00)	(0.20)	(0.00)	(6.12)	(6.6)	(0.00)	(0.00)	(11.61)

Table 6-6. Total Recoverable Trace Elements (μg/g dry) in Produce Collected from Regional Background, Perimeter, and On-Site Locations during 1999[a] (Cont.)

Location	Ag	As	Ba	Be	Cd	Cr	Hg	Ni	Pb	Se	Tl	Zn
Cochiti/Peña Blanca/Santo Domingo:												
Corn	1.00[b]	0.25[b]	0.36	0.10[b]	0.50[b]	0.50[b]	0.03[b]	3.40	8.1	0.20[b]	0.20[b]	27.00
Tomato	1.00[b]	0.25[b]	2.40	0.10[b]	0.50[b]	0.50[b]	0.03[b]	3.00	7.9	0.20[b]	0.20[b]	14.00
Apple	1.00[b]	0.25[b]	1.00	0.10[b]	0.50[b]	1.60	0.03[b]	1.00[b]	1.2	0.20[b]	0.20[b]	3.10
Cucumber	1.00[b]	0.25[b]	17.00	0.10[b]	0.50[b]	0.50[b]	0.03[b]	1.00[b]	1.9	0.20[b]	0.20[b]	34.00
Chile	1.00[b]	0.25[b]	1.00	0.10[b]	0.50[b]	0.50[b]	0.03[b]	3.20	4.9	0.20[b]	0.20[b]	17.00
Mean	1.00	0.25	4.35	0.10	0.50	0.72	0.03	2.32	4.8	0.20	0.20	19.02
(std dev)	(0.00)	(0.00)	(7.11)	(0.00)	(0.00)	(0.49)	(0.00)	(1.21)	(3.2)	(0.00)	(0.00)	(11.95)
San Ildefonso Pueblo:												
Corn	1.00[b]	0.25[b]	0.53	0.10[b]	0.50[b]	0.50[b]	0.03[b]	2.90	15.1	0.20[b]	0.20[b]	26.00
Squash	1.00[b]	0.25[b]	13.00	0.10[b]	0.50[b]	0.50[b]	0.03[b]	1.00[b]	4.4	0.20[b]	0.20[b]	26.00
Plum	1.00[b]	0.25[b]	1.50	0.10[b]	0.50[b]	0.50[b]	0.03[b]	17.00	6.8	0.20[b]	0.20[b]	4.00
Cucumber	1.00[b]	0.25[b]	21.00	0.10[b]	0.50[b]	0.50[b]	0.03[b]	1.00[b]	1.5	0.20[b]	0.20[b]	28.00
Tomato	1.00[b]	0.25[b]	2.20	0.10[b]	0.50[b]	0.50[b]	0.03[b]	1.00[b]	6.9	0.20[b]	0.20[b]	14.00
Mean	1.00	0.25	7.65	0.10	0.50	0.05	0.03	4.58	6.9	0.20	0.20	19.60
(std dev)	(0.00)	(0.00)	(9.01)	(0.00)	(0.00)	(0.00)	(0.00)	(6.99)	(5.1)	(0.00)	(0.00)	(10.33)
On-Site Stations												
LANL:												
Nectarine	1.00[b]	0.25[b]	6.40	0.10[b]	0.50[b]	0.50[b]	0.03[b]	1.00[b]	6.3	0.20[b]	0.20[b]	8.30
Peach	1.00[b]	0.25[b]	2.90	0.10[b]	0.50[b]	0.50[b]	0.03[b]	1.00[b]	2.7	0.20[b]	0.20[b]	9.10
Apple	1.00[b]	0.25[b]	3.90	0.10[b]	0.50[b]	0.50[b]	0.03[b]	1.00[b]	2.8	0.20[b]	0.20[b]	5.50
Crab apple	1.00[b]	0.25[b]	15.00	0.10[b]	0.50[b]	0.50[b]	0.03[b]	1.00[b]	5.7	0.20[b]	0.20[b]	5.00
Apple	1.00[b]	0.25[b]	4.10	0.10[b]	0.50[b]	0.50[b]	0.03[b]	1.00[b]	6.5	0.20[b]	0.20[b]	2.00
Mean	1.00	0.25	6.46	0.10	0.50	0.50	0.03	1.00	4.8	0.20	0.20	5.98
(std dev)	(0.00)	(0.00)	(4.94)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(1.9)	(0.00)	(0.00)	(2.83)

[a] Analysis by EPA Method 3051 for total recoverable metals, and there were no statistical differences in any of the mean concentrations form perimeter and on-site locations as compared with regional background at the 0.05 probability level using a Wilcoxon Rank Sum Test.

[b] Less-than values were converted to one-half the concentration.

[c] Regional Statistical Reference Level; this is the upper (95%) limit background concentration (mean + 2 std dev) based on data from 1994 to 1996.

Table 6-7. Radionuclides in Eggs Collected from Regional Background and Perimeter Locations during 1999[a]

Radionuclide	Perimeter San Ildefonso Pueblo	Perimeter Los Alamos Townsite	Perimeter White Rock Pajarito Acres	Regional Background Española	Regional Background RSRL[d]
^{238}Pu (pCi/L)	0.0124 (0.0068)[b]	–0.0003 (0.0058)[c]	0.0662 (0.0119)	0.0018 (0.0049)	0.045
^{239}Pu (pCi/L)	0.0202 (0.0100)	0.0291 (0.0102)	0.0322 (0.0100)	–0.0014 (0.0041)	0.158
^{90}Sr (pCi/L)	5.14 (0.73)	6.64 (0.75)	9.73 (0.89)	11.05 (1.01)	13.54
Total U (μg/L)	0.12 (0.01)	0.17 (0.02)	0.10 (0.01)	0.13 (0.01)	0.69
Tritium (pCi/mL)	0.16 (0.63)	0.41 (0.64)	0.06 (0.62)	0.03 (0.62)	0.47
^{137}Cs (pCi/L)	5.4 (14.9)	3.5 (11.3)	3.5 (5.8)	3.7 (14.1)	20.53
^{241}Am (pCi/L)	0.0119 (0.0053)	0.0066 (0.0028)	0.0144 (0.0054)	0.0224 (0.0069)	0.035

[a] 1L is equal to approximately 24 eggs, and the density of eggs is approximately 1,135 g/L.
[b] (±1 counting uncertainty); values are the uncertainty of the analytical results at the 65% confidence level.
[c] See Appendix B for an explanation of the presence of negative values.
[d] Regional Statistical Reference Level; this is the upper (95%) limit background concentration (mean + 2 std dev) based on data from 1995 to 1999.

Table 6-8. Radionuclides in Goat's Milk Collected from Regional Background and Perimeter Locations during 1999

Radionuclide	Perimeter Los Alamos		Perimeter White Rock/Pajarito Acres		Regional Background Albuquerque		Regional Background RSRL[a]
^{238}Pu (pCi/L)	–0.0179	(0.0145)[b,c]	0.0071	(0.0083)	–0.0240	(0.0137)	0.011
^{239}Pu (pCi/L)	–0.0098	(0.0135)	0.0064	(0.0060)	–0.0146	(0.0075)	0.020
^{90}Sr (pCi/L)	2.81	(0.54)	2.04	(0.35)	0.86	(0.21)	6.95
Total U (μg/L)		[d]		[d]		[d]	0.85
Tritium (pCi/mL)	0.28	(0.63)	0.31	(0.63)	–0.70	(0.61)	0.07
^{137}Cs (pCi/L)	–8.40	(104.00)	14.00	(10.00)	7.70	(12.00)	19.0
^{131}I (pCi/L)	0.00	(98.00)	19.00	(10.00)	–4.00	(77.00)	15.4
^{241}Am (pCi/L)	–0.014	(0.23)	0.054	(0.017)	–0.011	(0.059)	0.11

[a] Regional Statistical Reference Level; this is the upper (95%) limit background (mean + 2 std dev) based on data from 1994 to 1998.
[b] (±1 counting uncertainty); values are the uncertainty of the analytical results at the 65% confidence level.
[c] See Appendix B for an explanation of the presence of negative values.
[d] Sample lost in analysis, not analyzed, or outlier omitted.

Table 6-9. Radionuclides in Game and Nongame Fish Upstream and Downstream of Los Alamos National Laboratory during 1999

Location	^{3}H[a] (pCi/mL)	^{90}Sr (10^{-2} pCi/g dry)	^{137}Cs (10^{-2} pCi/g dry)	^{tot}U (ng/g dry)	^{238}Pu (10^{-5} pCi/g dry)	^{239}Pu (10^{-5} pCi/g dry)	^{241}Am (10^{-5} pCi/g dry)
Game Fish							
Upstream (Abiquiu, Heron, and El Vado):							
Crappie	[b]	1.45 (3.03)[c]	0.50 (0.61)	2.42 (1.21)	13.31 (10.89)	43.56 (18.15)	[b]
Crappie	[b]	4.72 (3.27)	1.17 (0.85)	3.63 (1.21)	9.68 (15.73)	14.52 (15.73)	[b]
Crappie	[b]	–1.09 (3.27)[d]	0.61 (0.24)	2.42 (1.21)	10.89 (12.10)	10.89 (13.31)	[b]
Walleye	[b]	1.21 (2.54)	1.33 (0.36)	2.42 (1.21)	10.89 (8.47)	20.57 (13.31)	[b]
Mean (std dev)	0.00 (0.30)[e]	1.57 (2.39)A[f]	0.90 (0.41)A	2.72 (0.61)A	11.19 (1.52)A	22.39 (14.67)A	22.3 (21.6)[g]
RSRL[h]	0.20	17.00	27.70	6.50	23.6	28.3	28.90
Downstream (Cochiti):							
Crappie	[b]	5.81 (2.90)	0.57 (0.19)	7.26 (1.21)	2.42 (29.04)	27.83 (25.41)	[b]
Crappie	[b]	5.81 (2.66)	0.24 (0.96)	6.05 (1.21)	62.92 (55.66)	60.50 (59.29)	[b]
Pike	[b]	0.73 (2.90)	0.00 (1.75)	2.42 (1.21)	12.10 (13.31)	7.26 (18.15)	[b]
Pike/Bass	[b]	5.08 (3.39)	0.00 (1.48)	3.63 (1.21)	[b]	[b]	[b]
Walleye	[b]	1.21 (2.90)	1.89 (0.30)	3.63 (1.21)	–7.26 (22.99)	26.62 (23.00)	[b]
Mean (std dev)	0.23 (0.40)[e]	3.73 (2.54)A	0.54 (0.79)A	4.60 (1.99)A	17.55 (31.27)A	30.55 (22.08)A	67.9 (103.3)[g]
Nongame Fish							
Upstream (Abiquiu, Heron, and El Vado):							
Catfish	[b]	4.66 (3.23)	0.38 (0.19)	12.35 (0.95)	0.95 (9.50)	7.60 (9.50)	[b]
Catfish	[b]	1.43 (2.95)	0.00 (2.51)	13.30 (0.95)	–2.85 (19.95)	0.00 (18.05)	[b]
Catfish	[b]	5.23 (3.04)	–0.04 (1.59)	13.30 (0.95)	–5.70 (24.70)	12.35 (33.25)	[b]
White Sucker	[b]	7.98 (3.04)	0.54 (0.29)	4.75 (0.95)	52.25 (37.05)	29.45 (26.60)	[b]
Carp	[b]	7.03 (2.57)	0.23 (0.19)	12.35 (0.95)	–5.70 (14.25)	–1.90 (15.20)	[b]
Carp	[b]	5.13 (2.10)	0.34 (0.19)	5.70 (0.95)	–23.75 (16.15)	18.08 (21.85)	[b]
Mean (std dev)	–0.03 (0.19)[e]	5.24 (2.26)A	0.24 (0.23)A	10.29 (3.96)A	2.53 (25.81)A	10.93 (11.76)A	14.4 (12.2)[g]
RSRL[h]	0.20	13.20	26.90	16.20	9.80	19.20	16.14

Table 6-9. Radionuclides in Game and Nongame Fish Upstream and Downstream of Los Alamos National Laboratory during 1999 (Cont.)

Location	^{3}H[a] (pCi/mL)	^{90}Sr (10^{-2} pCi/g dry)	^{137}Cs (10^{-2} pCi/g dry)	^{tot}U (ng/g dry)	^{238}Pu (10^{-5} pCi/g dry)	^{239}Pu (10^{-5} pCi/g dry)	^{241}Am (10^{-5} pCi/g dry)
Downstream (Cochiti):							
Catfish	[b]	0.19 (2.00)	0.00 (2.36)	14.25 (1.90)	7.60 (7.60)	19.95 (11.40)	[b]
White Sucker	[b]	5.61 (2.47)	0.00 (1.11)	6.65 (0.95)	9.50 (12.35)	27.55 (14.25)	[b]
Carp	[b]	2.95 (2.57)	0.20 (2.47)	26.60 (2.85)	4.75 (9.50)	10.45 (10.45)	[b]
Carp	[b]	7.98 (2.66)	0.33 (1.19)	29.45 (2.85)	17.10 (7.60)	43.70 (12.35)	[b]
Carp	[b]	6.08 (2.66)	–0.28 (5.00)	28.50 (2.85)	18.05 (17.10)	12.35 (15.20)	[b]
Mean (std dev)	0.40 (0.50)[e]	4.56 (3.03)A	0.05 (0.23)A	21.09 (10.13)A	11.40 (5.89)A	22.80 (13.50)A	30.2 (42.7)[g/]

[a] pCi/mL of tissue moisture.
[b] Sample lost in analysis, not analyzed, or outlier omitted.
[c] (±1 counting uncertainty); values are the uncertainty of the analytical results at the 65% confidence level.
[d] See Appendix B for an explanation of the presence of negative values.
[e] Data from 1995 to 1998.
[f] Means within the same column and fish type followed by the same upper-case letter are not significantly different from one another using a Wilcoxon Rank Sum Test at the 0.05 probability level.
[g] Data from 1996 to 1998.
[h] Regional Statistical Reference Level; this is the upper (95%) limit background concentration (mean + 2 std dev) based on data from 1981–1999.

Table 6-10. Tritium and Americium-241 (Negatively Biased) Concentrations in Game and Nongame Fish Upstream and Downstream of Los Alamos National Laboratory during 1999[a]

Location	^{3}H (pCi/mL)[b]		^{241}Am (10^{-5} pCi/g dry)	
Game Fish				
Upstream (Abiquiu, Heron, El Vado):				
Crappie	–0.09	(0.60)[c]	–84.70	(263.78)
Crappie	–0.18	(0.59)	–21.78	(49.61)
Crappie	–0.28	(0.58)	–49.61	(268.62)
Walleye	–0.08	(0.60)	2.42	(6.05)
Mean (std dev)	–0.16	(0.09)A[d]	–38.42	(37.47)A
Downstream (Cochiti):				
Crappie	0.02	(0.60)	–6.05	(8.47)
Crappie	–0.34	(0.57)	–64.13	(119.79)
Pike	–0.17	(0.59)	–1.21	(4.84)
Pike/Bass	–0.51	(0.56)	–32.67	(110.11)
Walleye	–0.26	(0.58)	–55.66	(111.32)
Mean (std dev)	–0.25	(0.20)A	–31.94	(28.35)A
Nongame Fish				
Upstream (Abiquiu, Heron, El Vado:				
Catfish	–0.18	(0.59)	–31.35	(28.50)
Catfish	–0.16	(0.59)	–40.85	(216.60)
Catfish	–0.22	(0.59)	–38.00	(19.95)
White Sucker	–0.03	(0.61)	–14.25	(19.00)
Carp	–0.21	(0.59)	8.55	(9.50)
Carp	–0.42	(0.57)	–34.20	(537.70)
Mean (std dev)	–0.20	(0.13)A	–25.02	(18.90)A
Downstream (Cochiti):				
Catfish	–0.12	(0.59)	–44.65	(38.95)
White Sucker	–0.08	(0.59)	–11.40	(7.60)
Carp	–0.15	(0.59)	–42.75	(30.40)
Carp	–0.09	(0.59)	–42.75	(42.75)
Carp	–0.35	(0.57)	1.90	(4.75)
Means (std dev)	–0.16	(0.11)A	–27.93	(21.69)A

[a] Negatively biased data are defined as a data set that contains over 50% negative numbers and are considered invalid because of analytical laboratory problems; the data appear in this report for documentary purposes.
[b] pCi/mL of tissue moisture.
[c] (±1 counting uncertainty); values are the uncertainty of the analytical results at the 65% confidence level.
[d] Means within the same column and fish type followed by the same upper-case letter are not significantly different from one another using a Wilcoxon Rank Sum Test at the 0.05 probability level.

Table 6-11. Total Recoverable Mercury in Bottom-Feeding Fish (µg/g wet) Collected Upstream and Downstream of Los Alamos National Laboratory in 1999

Abiquiu Reservoir (Background)		Cochiti Reservoir		RSRL[a]
0.28	(catfish)	0.17	(catfish)	
0.20	(catfish)	0.05	(white sucker)	
0.23	(catfish)	0.11	(carp)	
0.06	(white sucker)	0.28	(carp)	
0.42	(carp)	0.11	(carp)	
0.22	(carp)			
0.24	(0.12)A[b]	0.14	(0.09)B	0.41

[a] Regional Statistical Reference Level; this is the upper (95%) limit background concentration (mean + 2 std dev) based on data from 1991 to 1996.
[b] Means within the same row followed by the same upper-case letter are not significantly different from one another using a Students-test on log-transformed data at the 0.05 probabibility level.

Table 6-12. Radionuclides in Muscle and Bone Tissues of Elk Collected from On-Site and Regional Background Areas during 1998 and 1999

Tissue/Location/Date/Sample	^{3}H[a] (pCi/mL)	^{tot}U (ng/g dry)	^{137}Cs (10^{-3} pCi/g dry)	^{90}Sr (10^{-3} pCi/g dry)	^{238}Pu (10^{-5} pCi/g dry)	^{239}Pu (10^{-5} pCi/g dry)	^{241}Am (10^{-5} pCi/g dry)
Muscle:							
LANL Elk							
TA-8/Anchor West Road/6-25-99/Cow	0.08 (0.61)[b]	0.44 (0.44)	0.0 (17.4)	24.6 (20.7)	–4.0 (7.0)	2.2 (6.2)	8.8 (3.1)
WR/PA/State Road 4/10-19-98/Bull	–0.01 (0.63)[c]	0.44 (0.44)	3.3 (0.8)	3.5 (6.6)	4.8 (8.4)	15.4 (11.9)	–19.4 (14.5)
Mean (std dev)	0.04 (0.06)	0.44 (0.00)	1.7 (2.3)	14.1 (14.9)	0.4 (6.2)	8.8 (9.3)	–5.3 (19.9)
Regional Background Elk							
Mean (std dev)	0.21 (0.16)	0.83 (0.68)	95.1 (113.1)	0.7 (1.6)	–1.1 (2.5)	–0.5 (1.0)	4.4 (5.1)
RSRL[e]	0.53	2.19	321.4	3.9	3.9	1.6	14.5
Leg Bone:							
LANL Elk							
TA-8/Anchor West Road/6-25-99/Cow	0.05 (0.61)	5.80 (5.80)	0.0 (16.8)	1972.0 (226.2)	–58.0 (58.0)	116.0 (75.4)	[d]
WR/PA/State Road 4/10-19-98/Bull	0.01 (0.63)	5.80 (5.80)	1.8 (4.2)	2035.8 (203.0)	904.8 (475.6)	11.6 (319.0)	[d]
Mean (std dev)	0.03 (0.03)	5.80 (0.00)	0.9 (1.3)	2003.9 (45.1)	423.4 (680.8)	63.8 (73.8)	[d]
Regional Background Elk							
Mean (std dev)	–0.01 (0.26)	2.29 (1.96)	43.1 (77.5)	1300.7 (882.5)	13.7 (47.5)	–6.0 (8.2)	41.0 (5.3)
RSRL[e]	0.51	6.21	198.2	3065.7	108.8	10.4	51.6

[a] pCi/mL of tissue moisture.
[b] (±1 counting uncertainty); values are the uncertainty of the analytical results at the 65% confidence level.
[c] See Appendix B for an explanation of the presence of negative values.
[d] Sample lost in analysis, not analyzed, or outlier omitted.
[e] The mean (std dev) and the Regional Statistical Reference Level the upper (95%) limit background concentration (mean + 2 std dev) is based from 1991 to 1998 (Fresquez et al., 1998).

Table 6-13. Radionuclides in Muscle and Bone Tissues of Deer Collected from On-Site Locations and Regional Background Areas during 1999

Tissue/Location/Date/Sample	^{3}H[a] (pCi/mL)	^{tot}U (ng/g dry)	^{137}Cs (10^{-3} pCi/g dry)	^{90}Sr (10^{-3} pCi/g dry)	^{238}Pu (10^{-5} pCi/g dry)	^{239}Pu (10^{-5} pCi/g dry)	^{241}Am (10^{-5} pCi/g dry)
Muscle:							
LANL Deer							
TA-15/West of Q-Site/10-14-99/Buck	–0.1 (0.65)[b,c]	0.75 (0.37)	23.6 (7.02)	[d]	10.8 (8.1)	16.2 (7.7)	5.9 (2.7)
Regional Background Deer							
Mean (std dev)	0.15 (0.25)	1.10 (0.66)	14.5 (7.3)	14.2 (12.3)	–1.8 (2.8)	3.5 (5.7)	6.2 (10.7)
RSRL[e]	0.65	2.42	29.0	38.8	3.7	14.8	27.5
Leg Bone:							
LANL Deer							
TA-15/West of Q-Site/10-14-99/Buck	–0.01 (0.66)	3.44 (2.45)	6.6 (16.3)	1663.2 (167.2)	928.4 (347.6)	–145.2 (268.4)	[d]
Regional Background Deer							
Mean (std dev)	0.07 (0.25)	2.03 (2.10)	10.3 (25.7)	907.5 (106.1)	–5.9 (10.2)	0.6 (1.0)	59.5 (28.5)
RSRL[e]	0.57	6.23	61.8	1119.7	14.5	2.7	116.5

[a] pCi/mL of tissue moisture.
[b] (±1 counting uncertainty); values are the uncertainty of the analytical results at the 65% confidence level.
[c] See Appendix B for an explanation of the presence of negative values.
[d] Sample lost in analysis, not analyzed, or outlier omitted.
[e] Regional Statistical Reference Level; this is the upper (95%) limit background concentration (mean + 2 std dev) based on data from 1991 to 1998 (Fresquez et al., 1998).

Table 6-14. Radionuclides in Muscle and Bone of a Free-Range Beef Cattle Collected from the San Ildefonso Pueblo and Regional Background during 1999

Tissue/Location	^{3}H[a] (pCi/mL)	^{tot}U (ng/g dry)	^{137}Cs (10^{-3} pCi/g dry)	^{90}Sr (10^{-3} pCi/g dry)	^{238}Pu (10^{-5} pCi/g dry)	^{239}Pu (10^{-5} pCi/g dry)	^{241}Am (10^{-5} pCi/g dry)
Muscle:							
Pueblo Cattle							
San Ildefonso	–0.46 (0.60)[b,c]	0.74 (0.37)	42.6 (6.7)	57.7 (13.3)	14.8 (4.1)	13.0 (4.4)	1.9 (14.1)
Regional Background[d]	0.19 (0.18)	1.30 (0.26)	16.4 (20.3)	–1.5 (10.5)	–2.8 (8.1)	–4.8 (10.5)	–7.8 (27.2)
RSRL[e]	0.55	1.82	57.0	19.5	13.4	16.2	46.6
Leg Bone:							
Pueblo Cattle							
San Ildefonso	–0.07 (0.63)	10.00 (5.00)	15.0 (5.0)	3,125.0 (295.0)	75.0 (60.0)	235.0 (70.0)	355.0 (135.0)
Regional Background[d]	–0.29 (0.33)	5.00 (0.00)	14.8 (14.5)	3,420.0 (3,068.8)	–145.0 (155.6)	–195.0 (169.7)	–95.5 (314.7)
RSRL[e]	0.37	5.00	43.8	9,557.7	166.1	144.4	533.8

[a] pCi/mL of tissue moisture.
[b] (±1 one counting uncertainty); values are the uncertainty of the analytical results at the 65% confidence level.
[c] See Appendix B for an explanation of the presence of negative values.
[d] Background from El Rito and Jemez, NM.
[e] Regional Statistical Reference Level; this is the upper (95%) limit background concentration (mean + 2 std dev).

Table 6-15. Radionuclides in Navajo Tea (Cota) Collected from Regional and Perimeter Locations during 1999

	^{3}H (pCi/mL)	^{90}Sr (pCi/L)	^{238}Pu (pCi/L)	^{239}Pu (pCi/L)	^{137}Cs (pCi/L)	^{tot}U (µg/L)	^{241}Am (pCi/L)
Regional Background:							
Española/Santa Fe/Jemez	–0.05 (0.59)[a,b]	1.01 (0.69)	0.018 (0.012)	0.025 (0.013)	–8.6 (127)	0.67 (0.07)	0.029 (0.018)
RSRL[c]	0.13	2.55	0.024	0.039	27.9	5.12	0.085
Off-Site Perimeter:							
San Ildefonso	–0.06 (0.59)	–0.01 (0.47)	–0.002 (0.005)	0.009 (0.008)	12.0 (18)	0.73 (0.07)	0.027 (0.011)
Los Alamos Townsite	0.06 (0.59)	0.56 (0.50)	0.014 (0.011)	0.022 (0.012)	1.9 (19)	0.76 (0.08)	0.007 (0.006)
White Rock/Pajarito Acres	0.09 (0.61)	0.47 (0.50)	0.002 (0.015)	0.004 (0.009)	–12.0 (127)	0.31 (0.03)	0.013 (0.018)

[a] See Appendix B for an explanation of the presence of negative values.
[b] (±1 counting uncertainty); values are the uncertainty of the analytical results at the 65% confidence level.
[c] Regional Statistical Reference Level; this is the upper (95%) limit background concentration (mean + 2 std dev) based on data from 1996 to 1999.

Table 6-16. Radionuclides in Piñon Shoot Tips (Vegetation) Collected from Regional Background and Perimeter Areas during the 1999 Growing Season[a]

Location	^{3}H (pCi/mL)	^{tot}U (ng/g dry)	^{137}Cs (10^{-3} pCi/g dry)	^{90}Sr (10^{-3} pCi/g dry)	^{238}Pu (10^{-5} pCi/g dry)	^{239}Pu (10^{-5} pCi/g dry)	^{241}Am (10^{-5} pCi/g dry)
Regional Background:							
Española/Santa Fe/Jemez	–0.40 (0.57)[b,c]	19.2 (1.6)	12.0 (33.6)	444.8 (45.6)	–36.8 (82.4)	155.2 (68.0)	–8.8 (7.2)
RSRL[d]	0.21	102.3	23.4	739.1	68.2	217.6	214.4
Off-Site Perimeter:							
San Ildefonso	–0.11 (0.59)	20.0 (2.4)	23.4 (16.9)	293.0 (31.2)	–24.8 (56.8)	17.6 (57.6)	11.2 (7.2)
Los Alamos Townsite	–0.11 (0.59)	44.8 (4.8)	–15.2 (203.2)	380.0 (48.0)	–17.6 (98.4)	–12.8 (96.8)	10.4 (8.0)
White Rock/Pajarito Acres	0.06 (0.60)	33.6 (3.2)	42.6 (13.4)	364.8 (42.8)	–16.0 (41.6)	58.4 (60.0)	57.6 (16.0)

[a] These are the shoot tips of the piñon tree and are not piñon nuts.
[b] (±1 counting uncertainty); values are the uncertainty of the analytical results at the 65% confidence level.
[c] See Appendix B for an explanation of the presence of negative values.
[d] Regional Statistical Reference Level; this is the upper (95%) limit background concentration (mean + 2 std dev) based on data from 1997 to 1999.

Table 6-17. Radionuclide Concentrations in Piñon Pine Nuts from Los Alamos National Laboratory and Background Locations during the 1999 Growing Season

Location	^{3}H (pCi/mL)	^{137}Cs (10^{-3} pCi/g dry)	^{90}Sr (10^{-3} pCi/g dry)	^{tot}U (ng/g dry)	^{238}Pu (10^{-5}pCi/g dry)	$^{239,240}Pu$ (10^{-5}pCi/g dry)	^{241}Am (10^{-5} pCi/g dry)
On-Site Stations:							
TA-15	5.90 (0.99)[a]	–3.9 (2.9)[b]	[e]	1.56 (0.26)	0.52 (2.1)	5.98 (3.4)	13.0 (5.2)
TA-36	11.90 (1.30)	–4.7 (2.9)	[e]	1.30 (0.26)	1.30 (1.8)	5.98 (2.9)	5.5 (4.7)
TA-39	11.20 (1.20)	11.2 (2.1)	[e]	1.04 (0.26)	–2.60 (3.1)	–3.64 (3.9)	12.7 (5.5)
TA-49	11.00 (1.20)	13.5 (2.1)	[e]	1.30 (0.26)	–0.26 (2.1)	4.16 (3.4)	7.8 (4.7)
Mean (±SD)	10.00 (2.78)A[c]	4.0 (9.7)A		1.30 (0.21)A	–0.26 (1.7)A	3.12 (4.6)A	9.8 (3.7)A
Regional Background:							
Coyote	7.00 (1.00)	0.0 (2.9)	[e]	1.04 (0.26)	1.30 (2.6)	5.72 (2.6)	13.8 (4.4)
Tres Piedras	–0.01 (0.65)	12.0 (18.0)	[e]	0.78 (0.26)	–1.30 (6.2)	4.42 (4.9)	8.3 (3.4)
Jemez	0.61 (0.69)	17.4 (26.0)	[e]	1.82 (0.26)	–2.60 (1.8)	0.78 (2.6)	4.9 (3.9)
Mean (±SD)	2.53 (3.88)A	9.8 (8.9)A		1.21 (0.54)A	–0.87 (2.0)A	3.64 (2.6)A	9.0 (4.5)A
RSRL[d]	10.29	27.6		2.29	3.13	8.84	18.0

[a](±1 counting uncertainty); values are the uncertainty of the analytical results at the 65% confidence level.
[b]See Appendix B for an explanation of the presence of negative values.
[c]Means within the same column followed by the same upper-case letter are not significantly different at the 0.10 probability level using a nonparametric Wilcoxon Rank Sum Test.
[d]Regional Statistical Reference Level; this is the upper (95%) limit background concentration (mean + 2 std dev) based on data from 1998 (Fresquez et al., 2000).
[e]Sample lost in analysis, not analyzed, or outlier omitted (negatively biased).

Table 6-18. Strontium-90 (Negatively Biased) Concentrations in Piñon Pine Nuts from Los Alamos National Laboratory and Background Locations during 1999[a]

Location	^{90}Sr (10^{-3}pCi g dry)
On-Site Stations:	
TA-15	–15.6 (13.3)[b]
TA-36	–12.0 (6.8)
TA-39	–11.2 (7.3)
TA-49	–9.4 (8.6)
Mean (±SD)	–12.0 (2.6)A[c]
Regional Background:	
Coyote	–14.6 (10.4)
Tres Piedras	–21.8 (8.1)
Jemez	–38.0 (11.4)
Mean (±SD)	–24.8 (12.0)A

[a] Negatively biased data are defined as a data set that contains over 50% negative numbers and are considered invalid because of analytical laboratory problems; the data appear in this report for documentary purposes.
[b] (±1 counting uncertainty); values are the uncertainty of the analytical results at the 65% confidence level.
[c] Means within the column followed by the same upper-case letter are not significantly different from one another using a Wilcoxon Rank Sum Test at the 0.10 probability level.

Table 6-19. Radionuclides in Wild Spinach Collected from Regional Background and Perimeter Areas during the 1999 Growing Season

Location	^{3}H (pCi/mL)	^{tot}U (ng/g dry)	^{137}Cs (10^{-3} pCi/g dry)	^{90}Sr (10^{-3} pCi/g dry)	^{238}Pu (10^{-5} pCi/g dry)	^{239}Pu (10^{-5} pCi/g dry)	^{241}Am (10^{-5} pCi/g dry)
Regional Background:							
Española/Santa Fe/Jemez	0.02 (0.60)[a]	16.0 (1.3)	4.9 (19.7)	295.3 (54.5)	17.3 (50.5)	79.8 (46.6)	79.8 (25.3)
RSRL[c]	0.36	77.9	39.8	469.3	64.6	449.6	130.4
Off-Site Perimeter:							
San Ildefonso	–0.08 (0.59)[b]	25.3 (2.7)	21.7 (25.8)	166.3 (45.2)	–207.5 (236.7)	–182.2 (308.6)	–6.7 (8.0)
Los Alamos Townsite	–0.13 (0.59)	12.0 (1.3)	0.0 (41.0)	188.9 (51.9)	–62.5 (157.0)	–75.8 (135.7)	58.5 (18.6)
White Rock/Pajarito Acres	–0.04 (0.60)	6.7 (1.3)	34.6 (20.0)	150.3 (47.9)	–20.0 (75.8)	263.3 (75.8)	12.0 (12.0)

[a] (±1 counting uncertainty); values are the uncertainty of the analytical results at the 65% confidence level.
[b] See Appendix B for an explanation of the presence of negative values.
[c] Regional Statistical Reference Level; this is the upper (95%) limit background concentration (mean + 2 std dev) for most radionuclides based on data from 1995 and 1999. The RSRL for ^{241}Am is based on present data.

Table 6-20. Total Recoverable Trace Elements (μg/g dry) in Wild Spinach Collected from Regional Background and Perimeter Areas during the 1999 Growing Season[a]

Location	Ag	As	Ba	Be	Cd	Cu	Hg	Ni	Pb	Sb	Se	Tl
Regional Background:												
Española/Santa Fe/Jemez	1.0[b]	0.25[b]	55.0	0.10[b]	0.50[b]	3.4	0.03[b]	1.0[b]	0.20[b]	0.20[b]	0.20[b]	0.20[b]
RSRL[c]	1.4	0.66	27.4	0.53	0.46		0.06	23.5	22.00	0.20	0.30	0.20
RSRL[d]	1.0	0.30	66.0	0.10	0.50	5.5	0.03	0.5	0.20	0.20	0.20	0.20
Off-Site Perimeter:												
San Ildefonso	1.0[b]	0.25[b]	54.0	0.10[b]	0.50[b]	3.1	0.03[b]	1.0[b]	2.2	0.20[b]	0.20[b]	0.20[b]
Los Alamos Townsite	1.0[b]	0.25[b]	15.0	0.10[b]	0.50[b]	4.5	0.03[b]	35.0	27.5	0.20[b]	0.20[b]	0.20[b]
White Rock/Pajarito Acres	1.0[b]	0.25[b]	25.0	0.10[b]	0.50[b]	5.8	0.03[b]	3.3	1.1	0.20[b]	0.20[b]	0.20[b]

[a] Analysis by EPA Method 3051 for total recoverable metals, and there were no statistical differences in any of the mean concentrations from perimeter and on-site locations as compared with regional background at the 0.05 probability level using a Wilcoxon Rank Sum Test.

[b] Less-than values were converted to one-half the concentration.

[c] Regional Statistical Reference Level; this is the upper (95%) limit background concentration (mean + 2 std dev) based on produce data from 1994 to 1996.

[d] Regional Statistical Reference Level; this is the upper (95%) limit background concentration (mean + 2 std dev) based on wild spinach data from 1999.

Table 6-21. Radionuclides in Honey Collected from Regional Background and Perimeter Locations during 1999

Radioisotope		Perimeter			Regional Background		
		Los Alamos	White Rock		Jemez		RSRL[d]
^{3}H	(pCi/mL)[a]	0.08 (0.67)[b]	2.26	(0.81)	0.17	(0.68)	5.25
^{137}Cs	(pCi/L)	[e]	10.0	(19.0)	0.0	(127.0)	305.28
^{238}Pu	(pCi/L)	[e]	–0.017	(0.019)[c]	0.049	(0.020)	0.07
^{239}Pu	(pCi/L)	[e]	0.058	(0.029)	0.027	(0.028)	0.12
^{241}Am	(pCi/L)	[e]	–0.023	(0.013)	–0.017	(0.009)	0.05
^{90}Sr	(pCi/L)	[e]	2.29	(3.01)	1.65	(3.33)	5.04
^{tot}U	(µg/L)	[e]	0.41	(0.04)	0.32	(0.03)	5.00

[a] pCi/mL of honey moisture; honey contains approximately 18% water and has a density of 1,860 g/L.
[b] (±1 counting uncertainty); values are the uncertainty of the analytical results at the 65% confidence level.
[c] See Appendix B for an explanation of the presence of negative values.
[d] Regional Statistical Reference Level; this is the upper (95%) limit background concentration (mean + 2 std dev) based on data from 1979 to 1995 (Fresquez et al., 1997a).
[e] Sample lost in analysis or not analyzed or outlier omitted.

Table 6-22. Radionuclides in Alfalfa Forage Collected from Regional Background and Perimeter Areas during the 1999 Growing Season

Location	^{3}H (pCi/mL)	^{tot}U (µg/g ash)	^{137}Cs (pCi/g ash)	^{90}Sr (pCi/g ash)	^{238}Pu (pCi/g ash)	^{239}Pu (pCi/g ash)	^{241}Am (pCi/g ash)
Regional Background:							
Española/Santa Fe/Jemez	–0.27 (0.58)[a,b]	1.61 (0.16)	0.00 (1.28)	1.25 (0.41)	–0.0025 (0.0055)	–0.0035 (0.0071)	–0.0021 (0.0018)
RSRL[c]	0.89	1.93	2.56	2.07	0.0085	0.0036	0.0015
Off-Site Perimeter:							
San Ildefonso	–0.03 (0.60)	1.47 (0.15)	–0.14 (0.20)	3.58 (0.51)	0.0024 (0.0026)	0.0036 (0.0031)	0.0025 (0.0010)
Los Alamos Townsite	0.10 (0.61)	0.39 (0.04)	0.26 (0.20)	0.68 (0.31)	0.0002 (0.0037)	0.0015 (0.0028)	0.0019 (0.0007)
White Rock/Pajarito Acres	–0.03 (0.60)	0.17 (0.02)	0.00 (1.53)	0.84 (0.30)	–0.0007 (0.0026)	0.0017 (0.0021)	–0.0021 (0.0018)

[a](±1 counting uncertainty); values are the uncertainty of the analytical results at the 65% confidence level.
[b]See Appendix B for an explanation of the presence of negative values.
[c]Regional Statistical Reference Level; this is the upper (95%) limit background concentration (mean + 2 std dev) based on present data.

Table 6-23. Total Recoverable Trace Elements (µg/g dry) in Alfalfa Forage Collected from Regional Background and Perimeter Areas during the 1999 Growing Season[a]

Location	Ag	As	Ba	Be	Cd	Cu	Hg	Ni	Pb	Sb	Se	Tl
Regional Background:												
Española/Santa Fe/Jemez	1.0[b]	0.25[b]	16.0	0.10[b]	0.50[b]	6.8	0.03[b]	1.0[b]	1.4	0.20[b]	0.20[b]	0.20[b]
RSRL[c]	1.4	0.66	27.4	0.53	0.46		0.06	23.5	22.00	0.20	0.30	0.20
RSRL[d]	1.0	0.30	19.2	0.10	0.50	8.8	0.03	1.0	2.2	0.20	0.20	0.20
Off-Site Perimeter:												
San Ildefonso	1.0[b]	0.25[b]	27.0	0.10[b]	0.50[b]	4.6	0.03[b]	1.0[b]	1.0	0.20[b]	0.20[b]	0.20[b]
Los Alamos Townsite	1.0[b]	0.25[b]	83.0	0.10[b]	0.50[b]	7.1	0.03[b]	1.0[b]	1.1	0.20[b]	0.50	0.20[b]
White Rock/Pajarito Acres	1.0[b]	0.25[b]	47.0	0.10[b]	0.50[b]	4.4	0.03[b]	1.0[b]	1.3	0.20[b]	0.20[b]	0.20[b]

[a] Analysis by EPA Method 3051 for total recoverable metals, and there were no statistical differences in any of the mean concentrations from perimeter and on-site locations as compared with regional background at the 0.05 probability level using a Wilcoxon Rank Sum Test.

[b] Less-than values were converted to one-half the concentration.

[c] Regional Statistical Reference Level; this is the upper (95%) limit background concentration (mean + 2 std dev) based on produce data from 1994 to 1996.

[d] Regional Statistical Reference Level; this is the upper (95%) limit background concentration (mean + 2 std dev) based on alfalfa data from 1999.

Table 6-24. Concentration of Radionuclides in Understory Plants Sampled from Within and Around Los Alamos National Laboratory during 1999

Location	^{tot}U (µg/g ash)	Uncertainty	^{90}Sr (pCi/g ash)	Uncertainty	^{137}Cs (pCi/g ash)	Uncertainty	^{238}Pu (pCi/g ash)	Uncertainty	$^{239,240}Pu$ (pCi/g ash)	Uncertainty	^{241}Am (pCi/g ash)	Uncertainty	^{3}H (pCi/L)	Uncertainty
Regional Background Stations:														
Embudo	0.4000	0.040	3.170	0.560	0.500	0.750	0.0033	0.0011	0.0054	0.0018	0.0060	0.0026	–310.0	620.0
Cochiti	0.1600	0.020	0.970	0.240	0.370	0.560	–0.0006	0.0011	0.0019	0.0015	0.0032	0.0014	60.0	650.0
Jemez	0.1600	0.020	2.100	0.360	–0.170	0.100	0.0004	0.0011	0.0009	0.0012	0.0032	0.0032	1110.0	720.0
Mean	0.2400	0.0267	2.0800	0.3867	0.2333	0.4700	0.0010	0.0011	0.0027	0.0015	0.0041	0.0024	286.667	663.33
Perimeter Stations:														
Otowi	0.1500	0.020	2.140	0.580	0.430	0.650	0.0047	0.0025	0.0988	0.0087	0.0042	0.0045	–130.0	630.0
TA-8 (GT-Site)	0.0500	0.010	1.660	0.460	0.450	0.680	–0.0020	0.0009	0.0025	0.0015	–0.0013	0.0028	140.0	650.0
Near TA-49 (BNP)	0.1000	0.010	3.500	0.660	0.370	0.550	0.0013	0.0016	0.0029	0.0015	0.0002	0.0027	150.0	650.0
East Airport	0.1700	0.020	3.600	0.880	0.380	0.570	0.0009	0.0014	0.0063	0.0022	0.0022	0.0025	–20.0	640.0
West Airport	0.1900	0.020	1.190	0.650	–0.300	0.110	0.0012	0.0012	0.0095	0.0025	–0.0036	0.0016	210.0	660.0
North Mesa	0.0500	0.010	15.390	4.680	0.130	0.200	0.0005	0.0010	0.0012	0.0013	–0.0012	0.0026	280.0	660.0
Sportsman's Club	0.3200	0.030	4.210	0.860	–0.130	0.110	0.0178	0.0094	0.0145	0.0098	0.0257	0.0086	380.0	670.0
Tsankawi/ PM-1	0.5400	0.050	2.410	0.290	0.220	0.320	0.0024	0.0013	0.0103	0.0023	0.0081	0.0035	180.0	660.0
White Rock (East)	0.7000	0.070	3.710	0.350	0.390	0.580	0.0017	0.0026	0.0035	0.0022	0.0084	0.0027	–300.0	620.0
San Ildefonso	0.3600	0.040	2.720	0.280	0.330	0.500	0.0044	0.0019	0.0063	0.0027	0.0069	0.0021	550.0	680.0
Mean	0.2630	0.0280	4.0530	0.9690	0.2270	0.4270	0.0033	0.0024	0.0156	0.0035	0.0050	0.0034	144.000	652.00
On-Site Stations:														
TA-16 (S-Site)	0.1000	0.010	1.820	0.340	1.060	1.580	–0.0005	0.0015	–0.0013	0.0017	0.0037	0.0039	10.0	700.0
TA-21 (DP-Site)	0.7300	0.070	1.120	0.280	0.360	0.540	0.0013	0.0018	0.0267	0.0042	0.0017	0.0060	580.0	730.0
Near TA-33	0.1400	0.010	1.760	0.490	1.110	1.670	–0.0007	0.0017	0.0050	0.0022	0.0084	0.0085	390.0	720.0
TA-50	0.3800	0.040	0.540	0.290	0.410	0.610	0.0034	0.0018	0.0045	0.0019	0.0050	0.0028	490.0	730.0
TA-51	0.2800	0.030	2.430	0.360	1.010	1.520	0.0006	0.0009	0.0041	0.0017	0.0086	0.0033	310.0	710.0
West of TA-53	0.4800	0.050	1.400	0.270	1.310	1.970	0.0000	0.0000	0.0052	0.0021	0.0017	0.0023	270.0	710.0
East of TA-53	0.1300	0.010	1.620	0.370	0.140	0.200	–0.0005	0.0045	0.0094	0.0056	0.0140	0.0128	130.0	700.0
East of TA-54	0.1400	0.010	2.360	0.480	0.250	0.370	0.0012	0.0024	0.0180	0.0041	0.0081	0.0068	1310.0	780.0
Portillo Drive/TA-36	0.0900	0.010	0.950	0.340	0.480	0.110	–0.0014	0.0028	0.0074	0.0039	0.0057	0.0083	780.0	740.0
Near Test Well DT-9	0.0400	0.010	1.150	0.380	0.380	0.560	0.0007	0.0033	0.0032	0.0034	0.0096	0.0116	1300.0	770.0
R-Site Road East	0.1500	0.020	1.390	0.410	0.180	0.270	0.0032	0.0033	0.0092	0.0036	0.0116	0.0114	210.0	710.0
Two-Mile Mesa	0.1400	0.010	0.990	0.370	0.280	0.420	0.0002	0.0023	0.0054	0.0033	0.0081	0.0076	230.0	710.0
Mean	0.233	0.023	1.461	0.365	0.581	0.818	0.001	0.002	0.008	0.003	0.007	0.007	501	726

Table 6-25. Concentration of Radionuclides in Overstory Plants Sampled from Within and Around Los Alamos National Laboratory during 1999

Location	^{tot}U (µg/g ash)	Uncertainty	^{90}Sr (pCi/g ash)	Uncertainty	^{137}Cs (pCi/g ash)	Uncertainty	^{238}Pu (pCi/g ash)	Uncertainty	$^{239,240}Pu$ (pCi/g ash)	Uncertainty	^{241}Am (pCi/g ash)	Uncertainty	^{3}H (pCi/L)	Uncertainty
Regional Background Stations:														
Embudo	0.52	0.05	2.1200	0.320	0.480	0.720	0.0009	0.0012	0.0023	0.0014	0.0023	0.0022	80	650
Cochiti	0.35	0.04	1.8300	0.300	0.520	0.780	–0.0003	0.0010	0.0024	0.0013	0.0069	0.0019	–70	640
Jemez	0.25	0.03	2.3000	0.340	0.170	0.260	0.0019	0.0015	0.0026	0.0016	0.0048	0.0020	–200	630
Mean	0.373	0.040	2.0833	0.320	0.390	0.5867	0.0008	0.0012	0.0024	0.0014	0.0047	0.0020	–63.3	640
Perimeter Stations:														
Otowi	0.23	0.02	4.5900	0.580	0.290	0.440	0.0000	0.0000	0.0076	0.0032	0.0054	0.0042	190	660
TA-8 (GT-Site)	0.14	0.01	0.2700	0.350	0.540	0.810	–0.0008	0.0016	0.0045	0.0026	–0.0031	0.0030	200	660
Near TA-49 (BNP)	0.25	0.03	0.9200	0.360	0.510	0.770	0.0020	0.0020	0.0078	0.0036	0.0107	0.0066	960	710
East Airport	0.36	0.04	3.1700	0.440	0.610	0.920	–0.0010	0.0010	0.0053	0.0020	0.0101	0.0044	240	660
West Airport	0.22	0.02	2.4700	0.450	0.440	0.660	0.0180	0.0039	0.0213	0.0040	0.0005	0.0040	300	660
North Mesa	0.16	0.02	2.5500	0.480	0.200	0.300	–0.0006	0.0012	0.0046	0.0025	0.0011	0.0032	130	650
Sportsman's Club	0.23	0.02	5.7500	1.050	1.240	1.860	0.0009	0.0013	0.0000	0.0000	0.0138	0.0056	190	660
Tsankawi/ PM-1	0.42	0.04	2.2800	0.250	0.690	1.040	0.0010	0.0012	0.0040	0.0016	0.0035	0.0034	190	660
White Rock (East)	0.50	0.05	2.0000	0.280	1.140	1.710	–0.0001	0.0017	0.0045	0.0030	0.0070	0.0031	410	670
San Ildefonso	0.56	0.06	2.4100	0.360	–0.36	0.100	–0.0004	0.0014	0.0224	0.0030	0.0175	0.0046	–10	640
Mean	0.493	0.050	2.230	0.297	0.490	0.9500	0.0002	0.0014	0.0103	0.0025	0.0093	0.0037	197	657
On-Site Stations:														
TA-16 (S-Site)	0.14	0.01	1.1600	0.470	2.370	3.560	0.0009	0.0034	0.0013	0.0040	0.0212	0.0084	90	700
TA-21 (DP-Site)	0.45	0.05	0.2700	0.320	1.800	2.710	0.0031	0.0022	0.0175	0.0039	0.0057	0.0041	60	700
Near TA-33	0.39	0.04	4.3800	0.470	0.930	1.390	–0.0004	0.0006	0.0056	0.0021	–0.0008	0.0030	280	710
TA-50	0.68	0.07	0.7500	0.270	1.060	1.600	0.0000	0.0000	0.0095	0.0031	0.0067	0.0066	370	720
TA-51	0.83	0.08	2.2300	0.340	0.470	0.710	0.0030	0.0021	0.0100	0.0027	0.0101	0.0061	80	700
West of TA-53	0.33	0.03	0.4400	0.470	1.410	2.120	0.0013	0.0024	0.0089	0.0039	0.0178	0.0081	950	750
East of TA-53	0.58	0.06	3.4700	0.340	8.320	12.480	0.0012	0.0011	0.0039	0.0017	0.0194	0.0051	170	710
East of TA-54	0.38	0.04	4.5000	0.540	0.300	0.460	0.0000	0.0000	0.0257	0.0068	0.0378	0.0158	1530	790
Portillo Drive/TA-36	0.49	0.05	2.6000	0.400	0.080	0.120	–0.0015	0.0032	0.0047	0.0034	–0.0019	0.0165	290	710
Near Test Well DT-9	0.20	0.02	2.6700	0.500	0.390	0.580	–0.0023	0.0046	0.0100	0.0063	0.0342	0.0157	250	710
R-Site Road East	0.11	0.01	0.5900	0.710	0.570	0.860	0.0024	0.0051	–0.001	0.0063	0.0066	0.0133	1180	770
Two-Mile Mesa	0.07	0.01	0.5600	0.590	0.370	0.550	–0.0028	0.0027	0.0035	0.0035	0.0145	0.0132	310	710
Mean	0.127	0.013	1.273	0.600	0.443	0.6633	–0.0009	0.0041	0.0043	0.0054	0.0184	0.0141	580	730

F. Figures

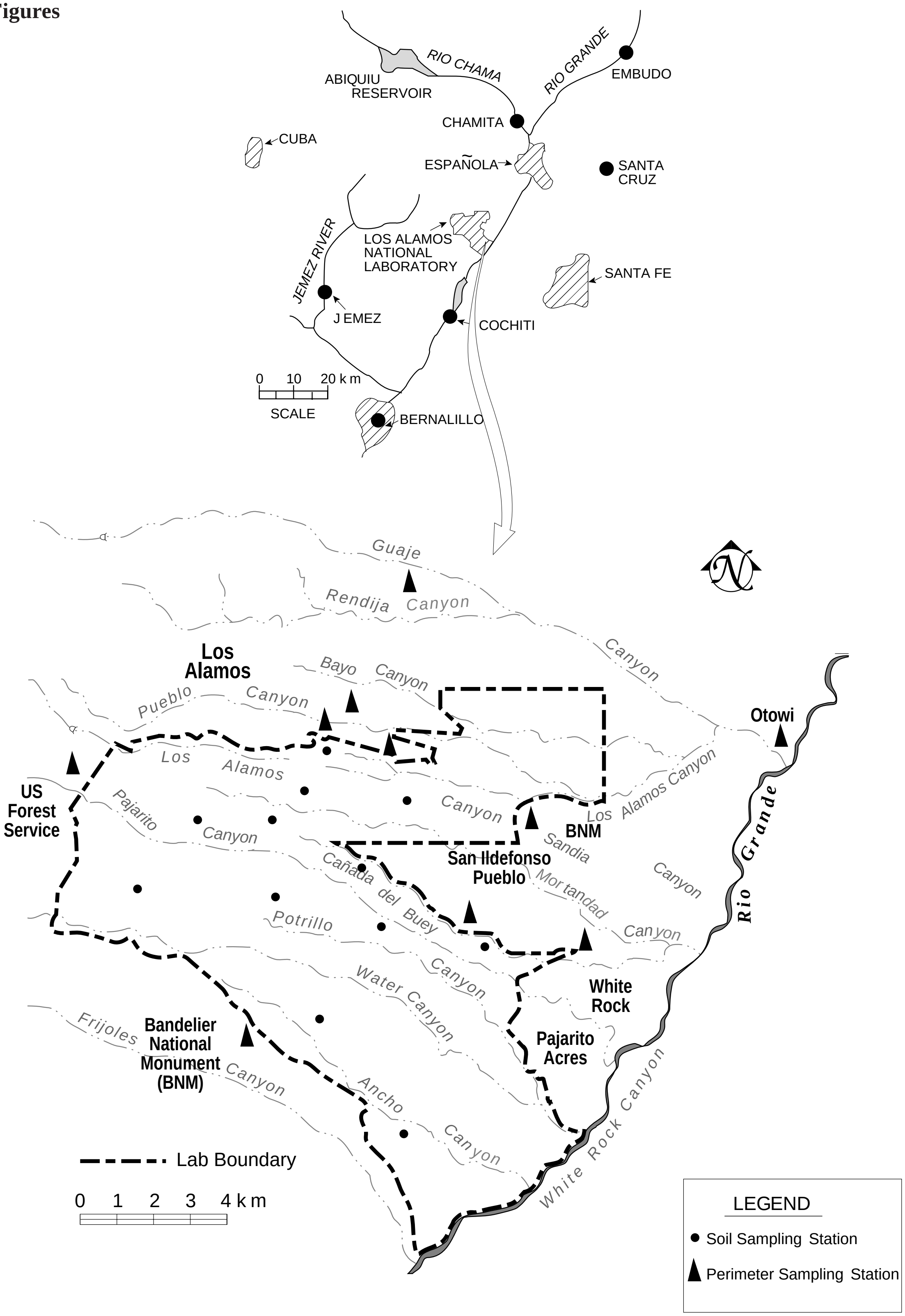

Figure 6-1. Off-site regional (top) and perimeter and on-site (bottom) Laboratory soil sampling locations.

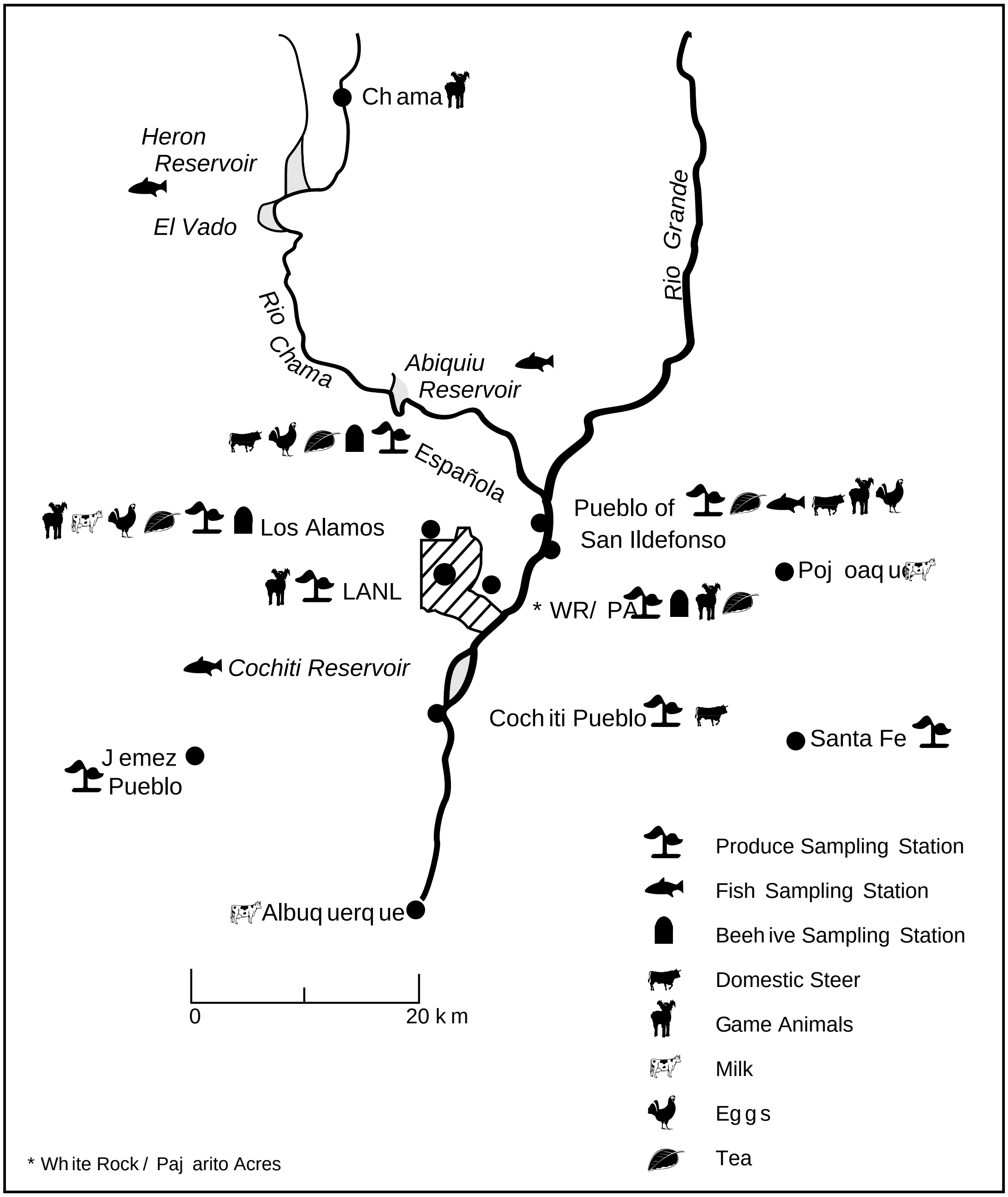

Figure 6-2. Produce, fish, milk, eggs, tea, domestic and game animals, and beehive sampling locations. (Map denotes general locations only.)

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Standards for Environmental Contaminants

Throughout this report, we compare concentrations of radioactive and chemical constituents in air and water samples with pertinent standards and guidelines in regulations of federal and state agencies. No comparable standards for soils, sediments, or foodstuffs are available. Los Alamos National Laboratory (LANL or the Laboratory) operations are conducted in accordance with directives for compliance with environmental standards. These directives are contained in Department of Energy (DOE) Orders 5400.1, "General Environmental Program;" 5400.5, "Radiation Protection of the Public and the Environment;" 5480.1, "Environmental Protection, Safety, and Health Protection Standards;" 5480.11, "Requirements for Radiation Protection for Occupational Workers;" 5484.1, "Environmental Radiation Protection, Safety, and Health Protection Information Reporting Requirements," Chap. III, "Effluent and Environmental Monitoring Program Requirements," and 231.1, "Environmental Safety and Health Reporting."

Radiation Standards. DOE regulates radiation exposure to the public and the worker by limiting the radiation dose that can be received during routine Laboratory operations. Because some radionuclides remain in the body and result in exposure long after intake, DOE requires consideration of the dose commitment caused by inhalation, ingestion, or absorption of such radionuclides. This evaluation involves integrating the dose received from radionuclides over a standard period of time. For this report, 50-yr dose commitments were calculated using the DOE dose factors from DOE 1988a and DOE 1988b. The dose factors DOE adopted are based on the recommendations of Publication 30 of the International Commission on Radiological Protection (ICRP 1988).

In 1990, DOE issued Order 5400.5, which finalized the interim radiation protection standard (RPS) for the public (NCRP 1987). Table A-1 lists currently applicable RPSs, now referred to as public dose limits (PDLs), for operations at the Laboratory. DOE's comprehensive PDL for radiation exposure limits the effective dose equivalent (EDE) that a member of the public can receive from DOE operations to 100 mrem per year. The PDLs and the DOE dose factors are based on recommendations in ICRP (1988) and the National Council on Radiation Protection and Measurements (NCRP 1987).

The EDE is the hypothetical whole-body dose that would result in the same risk of radiation-induced cancer or genetic disorder as a given exposure to an individual organ. It is the sum of the individual organ doses, weighted to account for the sensitivity of each organ to radiation-induced damage. The weighting factors are taken from the recommendations of the ICRP. The EDE includes doses from both internal and external exposure.

Radionuclide concentrations in air or water are compared to DOE's Derived Concentration Guides (DCGs) to evaluate potential impacts to members of the public. The DCGs for air are the radionuclide concentrations in air that, if inhaled continuously for an entire year, would give a dose of 100 mrem. Similarly, the DCGs for water are those concentrations in water that if consumed at a maximum rate of 730 liters per year, would give a dose of 100 mrem per year. Derived air concentrations (DACs) were developed for protection of workers and are the air concentrations that, if inhaled throughout a "work year," would give the limiting allowed dose to the worker. Table A-2 shows the DCGs and DACs.

In addition to DOE standards, in 1985 and 1989, the EPA established the National Emission Standards for Emissions of Radionuclides Other than Radon from Department of Energy Facilities, 40 CFR 61, Subpart H. This regulation states that 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. DOE has adopted this dose limit (Table A-1). This dose is calculated at the location of a residence, school, business or office. In addition, the regulation requires monitoring of all release points that can produce a dose of 0.1 mrem to a member of the public. A complete listing a 40 CFR 61 Subpart H is available in ESH-17 2000.

Nonradioactive Air Quality Standards. Table A-3 shows Federal and state ambient air quality standards for nonradioactive pollutants.

National Pollutant Discharge Elimination System. Table A-4 presents a summary of the outfalls, the types of monitoring required under National Pollutant Discharge Elimination System (NPDES), and the limits established for sanitary and industrial outfalls. Table A-5 presents NPDES annual water quality parameters for all outfalls.

Drinking Water Standards. For chemical constituents in drinking water, regulations and standards are issued by the Environmental Protection Agency (EPA) and adopted by the New Mexico Environment Department (NMED) as part of the New Mexico Drinking Water Regulations (Table A-6) (NMEIB 1995). EPA's secondary drinking water standards, which are not included in the New Mexico Drinking Water Regulations and are not enforceable, relate to contaminants in drinking water that primarily affect aesthetic qualities associated with public acceptance of drinking water (EPA 1989b). There may be health effects associated with considerably higher concentrations of these contaminants.

Radioactivity in drinking water is regulated by EPA regulations contained in 40 CFR 141 (EPA 1989b) and New Mexico Drinking Water Regulations, Sections 206 and 207 (NMEIB 1995). These regulations provide that combined radium-226 and radium-228 may not exceed 5 pCi per liter. Gross alpha activity (including radium-226, but excluding radon and uranium) may not exceed 15 pCi per liter.

A screening level of 5 pCi per liter for gross alpha is established to determine when analysis specifically for radium isotopes is necessary. In this report, plutonium concentrations are compared with both the EPA gross alpha standard for drinking water (Table A-6) and the DOE guides calculated for the DCGs applicable to drinking water (Table A-2).

For man-made beta- and photon-emitting radionuclides, EPA drinking water standards are limited to concentrations that would result in doses not exceeding 4 mrem per year, calculated according to a specified procedure. In addition, DOE Order 5400.5 requires that persons consuming water from DOE-operated public water supplies do not receive an EDE greater than 4 mrem per year. DCGs for drinking water systems based on this requirement are in Table A-2.

Surface Water Standards. Concentrations of radionuclides in surface water samples may be compared to either the DOE DCGs (Table A-2) or the New Mexico Water Quality Control Commission (NMWQCC) stream standard, which references the state's radiation protection regulations. However, New Mexico radiation levels are in general two orders of magnitude greater than DOE's DCGs for public dose, so only the DCGs will be discussed here. The concentrations of nonradioactive constituents may be compared with the NMWQCC Livestock Watering and Wildlife Habitat stream standards (NMWQCC 1995). (See Tables A-7 and A-8.) The NMWQCC groundwater standards can also be applied in cases where discharges may affect groundwater.

Organic Analysis of Surface and Groundwaters: Methods and Analytes. Organic analyses of surface waters, groundwaters, and sediments are made using SW-846 methods as shown in Table A-9. This table shows the number of analytes included in each analytical suite. The specific compounds analyzed in each suite are listed in Tables A-10 through A-13.

Table A-1. Department of Energy Public Dose Limits for External and Internal Exposures

	Effective Dose Equivalent[a] at Point of Maximum Probable Exposure
Exposure of Any Member of the Public[b]	
All Pathways	100 mrem/yr[c]
Air Pathway Only[d]	10 mrem/yr
Drinking Water	4 mrem/yr
Occupational Exposure[b]	
Stochastic Effects	5 rem (annual EDE[e])
Nonstochastic Effects	
Lens of eye	15 rem (annual EDE[e])
Extremity	50 rem (annual EDE[e])
Skin of the whole body	50 rem (annual EDE[e])
Organ or tissue	50 rem (annual EDE[e])
Unborn Child	
Entire gestation period	0.5 rem (annual EDE[e])

[a] As used by DOE, effective dose equivalent (EDE) includes both the EDE from external radiation and the committed EDE to individual tissues from ingestion and inhalation during the calendar year.

[b] In keeping with DOE policy, exposures must be limited to as small a fraction of the respective annual dose limits as practicable. DOE's public dose limit (PDL) applies to exposures from routine Laboratory operation, excluding contributions from cosmic, terrestrial, and global fallout; self-irradiation; and medical diagnostic sources of radiation. Routine operation means normal, planned operation and does not include actual or potential accidental or unplanned releases. Exposure limits for any member of the general public are taken from DOE Order 5400.5 (DOE 1990). Limits for occupational exposure are taken from 10 CFR 835, Occupational Radiation Protection.

[c] Under special circumstances and subject to approval by DOE, this limit on the EDE may be temporarily increased to 500 mrem/yr, provided the dose averaged over a lifetime does not exceed the principal limit of 100 mrem per year.

[d] This level is from EPA's regulations issued under the Clean Air Act, (40 CFR 61, Subpart H) (EPA 1989a).

[e] Annual EDE is the EDE received in a year.

Table A-2. Department of Energy's Derived Concentration Guides for Water and Derived Air Concentrations[a]

Nuclide	f_1[b]	DCGs for Water Ingestion in Uncontrolled Areas (pCi/L)	DCGs for Drinking Water Systems (pCi/L)	DCGs for Air Inhalation by the Public (µCi/mL)	Class[b]	DACs for Occupational Exposure (µCi/mL)
^{3}H	—	2,000,000	80,000	1×10^{-7}[c]	—	2×10^{-5}[c]
^{7}Be	5×10^{-3}	1,000,000	40,000	4×10^{-8}	Y	8×10^{-6}
^{89}Sr	2×10^{-5}	20,000	800	3×10^{-10}	Y	6×10^{-8}
^{90}Sr[b]	1×10^{-6}	1,000	40	9×10^{-12}	Y	2×10^{-9}
^{137}Cs	1×10^{0}	3,000	120	4×10^{-10}	D	7×10^{-8}
^{234}U	5×10^{-2}	500	20	9×10^{-14}	Y	2×10^{-11}
^{235}U	5×10^{-2}	600	24	1×10^{-13}	Y	2×10^{-11}
^{238}U	5×10^{-2}	600	24	1×10^{-13}	Y	2×10^{-11}
^{238}Pu	1×10^{-3}	40	1.6	3×10^{-14}	W	3×10^{-12}
^{239}Pu[b]	1×10^{-3}	30	1.2	2×10^{-14}	W	2×10^{-12}
^{240}Pu	1×10^{-3}	30	1.2	2×10^{-14}	W	2×10^{-12}
^{241}Am	1×10^{-3}	30	1.2	2×10^{-14}	W	2×10^{-12}

[a]Guides for uncontrolled areas are based on DOE's public dose limit for the general public (DOE 1990); those for occupational exposure are based on radiation protection standards in 10 CFR 835. Guides apply to concentrations in excess of those occurring naturally or that are due to worldwide fallout.
[b]Gastrointestinal tract absorption factors (f_1) and lung retention classes (Class) are taken from ICRP30 (ICRP 1988). Codes: Y = year, D = day, W = week.
[c]Tritium in the HTO form.

Table A-3. National (40 CFR 50) and New Mexico (20 NMAC 2.3) Ambient Air Quality Standards

Pollutant	Averaging Time	Unit	New Mexico Standard	Federal Standards Primary	Federal Standards Secondary
Sulfur dioxide	Annual	ppm	0.02	0.030[a]	
	24 hours	ppm	0.10	0.14[b]	
	3 hours	ppm			0.5[b]
Hydrogen sulfide	1 hour	ppm	0.010[b]		
Total reduced sulfur	1/2 hour	ppm	0.003[b]		
Total Suspended Particulates	Annual	μg/m^3	60	50	50
	30 days	μg/m^3	90		
	7 days	μg/m^3	110		
	24 hours	μg/m^3	150		
PM_{10}[c]	Annual	μg/m^3		50	50
	24 days	μg/m^3		150	150
$PM_{2.5}$[d]	Annual	μg/m^3		15[e]	15[e]
	24 hours	μg/m^3		65[e]	65[e]
Carbon monoxide	8 hours	ppm	8.7	9[b]	
	1 hour	ppm	13.1	35[b]	
Ozone[f]	1 hour	ppm		0.12	0.12
	8 hours	ppm		0.08	0.08
Nitrogen dioxide	Annual	ppm	0.05	0.053	0.053
	24 hours	ppm	0.10		
Lead and lead compounds	Calendar quarter	μg/m^3		1.5	1.5

[a]Not to be exceeded in a calendar year.
[b]Not to be exceeded more than once in a calendar year.
[c]Particles ≤10 μm in diameter.
[d]Particles ≤2.5 μm in diameter.
[e]Applicable when the changes to the NM State Implementation Plan are approved by EPA.
[f]As the result of a May 14, 1999, court ruling, EPA does not have the authority to implement the eight-hour ozone standard. Currently, LANL must meet the one-hour ozone standard. EPA has appealed the court decision.

Table A-4. Limits Established by National Pollutant Discharge Elimination System Permit No. NM0028355 for Sanitary and Industrial Outfall Discharges for 1999

Discharge Category	Permit Parameter		Daily Average		Daily Maximum	
Sanitary						
13S TA-46 SWS Facility	BOD[a]	concentration	30	mg/L	45	mg/L
		loading limit	100	lb/day	N/A[b]	
	TSS[c]	concentration	30	mg/L	45	mg/L
		loading limit	100	lb/day	N/A	
	Fecal coliform bacteria[d]		500	colonies/100 mL	500	colonies/100 mL
	pH		6.0–9.0 s.u.		6.0–9.0 s.u.	
	Flow[e]		Report		Report	

Discharge Category	Number of Outfalls	Sampling Frequency	Permit Parameter	Daily Average	Daily Maximum	Unit of Measurement
Industrial						
001 Power Plant	1	Monthly	TSS	30	100	mg/L
			Free available CL_2	0.2	0.5	mg/L
			pH	6.0–9.0	6.0–9.0	s.u.
02A Boiler Blowdown	1	Every 3 months	TSS	30	100	mg/L
			Total Fe	10	40	mg/L
			Total Cu	1.0	1.0	mg/L
			Total P	20	40	mg/L
			Sulfite	35	70	mg/L
			Total Cr	1.0	1.0	mg/L
			pH	6.0–9.0	6.0–9.0	s.u.
03A Treated Cooling Water	16	Every 3 months	TSS	30	100	mg/L
			Free available Cl	0.2	0.5	mg/L
			Total P	20	40	mg/L
			Total As	0.04	0.04	mg/L
			pH	6.0–9.0	6.0–9.0	s.u.
04A Noncontact Cooling Water	13	Every 3 months	pH	6.0–9.0	6.0–9.0	s.u.
			Total residual CL_2	Report[f]	Report	mg/L
051 Radioactive Liquid Waste Treatment Facility (TA-50)	1	Variable: weekly to monthly	COD[g]	94	156	lb/day
			TSS	18.8	62.6	lb/day
			Total Cd	0.06	0.30	lb/day
			Total Cr	0.19	0.38	lb/day
			Total Cu	0.63	0.63	lb/day
			Total Fe	1.0	2.0	lb/day
			Total Pb	0.06	0.15	lb/day
			Total Hg	0.003	0.09	lb/day
			Total Zn	0.62	1.83	lb/day
			TTO[h]	1.0	1.0	mg/L
			Total Ni[f]	Report	Report	mg/L
			Total N[f]	Report	Report	mg/L
			Nitrate-Nitrate as N[f]	Report	Report	mg/L
			Ammonia (as N)[f]	Report	Report	mg/L

Table A-4. (Cont.)

Discharge Category	Number of Outfalls	Sampling Frequency	Permit Parameter	Daily Average	Daily Maximum	Unit of Measurement
051 (Cont.)			pH	6.0–9.0	6.0–9.0	s.u.
			COD	125	125	mg/L
			Total Cd	0.2	0.2	mg/L
			Total Cr	5.1	5.1	mg/L
			Total Cu	1.6	1.6	mg/L
			Total Pb	0.4	0.4	mg/L
			Total Zn	95.4	95.4	mg/L
			^{226}Ra and ^{228}Ra	30.0	30.0	pCi/L
05A High Explosive Wastewater	2	Every 3 months	Oil & Grease	15	15	mg/L
			COD	125	125	mg/L
			TSS	30.0	45.0	mg/L
			pH	6.0–9.0	6.0–9.0	s.u.
06A Photo Wastewater	1	Every 3 months	Total Ag	0.5	1.0	mg/L
			pH	6.0–9.0	6.0–9.0	s.u.

[a]Biochemical oxygen demand.
[b]Not applicable.
[c]Total suspended solids.
[d]Logarithmic mean.
[e]Discharge volumes are reported to EPA but are not subject to limits.
[f]Concentrations are reported to EPA but are not subject to limits.
[g]Chemical oxygen demand.
[h]Total toxic organics.
Note: Sampling frequency for sanitary outfall varies from once a week to once every three months, depending on the parameter.

Table A-5. Annual Water Quality Parameters Established by National Pollutant Discharge Elimination System Permit No. NM0028355 for Sanitary and Industrial Outfall Discharges for 1999

Discharge Category	Number of Outfalls	Sampling Frequency	Permit Parameter	Daily Average	Daily Maximum	Unit of Measurement
All Outfall Categories: Annual Water Quality Parameters	36	Annually	Total Al	5.0	5.0	mg/L
			Total As	0.04	0.04	mg/L
			Total B	5.0	5.0	mg/L
			Total Cd	0.2	0.2	mg/L
			Total Cr	5.1	5.1	mg/L
			Total Co	1.0	1.0	mg/L
			Total Cu	1.6	1.6	mg/L
			Total Pb	0.4	0.4	mg/L
			Total Hg	0.01	0.01	mg/L
			Total Se	0.05	0.05	mg/L
			Total V	0.1	0.1	mg/L
			Total Zn	95.4	95.4	mg/L
			^{226}Ra and ^{228}Ra	30.0	30.0	pCi/L
			^{3}H[a]	3,000,000	3,000,000	pCi/L

[a]When accelerator produced.

Table A-6. Safe Drinking Water Act Maximum Contaminant Levels in the Water Supply for Radiochemicals, Inorganic Chemicals, and Microbiological Constituents

Contaminants	Level
Radiochemical:	**Maximum Contaminant Level**
Gross alpha	15 pCi/L[a]
Gross beta & photon	4 mrem/yr[a]
^{226}Ra & ^{228}Ra	5 pCi/L[a]
U	20 µg/L[a]
Radon	300 pCi/L[b]
	Screening Level
Gross alpha	5 pCi/L[a]
Gross beta	50 pCi/L[a]
Inorganic Chemical:	
Primary Standards	**Maximum Contaminant Level (mg/L)**
Asbestos	7 million fibers/L (longer than 10 µm)
As	0.05[a]
Ba	2
Be	0.004
Cd	0.005
CN	0.2
Cr	0.1
F	4
Hg	0.002
Ni	0.1
NO_3 (as N)	10
NO_2 (as N)	1
SO_4	500[c]
Se	0.05
Sb	0.006
Tl	0.002
	Action Levels (mg/L)
Pb	0.015
Cu	1.3
Secondary Standards	**(mg/L)**
Cl	250
Cu	1
Fe	0.3
Mn	0.05
Zn	5
Total Dissolved Solids	500
pH	6.5–8.5
Microbiological:	**Maximum Contaminant Level**
Presence of total coliforms	5% of samples/month
Presence of fecal coliforms or Escherichia coli	No coliform-positive repeat samples following a fecal coliform-positive sample

[a]Proposed.
[b]The proposed MCL for radon was withdrawn by the EPA on August 6, 1996.
[c]The proposed MCL for sulfate was suspended by the EPA on August 6, 1996.

Table A-7. Livestock Watering Standards[a]

Livestock Contaminant	Concentration	
Dissolved Al	5	mg/L
Dissolved As	0.2	mg/L
Dissolved B	5	mg/L
Dissolved Cd	0.05	mg/L
Dissolved Cr	1	mg/L
Dissolved Co	1	mg/L
Dissolved Cu	0.5	mg/L
Dissolved Pb	0.1	mg/L
Total Hg	0.01	mg/L
Dissolved Se	0.05	mg/L
Dissolved V	0.1	mg/L
Dissolved Zn	25	mg/L
^{226}Ra and ^{228}Ra	30	pCi/L
^{3}H	20,000	pCi/L
Gross alpha	15	pCi/L

[a]NMWQCC 1995.

Table A-8. Wildlife Habitat Stream Standards[a]

The following narrative standard shall apply:

1. Except as provided below in Paragraph 2 of this section, no discharge shall contain any substance, including, but not limited to selenium, DDT, PCBs, and dioxin, at a level which, when added to background concentrations, can lead to bioaccumulation to toxic levels in any animal species. In the absence of site-specific information, this requirement shall be interpreted as establishing a stream standard of 2 µg per liter for total recoverable selenium and of 0.012 µg per liter for total mercury.

2. The discharge of substances that bioaccumulate in excess of levels specified above in Paragraph 1 is allowed if, and only to the extent that, the substances are present in the intake waters which are diverted and utilized prior to discharge, and then only if the discharger utilizes best available treatment technology to reduce the amount of bioaccumulating substances which are discharged.

3. Discharges to waters which are designated for wildlife habitat uses, but not for fisheries uses, shall not contain levels of ammonia or chlorine in amounts which reduce biological productivity and/or species diversity to levels below those which occur naturally and in no case shall contain chlorine in excess of 1 mg per liter nor ammonia in excess of levels that can be accomplished through best reasonable operating practices at existing treatment facilities.

4. A discharge which contains any heavy metal at concentrations in excess of the concentrations set forth in Section 3101.J.1 of these standards shall not be permitted in an amount, measured by total mass, which exceeds by more than 5% the amount present in the intake waters which are diverted and utilized prior to the discharge, unless the discharger has taken steps (an approved program to require industrial pretreatment or a corrosion program) appropriate to reduce influent concentration to the extent practicable.

[a]NMWQCC 1995.

Table A-9. Organic Analytical Methods

Test	SW-846 Method	Extraction Water	Extraction Sediments	Number of Analytes
Volatiles	8260A	E0730	E0720	59
Semivolatiles	8270B[a]	E0530	E0510	69
PCB[b]	8080A, 8081	E0430	E0410	4
HE[c]	8330			14

[a] Direct injection used for method 8270B.
[b] Polychlorinated biphenyls.
[c] High explosives.

Table A-10. Volatile Organic Compounds

Analytes	Limit of Quantitation Water (μg/L)
Acetone	20
Benzene	5
Bromobenzene	5
Bromochloromethane	5
Bromodichloromethane	5
Bromoform	5
Bromomethane	10
Butanone [2-]	20
Butylbenzene [n-]	5
Butylbenzene [sec-]	5
Butylbenzene [tert-]	5
Carbon disulfide	5
Carbon tetrachloride	5
Chlorobenzene	5
Chlorodibromomethane	5
Chloroethane	10
Chloroform	5
Chloromethane	10
Chlorotoluene [o-]	5
Chlorotoluene [p-]	5
Dibromo-3-chloropropane [1,2]	10
Dibromoethane [1,2-]	5
Dibromomethane	5
Dichlorobenzene [m-] (1,3)	5
Dichlorobenzene [o-] (1,2)	5
Dichlorobenzene [p-] (1,4)	5
Dichlorodifluoromethane	10
Dichloroethane [1,1-]	5
Dichloroethane [1,2-]	5

Table A-10. Volatile Organic Compounds (Cont.)

Analytes	Limit of Quantitation Water (μg/L)
Dichloroethene [1,1-]	5
Dichloroethene [trans-1,2-]	5
Dichloropropane [1,2-]	5
Dichloropropane [1,3-]	5
Dichloropropane [2,2-]	5
Dichloropropene [1,1-]	5
Dichloropropene [cis-1,3-]	5
Dichloropropene [trans-1,3-]	5
Ethylbenzene	5
Hexachlorobutadiene	10
Hexanone [2-]	20
Isopropylbenzene	5
Isopropyltoluene [4-]	5
Methyl iodide	5
Methyl-2-pentanone [4-]	20
Methylene chloride	5
Naphthalene	10
Propylbenzene	5
Styrene	5
Tetrachloroethane [1,1,1,2-]	5
Tetrachloroethane [1,1,2,2-]	5
Tetrachloroethylene	5
Toluene	5
Trichloro-1,2,2-trifloroethane [1,1,2-]	5
Trichlorobutadiene [1,2,3-]	10
Trichlorobutadiene [1,2,4-]	10
Trichloroethane [1,1,1-]	5
Trichloroethane [1,1,2-]	5
Trichloroethene	5
Trichlorofluoromethane	5
Trichloropropane [1,2,3-]	5
Trimethylbenzene [1,2,4-]	5
Trimethylbenzene [1,3,5-]	5
Vinyl chloride	10
Xylene (o)	5
Xylene (x+p)	5
Xylenes (o + m + p) [Mixed-]	5

Table A-11. Semivolatile Organic Compounds

Analytes	Limit of Quantitation Water (μg/L)	Limit of Quantitation Sediments (mg/kg-avg)
Acenaphthene	10	0.38
Acenaphthylene	10	0.38
Aniline	10	0.38
Anthracene	10	0.38
Azobenzene	10	0.38
Benzidine [m-]	50	1.95
Benzo[a]anthracene	10	0.38
Benzo[a]pyrene	10	0.38
Benzo[b]fluoranthene	10	0.38
Benzo[g,h,i]perylene	10	0.38
Benzo[k]fluoranthene	10	0.38
Benzoic acid	50	1.95
Benzyl alcohol	10	0.38
Bis(2-chloroethoxy)methane	10	0.38
Bis(2-chloroethyl)ether	10	0.38
Bis(2-chloroisopropyl)ether	10	0.38
Bis(2-ethylhexyl)phthalate	10	0.38
Bromophenylphenyl ether [4-]	10	0.38
Butyl benzyl phthalate	10	0.38
Chloro-3-methylphenol [4-]	10	0.38
Chloroaniline [4-]	10	0.38
Chloronaphthalene [2-]	10	0.38
Chlorophenol [o-]	10	0.38
Chlorophenylphenyl ether [4-]	10	0.38
Chrysene	10	0.38
Di-n-butyl phthalate	10	0.38
Di-n-octyl phthalate	10	0.38
Dibenzo[a,h]anthracene	10	0.38
Dibenzofuran	10	0.38
Dichlorobenzene (1,2) [o-]	10	0.38
Dichlorobenzene (1,3) [m-]	10	0.38
Dichlorobenzene (1,4) [p-]	10	0.38
Dichlorobenzidine [3,3'-]	20	0.66
Dichlorophenol [2,4-]	10	0.38
Diethyl phthalate	10	0.38
Dimethyl phthalate	10	0.38
Dimethylphenol [2,4-]	10	0.38
Dinitrophenol [2,4-]	50	1.95
Dinitrotoluene [2,4-]	10	0.38
Dinitrotoluene [2,6-]	10	0.38
Fluoranthene	10	0.38
Fluorene	10	0.38
Hexachlorobenzene	10	0.38
Hexachlorobutadiene	50	1.95

Table A-11. Semivolatile Organic Compounds (Cont.)

Analytes	Limit of Quantitation Water (µg/L)	Limit of Quantitation Sediments (mg/kg-avg)
Hexachlorocyclopentadiene	10	0.38
Hexachloroethane	10	0.38
Indeno[1,2,3-cd]pyrene	10	0.38
Isophorone	10	0.38
Methyl-4,6-dinitrophenol [2-]	50	1.95
Methylnaphthalene [2-]	10	0.38
Methylphenol [2-]	10	0.38
Methylphenol [4-]	10	0.38
Naphthalene	10	0.38
Nitroaniline [2-]	20	0.66
Nitroaniline [3-]	20	0.66
Nitroaniline [4-]	20	0.66
Nitrobenzene	10	0.38
Nitrophenol [2-]	10	0.38
Nitrophenol [4-]	50	1.95
Nitrosodi-n-propylamine [N-]	10	0.38
Nitrosodimethylamine [N-]	10	0.38
Nitrosodiphenylamine [N-]	10	0.38
Pentachlorophenol	50	1.95
Phenanthrene	10	0.38
Phenol	10	0.38
Picoline [2-]	10	0.38
Pyrene	10	1.95
Pyridine	10	0.38
Trichlorobenzene [1,2,4-]	10	0.38
Trichlorophenol [2,4,5-]	10	0.38
Trichlorophenol [2,4,6-]	10	0.38

Table A-12. Polychlorinated Biphenyls

Analytes	Detection Limits Water (µg/L)	Detection Limits Sediments (mg/kg)
Aroclor 1016	0.5	0.25
Aroclor 1221	0.5	0.25
Aroclor 1232	0.5	0.25
Aroclor 1242	0.5	0.25
Aroclor 1248	0.5	0.25
Aroclor 1254	0.5	0.25
Aroclor 1260	0.5	0.25
Aroclor 1262	0.5	0.25

Table A-13. High-Explosives Analytes

	Limit of Quantitation	
Analytes	**Water (μg/L**	**Sediments (mg/kg)**
HMX	0.5	0.5
RDX	0.5	0.5
1,3,5-TNB	0.5	0.5
1,3-DNB	0.5	0.5
Tetryl	0.5	0.5
Nitrobenzene	0.5	0.5
2,4,6-TNT	0.5	0.5
4-A-2,6-DNT	0.5	0.5
2,6-DNT	0.5	0.5
2,4-DNT	0.5	0.5
2-NT	0.5	0.5
4-NT	0.5	0.5
3-NT	0.5	0.5

References

DOE 1988a: US Department of Energy, "Internal Dose Conversion Factors for Calculation of Dose to the Public," US Department of Energy report DOE/EH-0071 (July 1988).

DOE 1988b: US Department of Energy, "External Dose-Rate Conversion Factors for Calculation of Dose to the Public," US Department of Energy report DOE/EH-0070 (July 1988).

DOE 1990: US Department of Energy, "Radiation Protection of the Public and the Environment," US Department of Energy Order 5400.5 (February 8, 1990).

EPA 1989a: US Environmental Protection Agency, "40CFR 61, National Emission Standards for Hazardous Air Pollutants, Radionuclides; Final Rule and Notice of Reconsideration," Federal Register 54, 51 653-51 715 (December 15, 1989).

EPA 1989b: US Environmental Protection Agency, "National Interim Primary Drinking Water Regulations," Code of Federal Regulations, Title 40, Parts 141 and 142 (1989), and "National Secondary Drinking Water Regulations," Part 143 (1989).

ESH-17 2000: Air Quality Group, "Quality Assurance Project Plan for the Rad-NESHAP Compliance Project," Air Quality Group Document ESH-17-RN, R1 (January 2000).

ICRP 1988: International Commission on Radiological Protection, "Limits for Intakes of Radionuclides by Workers," ICRP Publication 30, Parts 1, 2, and 3, and their supplements, Annals of the ICRP 2(3/4) -8(4) (1979-1982), and Publication 30, Part 4, 19(4) (1988).

NCRP 1987: National Council on Radiation Protection and Measurements, "Recommendations on Limits for Exposure to Ionizing Radiation," NCRP report No. 91 (June 1987).

NMEIB 1995: New Mexico Environmental Improvement Board, "New Mexico Drinking Water Regulations," (as amended through January 1995).

NMWQCC 1995: New Mexico Water Quality Control Commission, "State of New Mexico Water Quality Standards for Interstate and Intrastate Streams," Section 3-101.K (as amended through January 23, 1995).

Units of Measurement

Throughout this report the International System of Units (SI) or metric system of measurements has been used, with some exceptions. For units of radiation activity, exposure, and dose, US Customary Units (that is, curie [Ci], roentgen [R], rad, and rem) are retained as the primary measurement because current standards are written in terms of these units. The equivalent SI units are the becquerel (Bq), coulomb per kilogram (C/kg), gray (Gy), and sievert (Sv), respectively.

Table B-1 presents prefixes used in this report to define fractions or multiples of the base units of measurements. Scientific notation is used in this report to express very large or very small numbers. Translating from scientific notation to a more traditional number requires moving the decimal point either left or right from the number. If the value given is 2.0×10^3, the decimal point should be moved three numbers (insert zeros if no numbers are given) to the **right** of its present location. The number would then read 2,000. If the value given is 2.0×10^{-5}, the decimal point should be moved five numbers to the **left** of its present location. The result would be 0.00002.

Table B-2 presents conversion factors for converting SI units into US Customary Units. Table B-3 presents abbreviations for common measurements.

Data Handling of Radiochemical Samples

Measurements of radiochemical samples require that analytical or instrumental backgrounds be subtracted to obtain net values. Thus, net values are sometimes obtained that are lower than the minimum detection limit of the analytical technique. Consequently, individual measurements can result in values of positive or negative numbers. Although a negative value does not represent a physical reality, a valid long-term average of many measurements can be obtained only if the very small and negative values are included in the population calculations (Gilbert 1975).

For individual measurements, uncertainties are reported as one standard deviation. The standard deviation is estimated from the propagated sources of analytical error.

Standard deviations for the station and group (off-site regional, off-site perimeter, and on-site) means are calculated using the following equation:

$$s = \sqrt{\frac{\sum_{i=1}^{N} \left(\bar{c} - c_i\right)^2}{(N-1)}},$$

where

c_i = sample i,

$\bar{c}$ = mean of samples from a given station or group, and

N = number of samples a station or group comprises.

This value is reported as one standard deviation ($1s$) for the station and group means.

Tables

Table B-1. Prefixes Used with SI (Metric) Units

Prefix	Factor	Symbol
mega	1 000 000 or 10^6	M
kilo	1 000 or 10^3	k
centi	0.01 or 10^{-2}	c
milli	0.001 or 10^{-3}	m
micro	0.000001 or 10^{-6}	μ
nano	0.000000001 or 10^{-9}	n
pico	0.000000000001 or 10^{-12}	p
femto	0.000000000000001 or 10^{-15}	f
atto	0.000000000000000001 or 10^{-18}	a

Table B-2. Approximate Conversion Factors for Selected SI (Metric) Units

Multiply SI (Metric) Unit	by	to Obtain US Customary Unit
celsius (°C)	9/5 + 32	fahrenheit (°F)
centimeters (cm)	0.39	inches (in.)
cubic meters (m^3)	35.3	cubic feet (ft^3)
hectares (ha)	2.47	acres
grams (g)	0.035	ounces (oz)
kilograms (kg)	2.2	pounds (lb)
kilometers (km)	0.62	miles (mi)
liters (L)	0.26	gallons (gal.)
meters (m)	3.28	feet (ft)
micrograms per gram (μg/g)	1	parts per million (ppm)
milligrams per liter (mg/L)	1	parts per million (ppm)
square kilometers (km^2)	0.386	square miles (mi^2)

Table B-3. Common Measurement Abbreviations and Measurement Symbols

aCi	attocurie
Bq	becquerel
Btu/yr	British thermal unit per year
Ci	curie
cm^3/s	cubic centimeters per second
cpm/L	counts per minute per liter
fCi/g	femtocurie per gram
ft	foot
ft^3/min	cubic feet per minute
ft^3/s	cubic feet per second
kg	kilogram
kg/h	kilogram per hour
lb/h	pound per hour
lin ft	linear feet
m^3/s	cubic meter per second
μCi/L	microcurie per liter
μCi/mL	microcurie per milliliter
μg/g	microgram per gram
$μg/m^3$	microgram per cubic meter
mL	milliliter
mm	millimeter
μm	micrometer
μmho/cm	micro mho per centimeter
mCi	millicurie
mg	milligram
mR	milliroentgen

Table B-3. Common Measurement Abbreviations and Measurement Symbols (Cont.)

m/s	meters per second
mrad	millirad
mrem	millirem
mSv	millisievert
nCi	nanocurie
nCi/dry g	nanocurie per dry gram
nCi/L	nanocurie per liter
ng/m^3	nanogram per cubic meter
pCi/dry g	picocurie per dry gram
pCi/g	picocurie per gram
pCi/L	picocurie per liter
pCi/m^3	picocurie per cubic meter
pCi/mL	picocurie per milliliter
pg/g	picogram per gram
pg/m^3	picogram per cubic meter
PM_{10}	small particulate matter (less than 10 μm diameter)
$PM_{2.5}$	small particulate matter (less than 2.5 μm diameter)
R	roentgen
s, ST or σ	standard deviation
s.u.	standard unit
sq ft (ft^2)	square feet
TU	tritium unit
>	greater than
<	less than
≥	greater than or equal to
≤	less than or equal to
±	plus or minus
~	approximately

Reference

Gilbert 1975: R. O. Gilbert, "Recommendations Concerning the Computation and Reporting of Counting Statistics for the Nevada Applied Ecology Group," Batelle Pacific Northwest Laboratories report BNWL-B-368 (September 1975).

Description of Technical Areas and Their Associated Programs

Locations of the technical areas (TAs) operated by the Laboratory in Los Alamos County are shown in Figure 1-2. The main programs conducted at each of the areas are listed in this Appendix.

TA-0: The Laboratory has about 180,000 sq ft of leased space for training, support, architectural engineering design, and unclassified research and development in the Los Alamos townsite and White Rock. The publicly accessible Community Reading Room and the Bradbury Science Museum are also located in the Los Alamos townsite.

TA-2, Omega Site: Omega West Reactor, an 8-MW nuclear research reactor, is located here. It was placed into a safe shutdown condition in 1993 and was removed from the nuclear facilities list. The reactor will be transferred to the institution for placement into the decontamination and decommissioning (D&D) program beginning in 2006.

TA-3, Core Area: The Administration Complex contains the Director’s office, administrative offices, and support facilities. Laboratories for several divisions are in this main TA of the Laboratory. Other buildings house central computing facilities, chemistry and materials science laboratories, earth and space science laboratories, physics laboratories, technical shops, cryogenics laboratories, the main cafeteria, and the Study Center. TA-3 contains about 50% of the Laboratory’s employees and floor space.

TA-5, Beta Site: This site contains some physical support facilities such as an electrical substation, test wells, several archaeological sites, and environmental monitoring and buffer areas.

TA-6, Two-Mile Mesa Site: The site is mostly undeveloped and contains gas cylinder staging and vacant buildings pending disposal.

TA-8, GT Site (or Anchor Site West): This is a dynamic testing site operated as a service facility for the entire Laboratory. It maintains capability in all modern nondestructive testing techniques for ensuring quality of material, ranging from test weapons components to high-pressure dies and molds. Principal tools include radiographic techniques (x-ray machines with potentials up to 1,000,000 V and a 24-MeV betatron), radioisotope techniques, ultrasonic and penetrant testing, and electromagnetic test methods.

TA-9, Anchor Site East: At this site, fabrication feasibility and physical properties of explosives are explored. New organic compounds are investigated for possible use as explosives. Storage and stability problems are also studied.

TA-11, K Site: Facilities are located here for testing explosives components and systems, including vibration testing and drop testing, under a variety of extreme physical environments. The facilities are arranged so that testing may be controlled and observed remotely and so that devices containing explosives or radioactive materials, as well as those containing nonhazardous materials, may be tested.

TA-14, Q Site: This dynamic testing site is used for running various tests on relatively small explosive charges for fragment impact tests, explosives sensitivities, and thermal responses.

TA-15, R Site: This is the home of PHERMEX (the pulsed high-energy radiographic machine emitting x-rays), a multiple-cavity electron accelerator capable of producing a very large flux of x-rays for weapons development testing. It is also the site where DARHT (the dual-axis radiographic hydrotest facility) is being constructed. This site is also used for the investigation of weapons functioning and systems behavior in nonnuclear tests, principally through electronic recordings.

TA-16, S Site: Investigations at this site include development, engineering design, prototype manufacture, and environmental testing of nuclear weapons warhead systems. TA-16 is the site of the Weapons Engineering Tritium Facility for tritium handled in gloveboxes. Development and testing of high explosives, plastics, and adhesives and research on process development for manufacture of items using these and other materials are accomplished in extensive facilities.

TA-18, Pajarito Laboratory Site: This is a nuclear facility that studies both static and dynamic behavior of multiplying assemblies of nuclear materials. The Category I quantities of special nuclear materials (SNM) are used to support a wide variety of programs such as Stockpile Management, Stockpile Stewardship, Emergency Response, Nonproliferation, Safeguards, etc. Experiments near critical are operated by remote control using low-power reactors called critical assemblies. The machines are housed in buildings known as kivas and are used primarily to provide a controlled means of assembling a critical amount of fissionable material so that the effects of various shapes, sizes, and configurations can be studied. These machines are also used as a large-quantity source of fission neutrons for experimental purposes. In addition, this facility provides the capability to perform hands-on training and experiments with SNM in various configurations below critical.

TA-21, DP Site: This site has two primary research areas: DP West and DP East. DP West has been in the D&D program since 1992, and six buildings have been demolished. The programs conducted at DP West, primarily in inorganic and biochemistry, were relocated during 1997, and the remainder of the site was scheduled for D&D in future years. DP East is a tritium research site.

TA-22, TD Site: This site is used in the development of special detonators to initiate high-explosive systems. Fundamental and applied research in support of this activity includes investigating phenomena associated with initiating high explosives and research in rapid shock-induced reactions.

TA-28, Magazine Area A: This is an explosives storage area.

TA-33, HP Site: An old, high-pressure, tritium-handling facility located here is being phased out. An intelligence technology group and the National Radio Astronomy Observatory's Very Large Baseline Array Telescope are located at this site.

TA-35, Ten Site: This site is divided into five facility management units. Work here includes nuclear safeguards research and development that are concerned with techniques for nondestructive detection, identification, and analysis of fissionable isotopes. Research is also done on reactor safety, laser fusion, optical sciences, pulsed-power systems, high-energy physics, tritium fabrication, metallurgy, ceramic technology, and chemical plating.

TA-36, Kappa Site: Phenomena of explosives, such as detonation velocity, are investigated at this dynamic testing site.

TA-37, Magazine Area C: This is an explosives storage area.

TA-39, Ancho Canyon Site: The behavior of nonnuclear weapons is studied here, primarily by photographic techniques. Investigations are also made into various phenomenological aspects of explosives, interactions of explosives, explosions involving other materials, shock wave physics, equation state measurements, and pulsed-power systems design.

TA-40, DF Site: This site is used in the development of special detonators to initiate high-explosive systems. Fundamental and applied research in support of this activity includes investigating phenomena associated with the physics of explosives.

TA-41, W Site: Personnel at this site engage primarily in engineering design and development of nuclear components, including fabrication and evaluation of test materials for weapons.

TA-43, Health Research Laboratory: This site is adjacent to the Los Alamos Medical Center in the townsite. Research performed at this site includes structural, molecular, and cellular radiobiology, biophysics, mammalian radiobiology, mammalian metabolism, biochemistry, and genetics. The Department of Energy Los Alamos Area Office is also located within TA-43.

TA-46, WA Site: This TA contains two facility management units. Activities include applied photochemistry research including the development of technology for laser isotope separation and laser enhancement of chemical processes. A new facility completed during 1996 houses research in inorganic and materials chemistry. The Sanitary Wastewater System Facility is located at the east end of this site. Environmental management operations are also located here.

TA-48, Radiochemistry Site: Laboratory scientists and technicians perform research and development (R&D) activities at this site on a wide range of chemical processes including nuclear and radiochemistry, geochemistry, biochemistry, actinide chemistry, and separations chemistry. Hot cells are used to produce medical radioisotopes.

TA-49, Frijoles Mesa Site: This site is currently restricted to carefully selected functions because of its location near Bandelier National Monument and past use in high-explosive and radioactive materials experiments. The Hazardous Devices Team Training Facility is located here.

TA-50, Waste Management Site: This site is divided into two facility management units, which include managing the industrial liquid and radioactive liquid waste received from Laboratory technical areas and activities that are part of the waste treatment technology effort.

TA-51, Environmental Research Site: Research and experimental studies on the long-term impact of radioactive waste on the environment and types of waste storage and coverings are performed at this site.

TA-52, Reactor Development Site: A wide variety of theoretical and computational activities related to nuclear reactor performance and safety are done at this site.

TA-53, Los Alamos Neutron Science Center: The Los Alamos Neutron Science Center, including the linear proton accelerator, the Manuel Lujan Jr. Neutron Scattering Center, and a medical isotope production facility is located at this TA. Also located at TA-53 are the Accelerator Production of Tritium Project Office, including the Low-Energy Demonstration Accelerator, and R&D activities in accelerator technology and high-power microwaves.

TA-54, Waste Disposal Site: This site is divided into two facility management units for the radioactive solid and hazardous chemical waste management and disposal operations and activities that are part of the waste treatment technology effort.

TA-55, Plutonium Facility Site: Processing of plutonium and research on plutonium metallurgy are done at this site.

TA-57, Fenton Hill Site: This site is located about 28 miles west of Los Alamos on the southern edge of the Valles Caldera in the Jemez Mountains and was the location of the Laboratory’s now decommissioned Hot Dry Rock geothermal project. The site is used for the testing and development of downhole well-logging instruments and other technologies of interest to the energy industry. The high elevation and remoteness of the site make Fenton Hill a choice location for astrophysics experiments. A gamma ray observatory is located at the site.

TA-58: This site is reserved for multiuse experimental sciences requiring close functional ties to programs currently located at TA-3.

TA-59, Occupational Health Site: Occupational health and safety and environmental management activities are conducted at this site. Emergency management offices are also located here.

TA-60, Sigma Mesa: This area contains physical support and infrastructure facilities, including the Test Fabrication Facility and Rack Assembly and the Alignment Complex.

TA-61, East Jemez Road: This site is used for physical support and infrastructure facilities, including the Los Alamos County sanitary landfill.

TA-62: This site is reserved for multiuse experimental science, public and corporate interface, and environmental research and buffer zones.

TA-63: This is a major growth area at the Laboratory with expanding environmental and waste management functions and facilities. This area contains physical support facilities operated by Johnson Controls Northern New Mexico.

TA-64: This is the site of the Central Guard Facility and headquarters for the Laboratory Hazardous Materials Response Team.

TA-66: This site is used for industrial partnership activities.

TA-67: This is a dynamic testing area that contains significant archeological sites.

TA-68: This is a dynamic testing area that contains archeological and environmental study areas.

TA-69: This undeveloped TA serves as an environmental buffer for the dynamic testing area.

TA-70: This undeveloped TA serves as an environmental buffer for the high-explosives test area.

TA-71: This undeveloped TA serves as an environmental buffer for the high-explosives test area.

TA-72: This is the site of the Protective Forces Training Facility.

TA-73: This area is the Los Alamos Airport.

TA-74, Otowi Tract: This large area, bordering the Pueblo of San Ildefonso on the east, is isolated from most of the Laboratory and contains significant concentrations of archeological sites and an endangered species breeding area. This site also contains Laboratory water wells and future well fields.

Related Websites

For more information on environmental topics at Los Alamos National Laboratory, access the following Web sites:

http://lib-www.lanl.gov/pubs/la-13775.pdf provides access to *Environmental Surveillance at Los Alamos during 1999*.

http://lib-www.lanl.gov/pubs/lalap-00-213.pdf provides access to *Overview of Environmental Surveillance at Los Alamos during 1999*.

http://www.lanl.gov reaches the Los Alamos National Laboratory Web site.

http://www.energy.gov reaches the national Department of Energy Web site.

http://labs.ucop.edu provides information on the three laboratories managed by the University of California.

http://www.esh.lanl.gov/~AirQuality accesses LANL's Air Quality Group.

http://www.esh.lanl.gov/~esh18/ accesses LANL's Water Quality and Hydrology Group.

http://www.esh.lanl.gov/~esh19/ accesses LANL's Hazardous and Solid Waste Group.

http://www.esh.lanl.gov/~esh20/esh20A.html accesses LANL's Ecology Group.

http://erproject.lanl.gov provides information on LANL's Environmental Restoration Project.

activation mixed fission	Activation products are formed when a substance is struck by protons or neutrons. The atoms of the original substance are converted to another element that is unstable and, therefore, radioactive.
activation products	Radioactive products generated as a result of neutrons and other subatomic particles interacting with materials such as air, construction materials, or impurities in cooling water. These activation products are usually distinguished, for reporting purposes, from fission products.
albedo dosimeters	Albedo dosimeters are used to measure neutrons around TA-18. They use a neutron-sensitive polyethylene phantom to capture neutron backscatter to simulate the human body.
alpha particle	A positively charged particle (identical to the helium nucleus) composed of two protons and two neutrons that are emitted during decay of certain radioactive atoms. Alpha particles are stopped by several centimeters of air or a sheet of paper.
ambient air	The surrounding atmosphere as it exists around people, plants, and structures. It is not considered to include the air immediately adjacent to emission sources.
aquifer	A saturated layer of rock or soil below the ground surface that can supply usable quantities of groundwater to wells and springs. Aquifers can be a source of water for domestic, agricultural, and industrial uses.
artesian well	A well in which the water rises above the top of the water-bearing bed.
background radiation	Ionizing radiation from sources other than the Laboratory. This radiation may include cosmic radiation; external radiation from naturally occurring radioactivity in the earth (terrestrial radiation), air, and water; internal radiation from naturally occurring radioactive elements in the human body; worldwide fallout; and radiation from medical diagnostic procedures.
beta particle	A negatively charged particle (identical to the electron) that is emitted during decay of certain radioactive atoms. Most beta particles are stopped by 0.6 cm of aluminum.
biota	The types of animal and plant life found in an area.
blank sample	A control sample that is identical, in principle, to the sample of interest, except that the substance being analyzed is absent. The measured value or signals in blanks for the analyte is believed to be caused by artifacts and should be subtracted from the measured value. This process yields a net amount of the substance in the sample.
blind sample	A control sample of known concentration in which the expected values of the constituent are unknown to the analyst.
BOD	Biochemical (biological) oxygen demand. A measure of the amount of oxygen in biological processes that breaks down organic matter in water; a measure of the organic pollutant load. It is used as an indicator of water quality.

CAA	Clean Air Act. The federal law that authorizes the Environmental Protection Agency (EPA) to set air quality standards and to assist state and local governments to develop and execute air pollution prevention and control programs.
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980. Also known as Superfund, this law authorizes the federal government to respond directly to releases of hazardous substances that may endanger health or the environment. The EPA is responsible for managing Superfund.
CFR	Code of Federal Regulations. A codification of all regulations developed and finalized by federal agencies in the *Federal Register*.
COC	Chain-of-Custody. A method for documenting the history and possession of a sample from the time of collection, through analysis and data reporting, to its final disposition.
contamination	(1) Substances introduced into the environment as a result of people's activities, regardless of whether the concentration is a threat to health (see pollution). (2) The deposition of unwanted radioactive material on the surfaces of structures, areas, objects, or personnel.
controlled area	Any Laboratory area to which access is controlled to protect individuals from exposure to radiation and radioactive materials.
Ci	Curie. Unit of radioactivity. One Ci equals 3.70×10^{10} nuclear transformations per second.
cosmic radiation	High-energy particulate and electromagnetic radiations that originate outside the earth's atmosphere. Cosmic radiation is part of natural background radiation.
CWA	Clean Water Act. The federal law that authorizes the EPA to set standards designed to restore and maintain the chemical, physical, and biological integrity of the nation's waters.
DOE	US Department of Energy. The federal agency that sponsors energy research and regulates nuclear materials used for weapons production.
dose	A term denoting the quantity of radiation energy absorbed.
EDE	Effective dose equivalent. The hypothetical whole-body dose that would give the same risk of cancer mortality and serious genetic disorder as a given exposure but that may be limited to a few organs. The effective dose equivalent is equal to the sum of individual organ doses, each weighted by degree of risk that the organ dose carries. For example, a 100-mrem dose to the lung, which has a weighting factor of 0.12, gives an effective dose that is equivalent to $100 \times 0.12 = 12$ mrem. CEDE: committed effective dose equivalent TEDE: total effective dose equivalent

maximum individual dose The greatest dose commitment, considering all potential routes of exposure from a facility's operation, to an individual at or outside the Laboratory boundary where the highest dose rate occurs. It takes into account shielding and occupancy factors that would apply to a real individual.

population dose The sum of the radiation doses to individuals of a population. It is expressed in units of person-rem. (For example, if 1,000 people each received a radiation dose of 1 rem, their population dose would be 1,000 person-rem.)

whole body dose A radiation dose commitment that involves exposure of the entire body (as opposed to an organ dose that involves exposure to a single organ or set of organs).

EA Environmental Assessment. A report that identifies potentially significant environmental impacts from any federally approved or funded project that may change the physical environment. If an EA shows significant impact, an Environmental Impact Statement is required.

effluent A liquid waste discharged to the environment.

EIS Environmental Impact Statement. A detailed report, required by federal law, on the significant environmental impacts that a proposed major federal action would have on the environment. An EIS must be prepared by a government agency when a major federal action that will have significant environmental impacts is planned.

emission A gaseous waste discharged to the environment.

environmental compliance The documentation that the Laboratory complies with the multiple federal and state environmental statutes, regulations, and permits that are designed to ensure environmental protection. This documentation is based on the results of the Laboratory's environmental monitoring and surveillance programs.

environmental monitoring The sampling of contaminants in liquid effluents and gaseous emissions from Laboratory facilities, either by directly measuring or by collecting and analyzing samples in a laboratory.

environmental surveillance The sampling of contaminants in air, water, sediments, soils, food-stuffs, and plants and animals, either by directly measuring or by collecting and analyzing samples in a laboratory.

EPA Environmental Protection Agency. The federal agency responsible for enforcing environmental laws. Although state regulatory agencies may be authorized to administer some of this responsibility, EPA retains oversight authority to ensure protection of human health and the environment.

exposure A measure of the ionization produced in air by x-ray or gamma ray radiation. (The unit of exposure is the roentgen.)

external radiation	Radiation originating from a source outside the body.
gallery	An underground collection basin for spring discharges.
gamma radiation	Short-wavelength electromagnetic radiation of nuclear origin that has no mass or charge. Because of its short wavelength (high energy), gamma radiation can cause ionization. Other electromagnetic radiation (such as microwaves, visible light, and radiowaves) has longer wavelengths (lower energy) and cannot cause ionization.
GENII	Computer code used to calculate doses from all pathways (air, water, foodstuffs, and soil).
gross alpha	The total amount of measured alpha activity without identification of specific radionuclides.
gross beta	The total amount of measured beta activity without identification of specific radionuclides.
groundwater	Water found beneath the surface of the ground. Groundwater usually refers to a zone of complete water saturation containing no air.
^{3}H	Tritium.
half-life, radioactive	The time required for the activity of a radioactive substance to decrease to half its value by inherent radioactive decay. After two half-lives, one-fourth of the original activity remains (1/2 × 1/2), after three half-lives, one-eighth (1/2 × 1/2 × 1/2), and so on.
hazardous waste	Wastes exhibiting any of the following characteristics: ignitability, corrosivity, reactivity, or yielding toxic constituents in a leaching test. In addition, EPA has listed as hazardous other wastes that do not necessarily exhibit these characteristics. Although the legal definition of hazardous waste is complex, the term generally refers to any waste that EPA believes could pose a threat to human health and the environment if managed improperly. Resource Conservation and Recovery Act (RCRA) regulations set strict controls on the management of hazardous wastes.
hazardous waste constituent	The specific substance in a hazardous waste that makes it hazardous and therefore subject to regulation under Subtitle C of RCRA.
HSWA	Hazardous and Solid Waste Amendments of 1984 to RCRA. These amendments to RCRA greatly expanded the scope of hazardous waste regulation. In HSWA, Congress directed EPA to take measures to further reduce the risks to human health and the environment caused by hazardous wastes.
hydrology	The science dealing with the properties, distribution, and circulation of natural water systems.
internal radiation	Radiation from a source within the body as a result of deposition of radionuclides in body tissues by processes such as ingestion, inhalation, or implantation. Potassium-40, a naturally occurring radionuclide, is a major source of internal radiation in living organisms. Also called self-irradiation.

ionizing radiation Radiation possessing enough energy to remove electrons from the substances through which it passes. The primary contributors to ionizing radiation are radon, cosmic and terrestrial sources, and medical sources such as x-rays and other diagnostic exposures.

isotopes Forms of an element having the same number of protons in their nuclei but differing in the number of neutrons. Isotopes of an element have similar chemical behaviors but can have different nuclear behaviors.

- long-lived isotope - A radionuclide that decays at such a slow rate that a quantity of it will exist for an extended period (half-life is greater than three years).
- short-lived isotope - A radionuclide that decays so rapidly that a given quantity is transformed almost completely into decay products within a short period (half-life is two days or less).

LLW Low-level waste. The level of radioactive contamination in LLW is not strictly defined. Rather, LLW is defined by what it is not. It does not include nuclear fuel rods, wastes from processing nuclear fuels, transuranic (TRU) waste, or uranium mill tailings.

MCL Maximum contaminant level. Maximum permissible level of a contaminant in water that is delivered to the free-flowing outlet of the ultimate user of a public water system (see Appendix A and Table A-6). The MCLs are specified by the EPA.

MEI Maximally exposed individual. The average exposure to the population in general will always be less than to one person or subset of persons because of where they live, what they do, and their individual habits. To try to estimate the dose to the MEI, one tries to find that population subgroup (and more specifically, the one individual) that potentially has the highest exposure, intake, etc. This becomes the MEI.

mixed waste Waste that contains a hazardous waste component regulated under Subtitle C of the RCRA and a radioactive component consisting of source, special nuclear, or byproduct material regulated under the federal Atomic Energy Act (AEA).

mrem Millirem. See definition of rem. The dose equivalent that is one-thousandth of a rem.

NEPA National Environmental Policy Act. This federal legislation, passed in 1969, requires federal agencies to evaluate the impacts of their proposed actions on the environment before decision making. One provision of NEPA requires the preparation of an EIS by federal agencies when major actions significantly affecting the quality of the human environment are proposed.

NESHAP National Emission Standards for Hazardous Air Pollutants. These standards are found in the CAA; they set limits for such pollutants as beryllium and radionuclides.

nonhazardous waste	Chemical waste regulated under the Solid Waste Act, Toxic Substances Control Act, and other regulations, including asbestos, PCB, infectious wastes, and other materials that are controlled for reasons of health, safety, and security.
NPDES	National Pollutant Discharge Elimination System. This federal program, under the Clean Water Act, requires permits for discharges into surface waterways.
nuclide	A species of atom characterized by the constitution of its nucleus. The nuclear constitution is specified by the number of protons, number of neutrons, and energy content—or alternately, by the atomic number, mass number, and atomic mass. To be a distinct nuclide, the atom must be capable of existing for a measurable length of time.
outfall	The location where wastewater is released from a point source into a receiving body of water.
PCB	Polychlorinated biphenyls. A family of organic compounds used since 1926 in electric transformers, lubricants, carbonless copy paper, adhesives, and caulking compounds. PCB are extremely persistent in the environment because they do not break down into new and less harmful chemicals. PCB are stored in the fatty tissues of humans and animals through the bioaccumulation process. EPA banned the use of PCB, with limited exceptions, in 1976.
PDL	Public Dose Limit. The new term for Radiation Protection Standards, a standard for external and internal exposure to radioactivity as defined in DOE Order 5400.5 (see Appendix A and Table A-1).
perched groundwater	A groundwater body above a slow-permeablity rock or soil layer that is separated from an underlying main body of groundwater by a vadose zone.
person-rem	A quantity used to describe the radiological dose to a population. Population doses are calculated according to sectors, and all people in a sector are assumed to get the same dose. The number of person-rem is calculated by summing the modeled dose to all receptors in all sectors. Therefore, person-rem is the sum of the number of people times the dose they receive.
pH	A measure of the hydrogen ion concentration in an aqueous solution. Acidic solutions have a pH less than 7, basic solutions have a pH greater than 7, and neutral solutions have a pH of 7.
pollution	Levels of contamination that may be objectionable (perhaps because of a threat to health [see contamination]).
point source	An identifiable and confined discharge point for one or more water pollutants, such as a pipe, channel, vessel, or ditch.
ppb	Parts per billion. A unit measure of concentration equivalent to the weight/volume ratio expressed as µg/L or ng/mL. Also used to express the weight/weight ratio as ng/g or µg/kg.

ppm Parts per million. A unit measure of concentration equivalent to the weight/volume ratio expressed as mg/L. Also used to express the weight/weight ratio as µg/g or mg/kg.

QA Quality assurance. Any action in environmental monitoring to ensure the reliability of monitoring and measurement data. Aspects of quality assurance include procedures, interlaboratory comparison studies, evaluations, and documentation.

QC Quality control. The routine application of procedures within environmental monitoring to obtain the required standards of performance in monitoring and measurement processes. QC procedures include calibration of instruments, control charts, and analysis of replicate and duplicate samples.

rad Radiation absorbed dose. The rad is a unit for measuring energy absorbed in any material. Absorbed dose results from energy being deposited by the radiation. It is defined for any material. It applies to all types of radiation and does not take into account the potential effect that different types of radiation have on the body.

1 rad = 1,000 millirad (mrad)

radionuclide An unstable nuclide capable of spontaneous transformation into other nuclides through changes in its nuclear configuration or energy level. This transformation is accompanied by the emission of photons or particles.

RESRAD A computer modeling code designed to model radionuclide transport in the environment.

RCRA Resource Conservation and Recovery Act of 1976. RCRA is an amendment to the first federal solid waste legislation, the Solid Waste Disposal Act of 1965. In RCRA, Congress established initial directives and guidelines for EPA to regulate hazardous wastes.

release Any discharge to the environment. Environment is broadly defined as water, land, or ambient air.

rem Roentgen equivalent man. The rem is a unit for measuring dose equivalence. It is the most commonly used unit and pertains only to people. The rem takes into account the energy absorbed (dose) and the biological effect on the body (quality factor) from the different types of radiation.

rem = rad × quality factor
1 rem = 1,000 millirem (mrem)

SAL Screening Action Limit. A defined contaminant level that if exceeded in a sample requires further action.

SARA Superfund Amendments and Reauthorization Act of 1986. This act modifies and reauthorizes CERCLA. Title III of this act is known as the Emergency Planning and Community Right-to-Know Act of 1986.

saturated zone	Rock or soil where the pores are completely filled with water, and no air is present.
SWMU	Solid waste management unit. Any discernible site at which solid wastes have been placed at any time, regardless of whether the unit was intended for the management of solid or hazardous waste. Such units include any area at or around a facility at which solid wastes have been routinely and systematically released, such as waste tanks, septic tanks, firing sites, burn pits, sumps, landfills (material disposal areas), outfall areas, canyons around LANL, and contaminated areas resulting from leaking product storage tanks (including petroleum).
terrestrial radiation	Radiation emitted by naturally occurring radionuclides such as internal radiation source; the natural decay chains of uranium-235, uranium-238, or thorium-232; or cosmic-ray-induced radionuclides in the soil.
TLD	Thermoluminescent dosimeter. A material (the Laboratory uses lithium fluoride) that emits a light signal when heated to approximately 300°C. This light is proportional to the amount of radiation (dose) to which the dosimeter was exposed.
TRU	Transuranic waste. Waste contaminated with long-lived transuranic elements in concentrations within a specified range established by DOE, EPA, and Nuclear Regulatory Agency. These are elements shown above uranium on the chemistry periodic table, such as plutonium, americium, and neptunium, that have activities greater than 100 nanocuries per gram.
TSCA	Toxic Substances Control Act. TSCA is intended to provide protection from substances manufactured, processed, distributed, or used in the United States. A mechanism is required by the act for screening new substances before they enter the marketplace and for testing existing substances that are suspected of creating health hazards. Specific regulations may also be promulgated under this act for controlling substances found to be detrimental to human health or to the environment.
tuff	Rock formed from compacted volcanic ash fragments.
uncontrolled area	An area beyond the boundaries of a controlled area (see controlled area in this glossary).
unsaturated zone	See vadose zone in this glossary.
UST	Underground storage tank. A stationary device, constructed primarily of nonearthen material, designed to contain petroleum products or hazardous materials. In a UST, 10% or more of the volume of the tank system is below the surface of the ground.
vadose zone	The partially saturated or unsaturated region above the water table that does not yield water for wells. Water in the vadose zone is held to rock

or soil particles by capillary forces and much of the pore space is filled with air.

water table The water level surface below the ground at which the unsaturated zone ends and the saturated zone begins. It is the level to which a well that is screened in the unconfined aquifer would fill with water.

water year October through September.

watershed The region draining into a river, a river system, or a body of water.

wetland A lowland area, such as a marsh or swamp, that is inundated or saturated by surface water or groundwater sufficient to support hydrophytic vegetation typically adapted for life in saturated soils.

wind rose A diagram that shows the frequency and intensity of wind from different directions at a particular place.

worldwide fallout Radioactive debris from atmospheric weapons tests that has been deposited on the earth's surface after being airborne and cycling around the earth.

AA-2	Internal Assessment Group (LANL)
AEC	Atomic Energy Commission
AIP	Agreement in Principle
AIRFA	American Indian Religious Freedom Act
AIRNET	Air Monitoring Network
AL	Albuquerque Operations Office (DOE)
AO	Administrative Order
AQCR	Air Quality Control Regulation (New Mexico)
ARPA	Archeological Resources Protection Act
BEIR	biological effects of ionizing radiation
BOD	biochemical/biological oxygen demand
BTEX	total aromatic hydrocarbon
Btu	British thermal unit
CAA	Clean Air Act
CAS	Connected Action Statement
CCNS	Concerned Citizens for Nuclear Safety
CEDE	committed effective dose equivalent
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CRO	Community Reltions Office (LANL)
CMR	Chemistry and Metallurgy Research (LANL building)
CO	compliance order
COC	chain-of-custody
COD	chemical oxygen demand
COE	Army Corps of Engineers
CST	Chemical Sciences and Technology (LANL division)
CST-3	Analytical Services Group (LANL)
CST-13	Radioisotopes and Industrial Wastewater Science Group (LANL)
CWA	Clean Water Act
CY	calendar year
DAC	derived air concentration (DOE)
DARHT	Dual Axis Radiographic Hydrotest facility
DCG	Derived Concentration Guide (DOE)
D&D	decontamination and decommissioning
DEC	DOE Environmental Checklist
DOE	Department of Energy
DOE-EM	DOE, Environmental Management
DOU	Document of Understanding
EA	Environmental Assessment
EDE	effective dose equivalent
EIS	Environmental Impact Statement
EML	Environmental Measurements Laboratory
EO	Executive Order
EPA	Environmental Protection Agency
EPCRA	Emergency Planning and Community Right-to-Know Act

ER	Environmental Restoration
ESH	Environment, Safety, & Health
ESH-4	Health Physics Measurements Group (LANL)
ESH-13	ESH Training Group (LANL)
ESH-14	Quality Assurance Support Group (LANL)
ESH-17	Air Quality Group (LANL)
ESH-18	Water Quality & Hydrology Group (LANL)
ESH-19	Hazardous & Solid Waste Group (LANL)
ESH-20	Ecology Group (LANL)
ESO	Environmental Stewardship Office (LANL)
EST	Ecological Studies Team (ESH-20)
FFCA	Federal Facilities Compliance Agreement
FFCAct	Federal Facilities Compliance Act
FFCAgreement	RCRA Federal Facility Compliance Agreement
FFCO	Federal Facility Compliance Order
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
FIMAD	Facility for Information Management, Analysis, and Display
FONSI	Finding of No Significant Impact
FY	fiscal year
GENII	Generation II
GIS	geographic information system
G/MAP	gaseous/mixed air activation products
GPS	global positioning system
GWPMPP	Groundwater Protection Management Program Plan
HAZWOPER	hazardous waste operations (training class)
HE	high-explosive
HEWTP	High-Explosive Wastewater Treatment Plant
HMPT	Hazardous Materials Packaging and Transportation
HPAL	Health Physics Analytical Laboratory
HSWA	Hazardous and Solid Waste Amendments
HWA	Hazardous Waste Act (New Mexico)
HWMR	Hazardous Waste Management Regulations (New Mexico)
ICRP	International Commission on Radiological Protection
JCNNM	Johnson Controls Northern New Mexico
JENV	JCNNM Environmental Laboratory
LAAO	Los Alamos Area Office (DOE)
LANSCE	Los Alamos Neutron Science Center
LANL	Los Alamos National Laboratory (or the Laboratory)
LEDA	Low-Energy Demonstration Accelerator
LLW	low-level radioactive waste
LLMW	low-level mixed waste
LOQ	limit of quantitation
MAP	Mitigation Action Plan
MCL	maximum contaminant level
MDA	minimum detectable amount

MEI	maximally exposed individual
NAGPRA	Native American Grave Protection and Repatriation Act
NCRP	National Council on Radiation Protection and Measurements
NEPA	National Environmental Policy Act
NERF	NEPA Review Form
NESHAP	National Emission Standards for Hazardous Air Pollutants
NEWNET	Neighborhood Environmental Watch Network
NHPA	National Historic Preservation Act
NMDA	New Mexico Department of Agriculture
NMED	New Mexico Environment Department
NMEIB	New Mexico Environmental Improvement Board
NMWQCA	New Mexico Water Quality Control Act
NMWQCC	New Mexico Water Quality Control Commission
NPDES	National Pollutant Discharge Elimination System
NRC	US Nuclear Regulatory Commission
OB/OD	open burning/open detonation
ODS	ozone depleting substance
O&G	oil and grease
OHL	Occupational Health Laboratory (LANL)
OSHA	Occupational Safety and Health Act/Administration
PCB	polychlorinated biphenyls
PDL	public dose limit
PHERMEX	Pulsed high-energy radiographic machine emitting x-rays
ppb	parts per billion
ppm	parts per million
QA	quality assurance
QAP	Quality Assurance Program
QC	quality control
RCRA	Resource Conservation and Recovery Act
RD&D	research, development, and demonstration
RESRAD	residual radioactive material computer code
RLWTF	Radioactive Liquid Waste Treatment Facility (LANL)
RSRL	regional statistical reference level
SAL	screening action level
SARA	Superfund Amendments and Reauthorization Act
SDWA	Safe Drinking Water Act
SHPO	State Historic Preservation Officer (New Mexico)
SLD	Scientific Laboratory Division (New Mexico)
SOC	synthetic organic compound
SPCC	Spill Prevention Control and Countermeasures
SVOC	semivolatile organic compound
SWA	Solid Waste Act
SWPP	Storm Water Prevention Plan
SWMR	solid waste management regulations
SWMU	solid waste management unit

SWSC	Sanitary Wastewater Systems Consolidation Plant (LANL)
TA	Technical Area
TDS	total dissolved solids
TEDE	total effective dose equivalent
TLD	thermoluminescent dosimeter
TLDNET	thermoluminescent dosimeter network
TRI	toxic chemical release inventory
TRU	transuranic waste
TRPH	total recoverable petroleum hydrocarbon
TSCA	Toxic Substances Control Act
TSS	total suspended solids
TTHM	total trihalomethane
TWISP	Transuranic Waste Inspectable Storage Project (LANL)
UC	University of California
USFS	United States Forest Service
USGS	United States Geological Survey
UST	underground storage tank
VAP	vaporous activation products
VOC	volatile organic compound
WASTENET	Waste Management Areas Network (for air monitoring)
WM	Waste Management (LANL)
WSC	Waste Stream Characterization
WWW	World Wide Web

Elemental and Chemical Nomenclature

Actinium	Ac	Molybdenum	Mo
Aluminum	Al	Neodymium	Nd
Americium	Am	Neon	Ne
Argon	Ar	Neptunium	Np
Antimony	Sb	Nickel	Ni
Arsenic	As	Niobium	Nb
Astatine	At	Nitrate (as Nitrogen)	NO_3-N
Barium	Ba	Nitrite (as Nitrogen)	NO_2-N
Berkelium	Bk	Nitrogen	N
Beryllium	Be	Nitrogen dioxide	NO_2
Bicarbonate	HCO_3	Nobelium	No
Bismuth	Bi	Osmium	Os
Boron	B	Oxygen	O
Bromine	Br	Palladium	Pd
Cadmium	Cd	Phosphaeus	P
Calcium	Ca	Phosphate (as Phosphous)	PO_4-P
Californium	Cf	Platinum	Pt
Carbon	C	Plutonium	Pu
Cerium	Ce	Polonium	Po
Cesium	Cs	Potassium	K
Chlorine	Cl	Praseodymium	Pr
Chromium	Cr	Promethium	Pm
Cobalt	Co	Protactinium	Pa
Copper	Cu	Radium	Ra
Curium	Cm	Radon	Rn
Cyanide	CN	Rhenium	Re
Carbonate	CO_3	Rhodium	Rh
Dysprosium	Dy	Rubidium	Rb
Einsteinium	Es	Ruthenium	Ru
Erbium	Er	Samarium	Sm
Europium	Eu	Scandium	Sc
Fermium	Fm	Selenium	Se
Fluorine	F	Silicon	Si
Francium	Fr	Silver	Ag
Gadolinium	Gd	Sodium	Na
Gallium	Ga	Stronium	Sr
Germanium	Ge	Sulfate	SO_4
Gold	Au	Sulfite	SO_3
Hafnium	Hf	Sulfur	S
Helium	He	Tantalum	Ta
Holmium	Ho	Technetium	Tc
Hydrogen	H	Tellurium	Te
Hydrogen oxide	H_2O	Terbium	Tb
Indium	In	Thallium	Tl
Iodine	I	Thorium	Th
Iridium	Ir	Thulium	Tm
Iron	Fe	Tin	Sn
Krypton	Kr	Titanium	Ti
Lanthanum	La	Tritiated water	HTO
Lawrencium	Lr (Lw)	Tritium	^3H
Lead	Pb	Tungsten	W
Lithium	Li	Uranium	U
Lithium fluoride	LiF	Vanadium	V
Lutetium	Lu	Xenon	Xe
Magnesium	Mg	Ytterbium	Yb
Manganese	Mn	Yttrium	Y
Mendelevium	Md	Zinc	Zn
Mercury	Hg	Zirconium	Zr

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Group ESH-18, Water Quality and Hydrology
Group ESH-19, Hazardous and Solid Waste
Group ESH-20, Ecology Group
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Ecology Group, ESH-20 (Phillip Fresquez, Coordinator)

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