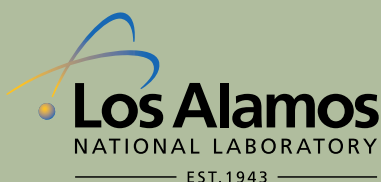


Environmental Surveillance at Los Alamos during 2007



LA-14369-ENV

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It is the policy of Los Alamos National Laboratory that we will be responsible stewards of our environment. It is our policy to:



Manage and operate our site in compliance with environmental laws and standards and in harmony with the natural and human environment



Meet our environmental permit requirements



Use continuous improvement processes to recognize, monitor and minimize the consequences to the environment stemming from our past, present, and future operations



Prevent pollution



Foster sustainable use of natural resources



Work to increase the body of knowledge regarding our environment

Environmental Surveillance at Los Alamos during 2007

Waste and Environmental Services Division

505-667-0808

Water Stewardship Program

505-667-0132

Corrective Actions Program

505-667-2623

Environmental Protection Division

505-667-2211

Ecology and Air Quality Group

505-665-8855

Water Quality and RCRA Group

505-665-0453

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Abstract

Environmental Surveillance at Los Alamos reports are prepared annually by the Los Alamos National Laboratory (the Laboratory) Environmental Directorate, as required by US Department of Energy Order 450.1, General Environmental Protection Program, and US Department of Energy Order 231.1A, Environment, Safety, and Health Reporting.

These annual reports summarize environmental data that are used to determine compliance 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 and explains the risks and the actions taken to reduce risks at the Laboratory from environmental legacies and waste management operations. Chapter 2 reports the Laboratory's compliance status for 2007. Chapter 3 provides a summary of the maximum radiological dose the public and biota populations could have potentially received from Laboratory operations and discusses chemical exposures. The environmental surveillance and monitoring data are organized by environmental media (Chapter 4, air; Chapters 5 and 6, water and sediments; Chapter 7, soils; and Chapter 8, foodstuffs and biota) in a format to meet the needs of a general and scientific audience. Chapter 9 provides a summary of the status of environmental restoration work around LANL. 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, Appendix C describes the Laboratory's technical areas and their associated programs, and Appendix D provides web links to more information.

In printed copies of this report or Executive Summary, we have also enclosed a compact disc with a copy of the full report in Adobe Acrobat (PDF) form and detailed supplemental tables of data from 2007 in Microsoft Excel format. These files are also available for download from the web.

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://www.lanl.gov/environment/all/esr.shtml>

Environmental Surveillance at Los Alamos during 2007

Executive Summary



LA-14369-ENV

Approved for public release; distribution is unlimited.

Executive Summary

The Los Alamos National Laboratory (LANL or the Laboratory) is located in Los Alamos County, in north-central New Mexico (NM), approximately 60 miles north-northeast of Albuquerque and 25 miles northwest of Santa Fe (Figure ES-1). The 40-square-mile Laboratory is situated on the Pajarito Plateau, a series of mesas separated by deep east-to-west-oriented canyons cut by stream channels. Mesa tops range in elevation from approximately 7,800 ft on the flanks of the Jemez Mountains to about 6,200 ft above the Rio Grande at White Rock Canyon. Most Laboratory and Los Alamos County community developments are confined to the mesa tops. With the exception of the towns of Los Alamos and White Rock, 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, the US Bureau of Land Management, the Bandelier National Monument, the US General Services Administration, and Los Alamos County. In addition, Pueblo de San Ildefonso borders the Laboratory to the east.

The mission of LANL is to develop and apply science and technology to (1) ensure the safety and reliability of the US nuclear deterrent, (2) reduce global threats, and (3) solve other emerging national security challenges. Meeting this diverse mission requires excellence in science and technology to solve multiple national and international challenges. Inseparable from the Laboratory's focus on excellence in science and technology is the commitment to environmental stewardship and full compliance with environmental protection laws. Part of LANL's commitment is to report on its environmental performance. This report

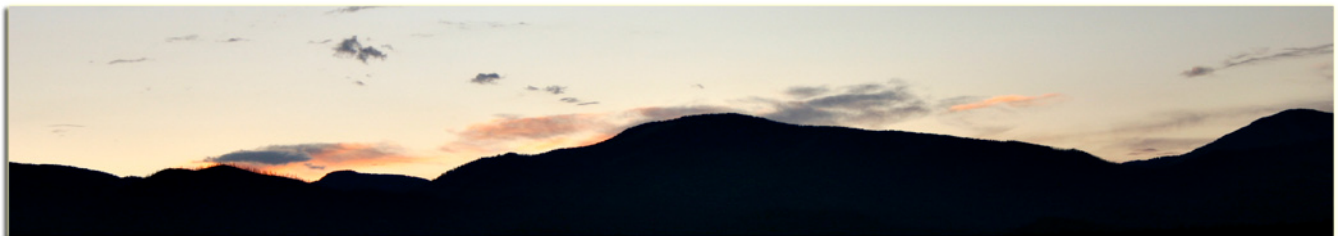
- characterizes LANL's environmental management,
- summarizes environmental occurrences and responses,
- describes compliance with environmental standards and requirements, and
- highlights significant programs and efforts.

ENVIRONMENTAL MANAGEMENT SYSTEM

As part of its commitment to protect the environment and improve its environmental performance, LANL implemented an Environmental Management System (EMS) pursuant to US Department of Energy (DOE) Order 450.1 and the international standard (ISO) 14000-2004. DOE defines an EMS as "a continuous cycle of planning, implementing, evaluating, and improving processes and actions undertaken to achieve environmental missions and goals." The EMS provides a systematic method for assessing mission activities, determining the environmental impacts of those activities, prioritizing improvements, and measuring results. In

April 2006, LANL became the first National Nuclear Security Administration (NNSA) national laboratory and the first University of California-operated facility to receive full certification.

- ▶ *Additional certification audits in 2007 by an independent registrar concluded that the Laboratory's environmental management system continues to meet all requirements for full certification to the international standard.*
- ▶ *NNSA again recognized the success of the EMS management by giving the Laboratory the 2007 NNSA "Environmental Stewardship" Award for EMS-developed projects.*



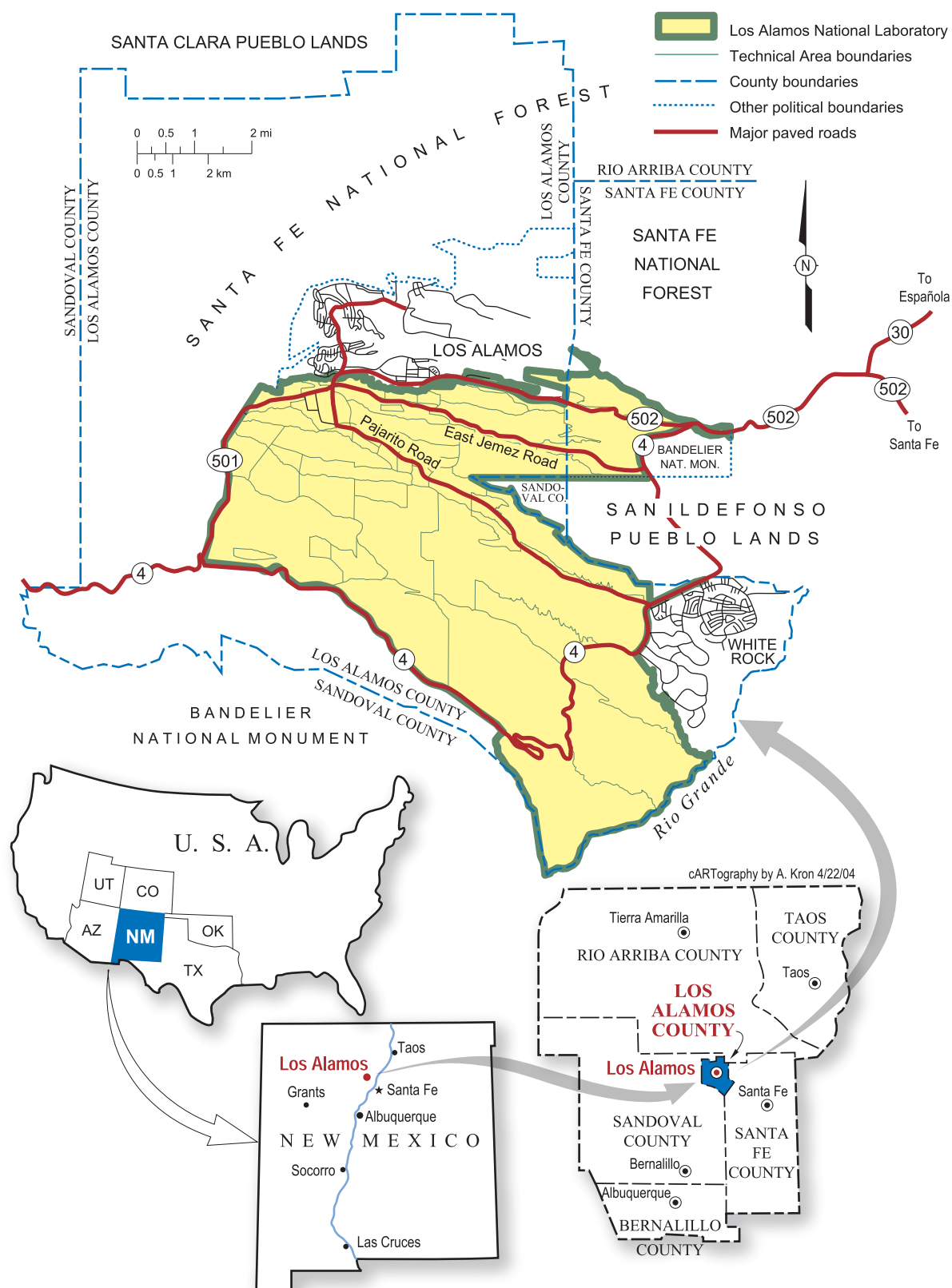


Figure ES-1. Regional location of Los Alamos National Laboratory.

During 2007, the EMS was audited two times by the same independent third-party ISO 14001 auditor who conducted three audits in 2006. The auditors concluded that the LANL EMS continues to meet all the requirements of the ISO 14001-2004 standard with no major non-conformities and recommended that LANL maintain full certification. NNSA recognized the success of the EMS management and the unique approach by giving the Laboratory the 2007 NNSA “Environmental Stewardship” Award for EMS-developed projects.

Federal Facility Compliance Agreement

During 2007, the DOE and the Laboratory continued to work under the requirements of a Federal Facility Compliance Agreement (FFCA) with the US Environmental Protection Agency (EPA) and the New Mexico Environment Department (NMED). The agreement establishes a compliance plan for the regulation of storm water point source discharges from solid waste management units (SWMUs) and areas of concern at the Laboratory; the agreement will remain in effect until those sources are regulated by an individual storm water permit issued by EPA.

Compliance Order on Consent

The March 2005 Compliance Order on Consent (the Consent Order) between LANL, DOE, and the NMED is the principal regulatory driver for LANL’s environmental restoration programs including the Water Stewardship Program. The Consent Order contains requirements for investigation and cleanup of SWMUs and areas of concern at the Laboratory. The major activities conducted by the Laboratory included investigations and cleanup actions. All major deliverables of the Consent Order were met by the Laboratory during 2007. In June 2007, the NMED Hazardous Waste Bureau issued a Notice of Violation (NOV) to DOE and LANL for failing to complete the sampling of all wells within the Water Canyon watershed within 21 days of the start of a groundwater sampling event. LANL made changes to the methods for notifying organizations that must allow access and reassigned responsibility for coordinating and tracking sample scheduling. NMED determined that the proposed corrective actions should help ensure future compliance. A second NOV was issued in August by NMED’s Hazardous Waste Bureau for two alleged violations noted during the 2006 Resource Conservation and Recovery Act (RCRA) compliance inspection. LANL made penalty payments to settle this NOV and two previous NOV’s issued in 2006.

- ▶ *The Consent Order is the principal regulatory driver for the Laboratory’s environmental restoration activities and the Water Stewardship Program. It specifies actions that the Laboratory must complete to characterize contaminated sites and monitor the movement of contaminants.*
- ▶ *The Laboratory met all major deliverables of the Consent Order.*
- ▶ *The NMED issued two Notices of Violation to LANL and DOE related to the Consent Order for failure to complete a watershed sampling within the required 21 days and for hazardous waste storage violations.*

Improvement Targets

Improvement goals for the Laboratory include continuing to improve RCRA compliance. The Laboratory’s RCRA non-compliance rate increased by 0.69% to 3.71% in 2007. The Laboratory continues to improve its processes, systems, and training to reduce the number of violations in the future. Under its new EMS, the Laboratory must identify and minimize environmental impacts and waste sources. Chromium discharged from a cooling tower in the 1960s through 1972 was discovered in the regional aquifer in early 2006, and LANL has installed monitoring wells to evaluate the extent of contamination. Though perchlorate and high explosives residues are no longer discharged, their movement from past effluent discharges is being monitored to determine if they could pose a threat to drinking water sources.



Design of Surveillance System and Sample Locations

To achieve its mission activities, LANL uses a variety of materials, some of which are hazardous or radioactive. Experiments and mission activities result in air emissions, water discharges, and waste generation. These emissions and discharges have the potential to affect different receptors or components of the environment including people, air, water, soil, foodstuffs, plants, and animals by one or more pathways such as inhalation of or contact with hazardous materials.

The Laboratory uses data from monitoring (surveillance) of known release points and multiple receptors (people, air, water, soil, foodstuffs, plants, and animals) over a long time period as a basis for policy and to determine actions to protect the environment. We collect data from the surrounding region to establish baseline environmental conditions not influenced by LANL operations. Regional monitoring also indicates whether LANL operations are impacting areas beyond LANL's boundaries. Examples of regional monitoring include the radiological ambient air sampling network (AIRNET) and foodstuffs and biota (plants and animals) sampling. We also collect data at the Laboratory perimeter to determine if operations are impacting LANL or neighboring properties (e.g., Pueblo and County lands). Perimeter monitoring also measures the highest potential impact to the public. To better quantify releases, we monitor at specific discharge or release points or other locations on LANL property that are known to or have the potential to release contaminants. Examples of locations with this type of monitoring include facility stacks, the Dual Axis Radiographic Hydrodynamic Test (DARHT) Facility, the Los Alamos Neutron Science Center (LANSCE), remediation sites where legacy waste is being managed, decontamination and decommissioning projects, Area G at Technical Area (TA-) 54 (where waste is being handled and stored), and water discharge locations (outfalls). We use these data to demonstrate compliance with applicable environmental laws and regulations. During 2007, the Laboratory collected more than 8,000 environmental monitoring samples from more than 940 locations and requested about 162,000 analyses or measurements on these samples.

Risk Reduction

Risk is evaluated either as current (present-day) or prospective (future) risk. The Laboratory assesses hazards and the corresponding risks by evaluating environmental data, measurements, inventories of buried or stored materials, and potential exposure pathways and scenarios. We use models, data, and computer programs to assist with these estimates.

Over the years, the Laboratory has decreased its release of materials into the environment and has reduced the amount of legacy contamination. Examples include the reduction in both the number of outfalls (plant and process discharges) and the volume of water released, the reduction in air emissions, changes to effluent treatment processes at the Radioactive Liquid Waste Treatment Facility at TA-50, and the removal of contaminated material and waste at sites such as Material Disposal Area (MDA) P. These efforts have significantly reduced or eliminated potential exposure and risk to workers, the public, and the environment.

Examples of ongoing risk reduction activities include the transport of stored legacy transuranic waste from Area G to the Waste Isolation Pilot Plant (WIPP) in Carlsbad, NM; the planned cleanup and remediation of the former plutonium processing facility at TA-21; ongoing studies of groundwater contamination to evaluate future hazards and risks; and numerous investigations and corrective actions at potentially contaminated sites.

- ▶ *Past risk reduction successes include the reduction in the number of outfalls (plant and process discharges) and the volume of water released from them, the reduction in air emissions over the past several years, changes to effluent treatment processes at the Radioactive Liquid Waste Treatment Facility at Technical Area 50, and the removal of contaminated material and waste at former waste disposal sites.*
- ▶ *Ongoing risk reduction efforts include the transport of waste from Area G to permanent disposal at WIPP, studies of the movement of contaminants in groundwater, and planned or active cleanup operations at former waste and radionuclide processing sites.*
- ▶ *The environmental surveillance programs can detect very low levels of potential contaminants and thus help determine whether a new hazard is present and evaluate the associated level of risk.*

The sensitivity of measurements obtained by LANL's environmental surveillance program allows detection of hazardous and radioactive materials and other contaminants during cleanup or normal operations at locations near and remote. All major pathways to people and the environment are monitored. The data from monitoring can be used to assist with possible mitigation of impacts. Air monitoring by the AIRNET system has regularly detected airborne contaminants where both known and unexpected contamination is present on the surface; in many cases, remediation was initiated to remove the source, though levels have never approached regulatory limits. The AIRNET system can detect low levels of radionuclides that are dispersed during cleanup operations, and many additional samplers have been added in anticipation of upcoming cleanup operations. The Direct Penetrating Radiation network detects neutrons and gamma rays from the stored waste at Area G and is used to help keep radiation levels as low as reasonably achievable. Biota and foodstuffs monitoring is conducted to ensure there is no spread of contamination into plants, animals, and food. The monitoring of constituents in groundwater keeps track of the movement of previously-released contaminants and their potential migration in the aquifers.

Compliance

The Laboratory uses the status of compliance with environmental requirements as a key indicator of its environmental performance. Federal and state regulations provide specific requirements and standards to implement these statutes and maintain environmental quality. The EPA and the NMED are the principal administrative authorities for these laws. The Laboratory also is subject to DOE requirements for control of radionuclides. Table ES-1 presents a summary of the Laboratory's status in regard to environmental statutes and regulations.

Table ES-1
Environmental Statutes under which LANL Operates and Compliance Status in 2007

| Federal Statute | What it Covers | Status |
|---|---|--|
| Resource Conservation and Recovery Act (RCRA) | Generation, management, and disposal of hazardous waste and cleanup of inactive, historical waste sites | <p>The Laboratory completed 1,939 self-assessments that resulted in a non-conformance finding rate of 3.71%.</p> <p>The Consent Order replaces Module VIII of the Hazardous Waste Facility Permit. All deliverables required by the Consent Order were submitted to NMED on time. NMED issued a Notice of Violation (NOV) to DOE and LANL that alleged for failing to complete the sampling of all monitoring wells in a single watershed within 21 days of the start of a groundwater sampling event. LANL submitted a proposed corrective action and NMED determined no further action was required. The NMED issued a second NOV regarding storage of hazardous waste.</p> <p>The Laboratory is in compliance with groundwater monitoring requirements. Two regional aquifer wells were installed in Sandia Canyon in 2007.</p> |
| Clean Air Act (CAA) | Air quality and emissions into the air from facility operations | <p>The Laboratory met all permit limits for emissions to the air. Non-radiological air emissions were lower than the previous year for nitrogen oxides, carbon monoxide, and particulate matter and similar to the previous year for volatile organic compounds and particulate matter. A smoke opacity deviation 5% greater than permit limits occurred briefly at the power plant. The dose to the maximally exposed individual (MEI) from radioactive air emissions was 0.52 mrem, which is similar to the very low dose for the previous year.</p> |
| Clean Water Act (CWA) | Water quality and effluent discharges from facility operations | <p>Only three of 1408 samples collected from industrial outfalls and none of the 130 samples collected from the Sanitary Wastewater Systems Plant's outfall exceeded effluent limits.</p> |

Table ES-1 (continued)

| Federal Statute | What it Covers | Status |
|---|--|--|
| CWA (continued) | Water quality and effluent discharges from facility operations | <p>The Laboratory conducted 542 storm water inspections and 99% of the Laboratory's 51 permitted construction sites were compliant with National Pollutant Discharge Elimination System (NPDES) requirements contained in construction site storm water pollution prevention plans. Thirteen precipitation gauges were installed across the Lab to ensure refined data are used to trigger storm water inspections.</p> <p>The Laboratory continued to implement 15 Storm Water Pollution Prevention Plans covering 26 industrial facilities and site-wide SWMUs. This included sampling of storm water discharges from industrial activities and installing and maintaining Best Management Practices to manage pollutants and runoff at these locations.</p> |
| Aboveground storage tank compliance program | Liquid storage tank monitoring and compliance | Four tank systems at LANSCE (TA-53) and three in TA-3 were closed out with NMED in 2007 leaving a total of 20 regulated tanks. LANL performed additional characterization of the 2002 diesel release from a tank at TA-21 and completed initial characterization of the diesel-contaminated soil near a tank at the TA-3 power plant. The Laboratory paid annual registration fees of \$100 per tank to the NMED. |
| Toxic Substances Control Act (TSCA) | Chemicals such as polychlorinated biphenyls (PCBs) | The Laboratory shipped 46 containers of PCB waste, 60 lbs of capacitors, and 2,795 lbs of fluorescent light ballasts for disposal or recycling in compliance with all manifesting, record keeping, and disposal requirements. |
| Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) | Storage and use of pesticides | The Laboratory remained in compliance with regulatory requirements regarding use of pesticides and herbicides. The Laboratory used 620 oz of insecticides and 185.5 gal. plus 12 lbs of herbicides. |
| Emergency Planning and Community Right-to-Know Act (EPCRA) | The public's right to know about chemicals released into the community | The Laboratory reported releases, waste disposal, and waste transfers totaling 10,883 lbs of lead and 557 lbs of nitric acid. No updates to Emergency Planning Notifications were necessary in 2007. Chemical Inventory Reports were updated to the Los Alamos County fire and police departments for 36 chemicals or explosives. |
| Endangered Species Act (ESA) & Migratory Bird Treaty Act (MBTA) | Rare species of plants and animals | The Laboratory maintained compliance with the ESA and MBTA and reviewed 636 excavation permits and 107 project profiles for potential impacts to threatened or endangered species. The Laboratory conducted annual surveys for Mexican spotted owl, Southwestern willow flycatcher, Jemez Mountain salamander and grey vireo. LANL prepared biological assessments for one project regarding potential impacts on federally listed threatened or endangered species. |
| National Historic Preservation Act (NHPA) and others | Cultural resources | The Laboratory maintained compliance with the NHPA. Laboratory conducted 32 projects that required some field verification of previous survey information and identified four new archaeological sites and no new historic buildings. Fifteen archaeological sites were determined eligible for the National Register of Historic Places. |
| National Environmental Policy Act (NEPA) | Projects evaluated for environmental impacts | During 2007, the Laboratory and NNSA incorporated public comments into the final Site-Wide Environmental Impact Statement for continued operation of LANL. The document was released in early 2008 for a final decision in late 2008 on one of three alternatives. |

Unplanned Releases

There were no unplanned airborne releases from LANL in 2007. There were no unplanned releases of radioactive liquids. There were 17 spills or releases of potable water, fire suppression water, or domestic wastewater and one spill of a quart of motor oil into a storm drain. All liquid releases were reported to NMED and will be administratively closed upon final inspection. A smoke opacity deviation of 25% (just above the permit limit of 20%) was observed for a very short time at the power plant at TA-3.

Radiological Dose Assessment

Humans, plants, and animals potentially receive radiation doses from various Laboratory operations (Table ES-2). The DOE dose limits for the public and biota are the mandated criteria that are used to determine whether a measurement represents a potential exposure concern. Figure ES-2 shows doses to the hypothetical maximally exposed individual (MEI) via the air pathway over the last 13 years at an off-site location; this location was East Gate through 2005 but was at the Los Alamos County Airport terminal for 2006 and at a location along DP Road in 2007. The annual dose to the MEI was approximately 0.52 mrem, compared to 0.47 mrem in 2006 and a regulatory limit of 10 mrem (Figure ES-2). Contributing to the low dose at this location was disturbed soil from road grading as part of preparations for a cleanup activity at a material disposal area adjacent to DP Road. The Laboratory calculated potential radiological doses to members of the public from LANL emissions and discharges. During 2007, the population within 80 km of LANL received a collective dose of about 0.36 person-rem, down from 0.6 person-rem in 2006 and a substantial decrease from the dose of 2.46 person-rem reported for 2005. The doses received in 2007 from LANL operations by an average Los Alamos residence and an average White Rock residence totaled about 0.022 mrem and 0.024 mrem, respectively. Direct radiation from waste stored at TA-54, Area G could result in an exposure to an individual in the adjacent sacred area of Pueblo de San Ildefonso of 0.8 mrem per year.

- ▶ *Radiation dose to the hypothetical maximally exposed individual (MEI) was slightly lower than the very low level measured in 2006 and is partly attributable to the additional emission control system added in late 2005.*
- ▶ *The MEI location was determined to be along DP Road in eastern Los Alamos. This location received a combination of low levels of radiation from stack emissions and low levels of contamination from road grading next to a former material disposal area.*

Table ES-2
What are the Sources of Radiological Doses?

| Source | Recipient | Dose | Location | Trends |
|--|---------------------|--------------|---|--|
| Background (includes man-made sources) | Humans | ~470 mrem/yr | All sites | Not applicable |
| Air | Humans | 0.52 mrem/yr | Along DP Road in Los Alamos | Similar to very low level in previous year |
| Direct irradiation | Humans | 0.8 mrem/yr | San Ildefonso – offsite | Lower than previous year |
| Food | Humans | <0.1 mrem/yr | All sites | Steady |
| Drinking water | Humans | <0.1 mrem/yr | All sites | Steady |
| All | Terrestrial animals | <20 mrad/day | TA-15 “EF site”, TA-21 material disposal area (MDA) B | Steady |
| All | Terrestrial plants | <50 mrad/day | TA-21 MDA B | Steady |



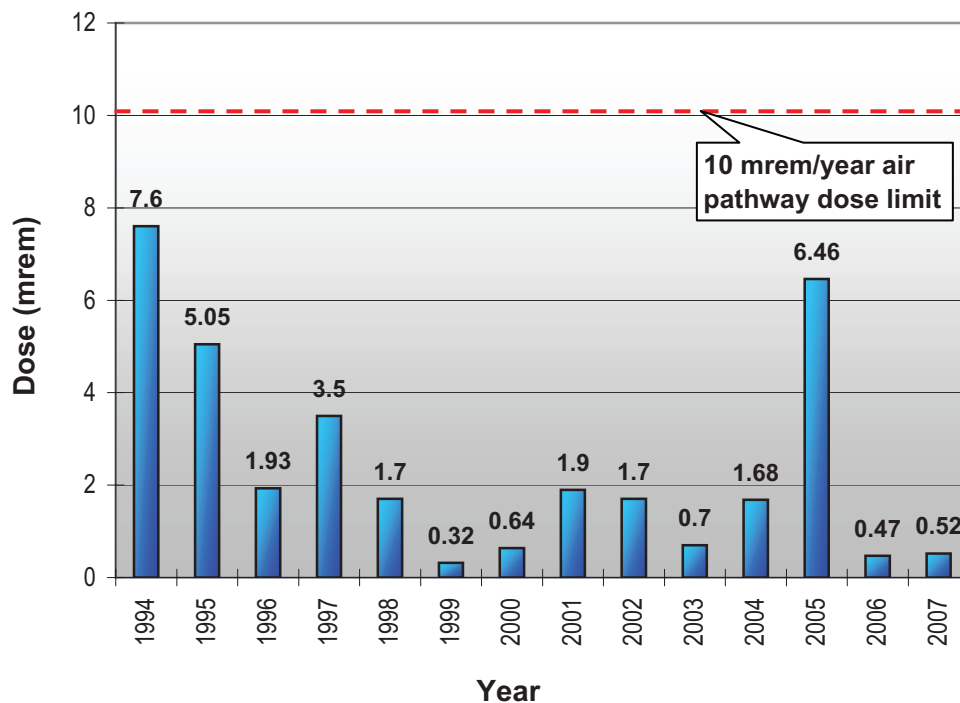


Figure ES-2. Annual airborne pathway dose (mrem) to the off-site MEI over the past 14 years. The location of the calculated MEI changed to a location other than East Gate, in this case to a location along DP Road in the eastern part of Los Alamos.

Biota Dose

The DOE biota dose limits are intended to protect populations of plants and animals, especially with respect to preventing the impairment of reproductive capability within the biota population. All radionuclide concentrations in vegetation sampled were far below the plant 0.1 rad/day biota dose screening level (10% of 1 rad/day dose limit), and all radionuclide concentrations in terrestrial animals sampled were far below the terrestrial animal 0.01 rad/day biota dose screening level (10% of 0.1 rad/day dose limit) (Table ES-2). Two storm runoff samples contained slightly elevated uranium levels and triggered an evaluation of biota doses. The locations of these samples, near TA-15 firing sites, do not contain aquatic habitats; nevertheless, the most conservative (worst case) assumptions result in potential doses of up to 0.5 mrad/day to terrestrial animals and 0.1 mrad/day to terrestrial plants, both of which are less than 1% of the DOE biota dose limits.

Air Emissions and Air Quality

The Laboratory measures the emissions of radionuclides at the emission sources (building stacks) and categorizes these radioactive stack emissions into one of four types: (1) particulate matter, (2) vaporous

activation products (radioactive elements created by the LANSCE particle accelerator beam), (3) tritium, and (4) air activation products. Similarly, the Laboratory collects air samples at general locations within LANL boundaries, at the LANL perimeter, and regionally to estimate the extent and concentration of radionuclides that may be released from Laboratory operations. These radionuclides include isotopes of plutonium, americium, uranium, and tritium.

► *Emissions from the stacks at LANSCE, normally the source of most radionuclide emissions, remained very low in 2007.*

► *Emissions of radionuclides from other Laboratory stacks were comparable to previous years.*

Gaseous activated air product emissions from the LANSCE stack were the lowest since 1999. Emissions from all other stacks were comparable to previous years or slightly lower. Total stack emissions during 2007 were approximately 477 curies (Ci), a drop of 60% compared to 2006 levels. Diffuse emissions from the LANSCE facility and other smaller sources contributed another 83 Ci. Of the total, tritium emissions composed about 260 Ci (70% less than 2006) and short-lived air activation products from LANSCE stacks and diffuse emissions contributed 301 Ci (45% less than in 2006). Most of the curies from LANSCE are from very short-lived radionuclides that decay significantly before reaching the location of the MEI; these gasses also have a very low dose impact to a human. Combined airborne emissions of other radionuclides, such as plutonium, uranium, americium, and thorium, were less than 0.000012 Ci (about 67% less) and emissions of particulate/vapor activation products decreased by about two orders of magnitude from 2006 to 0.016 Ci.

Radionuclide concentrations from ambient air samples in 2007 were generally comparable with concentrations in past years. As in past years, the AIRNET system detected contamination from known areas of contamination below the Ashley Hotel and Suites (formerly Los Alamos Inn), at the Laboratory's waste disposal site at Area G, and from the former plutonium processing site at TA-21. No new or increased airborne radioactivity was detected. At regional locations away from Los Alamos, all air sample measurements were consistent with background levels. Annual mean radionuclide concentrations at all LANL perimeter stations were less than 1% of the EPA dose limit for the public. Measurable amounts of tritium were reported at most on-site locations and at perimeter locations; the highest concentrations were measured at the Area G waste site in TA-54 after a decommissioned tank from TA-21 was moved to Area G. The tank was subsequently moved to the tritium shafts at Area G and tritium levels declined. The highest off-site tritium concentration (measured at station #75 along DP Road) was 3.7 pCi/m³ (0.25% of the EPA public dose limit of 1,500 pCi/m³). The highest on-site tritium measurement (0.001% of the DOE limit for workers) was made at Area G near a pit containing tritium-contaminated waste. Plutonium-238 was detected at two LANL perimeter stations: near the Ashley Hotel and Suites (formerly Los Alamos Inn) at about 19 aCi/m³ or about 1% of the EPA public dose limit (from historical activities at LANL's old main technical area), and at very low levels near MDA B where soil disturbance from road construction occurred in preparation for remediation of the MDA.

- ▶ *Measurable concentrations of radionuclides in ambient air were not detected at regional sampling locations nor at most perimeter locations.*
- ▶ *The highest mean air concentrations at perimeter locations were below 1% of the applicable EPA limits.*



On-site detections of plutonium occurred at Area G (an area with known low levels of contamination) and levels were substantially below 0.005% of the DOE limit for workplace exposure. Americium-241 was detected near Area G at levels less than 0.001% of worker exposure limits and at eight off-site locations at levels less than 0.5% of public exposure limits. The maximum annual uranium concentrations were from natural uranium at locations with high dust levels from local soil disturbances. The regional and pueblo samples had higher average concentrations of natural uranium isotopes than the perimeter group. Depleted uranium (which has lower radioactivity than natural uranium) was detected in seven samples from areas around LANL firing sites where depleted uranium was used in the past. Enriched uranium was not detected during 2007. Uranium concentrations have been generally declining since the Cerro Grande fire in 2000.

▶ *As in previous years, PM-10 and PM-2.5 particulate measurements in ambient air were well below EPA standards.*

▶ *Most of the dust measured by the PM-10 and PM-2.5 samplers is from natural sources such as dust and wildfire smoke.*

Air monitoring for particles with diameters of 10 micrometers (μm) or less (PM-10) and for particles with diameters of 2.5 μm or less (PM-2.5) continued at one White Rock and two Los Alamos locations. The annual averages at all locations for PM-10 was about 14 micrograms (μg)/ m^3 and about 8 $\mu\text{g}/\text{m}^3$ for PM-2.5 and were mostly caused by natural dust and wildfire smoke. These averages are each only 1 μg greater than measured in 2006 and are 28% and 53% of the EPA

standards, respectively. In addition, the 24-hour maxima for both PM-10 and PM-2.5 at all three locations never exceeded 44% and 30% of the respective EPA standards.

The Laboratory analyzed filter samples from 23 sites for beryllium. These sites are located near potential beryllium sources at LANL or in nearby communities. Beryllium air concentrations for 2007 were similar to those measured in recent years and are equal to or less than 1% of the National Emission Standard for Hazardous Air Pollutants (NESHAP) standard. Past studies correlated beryllium concentrations with aluminum concentrations, which indicate that all measurements of beryllium are from naturally occurring beryllium in resuspended dust.

Groundwater Monitoring

▶ *In general, groundwater quality at LANL continues to improve as a result of past efforts that have eliminated outfalls, reduced the quantity of discharges, and improved the quality of discharges.*

▶ *Contamination may be discovered in additional locations, however, as groundwater characterization continues.*

Groundwater at the Laboratory occurs as a regional aquifer (water-bearing rock capable of yielding significant quantities of water to wells and springs) at depths ranging from 600 to 1,200 ft and as perched groundwater of limited thickness and horizontal extent, either in canyon alluvium or at intermediate depths of a few hundred feet (Figure ES-3). All water produced by the Los Alamos County water supply system comes from the regional aquifer and meets federal and state drinking

water standards. No drinking water is supplied from the alluvial and intermediate groundwater.

Laboratory contaminants have affected deep groundwater, including intermediate perched zones and the regional aquifer, primarily through liquid effluent disposal. Since the early 1990s, the Laboratory has significantly reduced both the number of industrial outfalls (from 141 to 17 active) and the volume of water released (by more than 86%). For 1993 to 1997, total estimated average flow was 1,300 million gal./yr; in 2006, the flow was 222 million gal. and in 2007 the flow was 178 million gal. All discharges met applicable federal and state standards. Where Laboratory contaminants are found at depth, the setting is either a canyon where alluvial groundwater is usually present (perhaps because of natural runoff or Laboratory effluents) or a location where large amounts of liquid effluent have been discharged (e.g., Mortandad Canyon and upper Sandia Canyon). Table ES-3 summarizes contaminants detected in portions of the groundwater system.

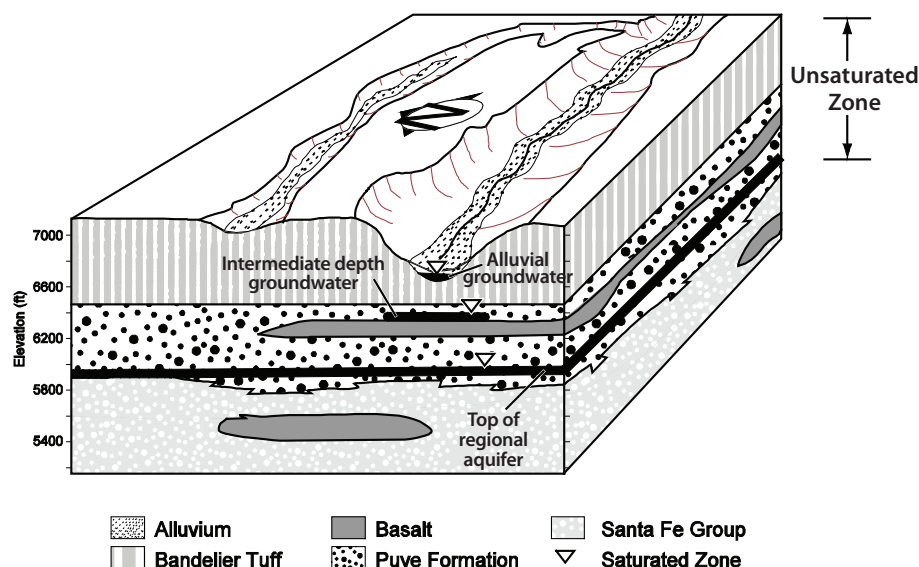


Figure ES-3. Illustration of geologic and hydrologic relationships in the Los Alamos area, showing the three modes of groundwater occurrence.

Drainages that received liquid radioactive effluents in the past include Mortandad Canyon, Pueblo Canyon from its tributary Acid Canyon, and Los Alamos Canyon; only Mortandad currently receives radioactive effluent from the Radioactive Liquid Waste Treatment Facility. For the past seven years, this facility has met all DOE radiological discharge standards in all but two months, met all National Pollutant Discharge Elimination System requirements, and voluntarily met NM groundwater standards for fluoride, nitrate, and total dissolved solids in all but two weeks.

The contaminated alluvial and intermediate perched groundwater bodies are separated from the regional aquifer by hundreds of feet of dry rock, so infiltration from the shallow groundwater occurs slowly. As a result, less contamination reaches the regional aquifer than the shallow perched groundwater bodies, and impacts on the regional aquifer are small.

Water Canyon and its tributary Cañon de Valle formerly received effluents produced by high explosives processing and experimentation. In past years, Los Alamos County has operated three sanitary treatment plants in Pueblo Canyon; currently only one plant is operating. The Laboratory also operated many sanitary treatment plants but currently operates only one plant that discharges into Sandia Canyon.

Figure ES-4 summarizes groundwater quality issues in the regional aquifer at the Laboratory. The high explosive compound Royal Demolition Explosive (RDX) continued to be detected in the regional aquifer at Pajarito Canyon regional well R-18. The concentration was near the analytical detection limit and at 2% of the EPA tap water screening level. RDX was not found in samples taken during 2005 from this well.

- ▶ *LANL detected chromium contamination in the regional aquifer under one canyon at concentrations above the NM Groundwater Standards and under an adjacent canyon at 70% of the standard.*
- ▶ *The contamination is likely the result of cooling tower discharges containing chromate from the late 1950s to early 1970s.*
- ▶ *No drinking water wells have been affected by the chromium contamination.*

- ▶ *All water produced by the Los Alamos County water supply system comes from the regional aquifer and meets federal and state drinking water standards. No drinking water is supplied from the alluvial and intermediate groundwater.*
- ▶ *No drinking water supply wells have been affected by Laboratory contaminants. One currently unused well has levels of perchlorate at 1/10th of the EPA guidance for drinking water.*

Table ES-3
Where Can We See LANL Impacts on Groundwater that Result in Values Near or Above Regulatory Standards, Screening, or Risk Levels?

| Chemical | On-Site | Off-Site | Significance | Trends |
|---|--|--|--|--|
| Tritium | Intermediate groundwater in Mortandad Canyon | No | Not used as a drinking water supply | Insufficient data to define trend |
| Strontium-90 and gross beta | Alluvial groundwater in DP/Los Alamos and Mortandad Canyons | No | Not used as a drinking water supply; has not penetrated to deeper groundwater | Mainly fixed in location; some decrease due to effluent quality improvement |
| Chromium | Regional aquifer in Sandia and Mortandad Canyons, intermediate groundwater in Mortandad Canyon | No | Found in regional aquifer above groundwater standards; not affecting drinking water supply wells; source eliminated in 1972. | Insufficient data to define trends |
| Perchlorate | Alluvial and intermediate groundwater in Mortandad Canyon | No | Not used as a drinking water supply; source eliminated in 2002 | Decreasing in Mortandad Canyon alluvial groundwater as effluent quality improves; insufficient data for intermediate groundwater |
| Nitrate | Alluvial and intermediate groundwater in Pueblo and lower Los Alamos canyons, regional aquifer in Sandia Canyon, intermediate groundwater and regional aquifer in Mortandad Canyon | Yes, Pueblo Canyon | In Pueblo and lower Los Alamos canyons, result may be due to Los Alamos County's Bayo Sewage Treatment Plant; otherwise due to effluent discharges | Insufficient data in Mortandad Canyon, values in Pueblo Canyon are variable, values in Sandia Canyon rising |
| Fluoride | Intermediate groundwater in Pueblo Canyon, alluvial groundwater in DP and Mortandad Canyons | Yes, Pueblo Canyon | Result of past effluent releases; not affecting drinking water supply wells | Slow decrease in concentration due to effluent quality improvement |
| Dioxane[1,4-] | Intermediate groundwater in Mortandad Canyon | No | Not used as drinking water supply; limited in extent | Insufficient data for trends |
| Dichloroethene[1,1-], Dioxane[1,4-], Trichloroethane[1,1,1-], Trichloroethene | Intermediate groundwater below former warehouse in main technical area | No | Not used as drinking water supply; limited in extent | Generally stable, seasonal fluctuations |
| Tetrachloroethene, Trichloroethene | Alluvial and intermediate groundwater in Cañon de Valle | No | Not used as drinking water supply; limited in extent | Generally stable, seasonal fluctuations |
| Boron | Intermediate groundwater in Cañon de Valle | No | Not used as drinking water supply; limited in extent | Generally stable, seasonal fluctuations |
| Barium | Alluvial groundwater in Cañon de Valle and Water Canyon | No | Not used as drinking water supply; limited in extent | Generally stable, seasonal fluctuations |
| RDX | Alluvial and intermediate groundwater in Cañon de Valle, intermediate groundwater in Pajarito Canyon | No | Not used as drinking water supply; limited in extent | Generally stable, seasonal fluctuations |
| Chloride, TDS | Alluvial groundwater in Pueblo, DP, Sandia, Mortandad, Pajarito canyons, intermediate groundwater near SM-30 and in Sandia Canyon | Yes, Pueblo Canyon | May be caused by road salt in snowmelt runoff, except intermediate groundwater in Sandia Canyon | Values highest in winter samples |
| Fluoride, uranium, nitrate, TDS | No | Yes, Pine Rock Spring, Pueblo de San Ildefonso | Water quality apparently affected by irrigation with sanitary effluent at Overlook Park | Steady over several years |

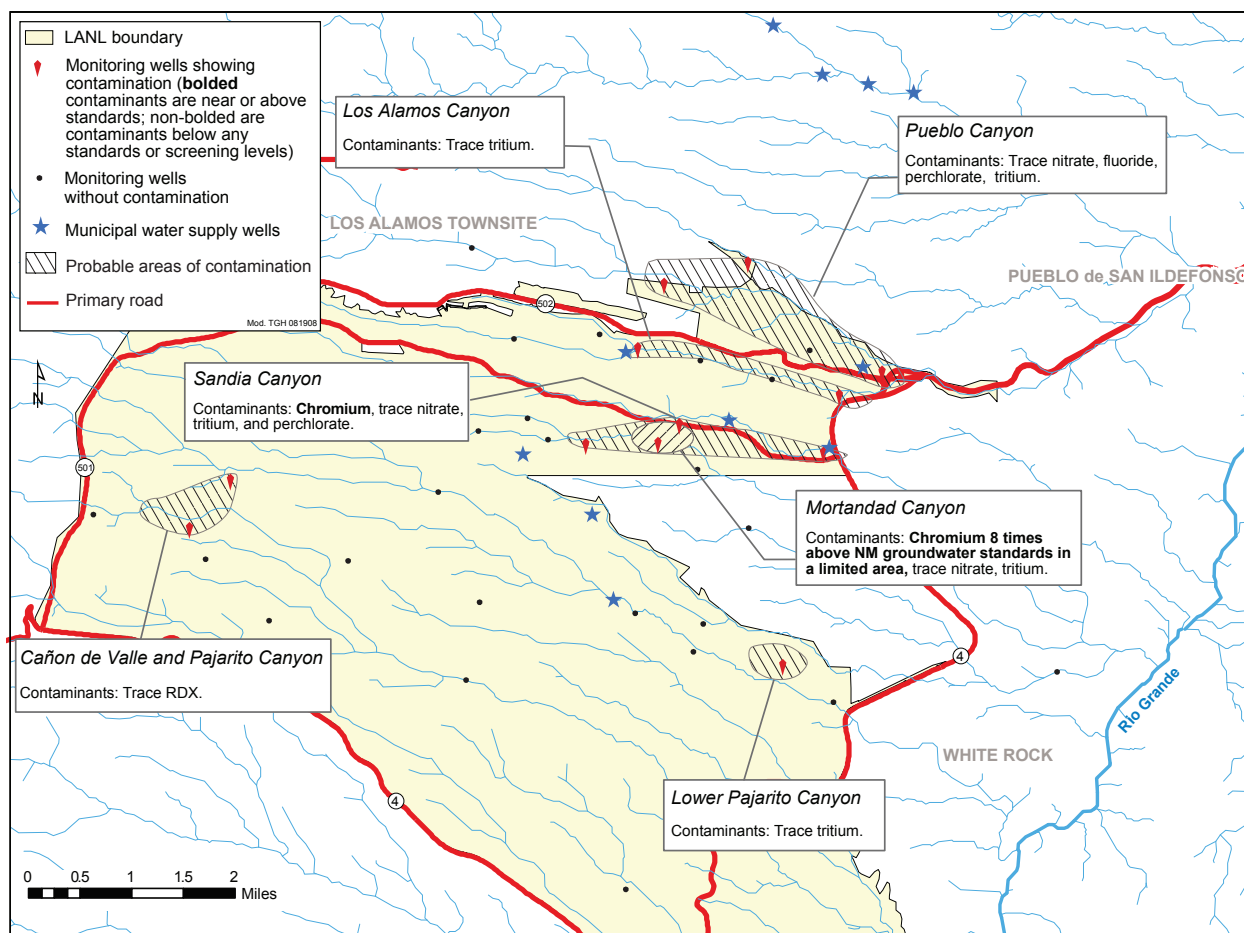


Figure ES-4. Summary of regional aquifer groundwater quality issues at the Laboratory.

The Laboratory detected hexavalent chromium and nitrate in several regional aquifer monitoring wells. The hexavalent chromium was above the NM groundwater standard in one regional aquifer well in Mortandad Canyon and at 70% of the standard in another nearby regional well in Sandia Canyon. Nitrate reached 50% of the NM groundwater standard in two regional aquifer monitoring wells and fluoride was 50% of the standard in one well. Traces of tritium and perchlorate were also detected in the regional aquifer.

Naturally occurring uranium was the main radioactive element detected in the regional aquifer, springs, and wells throughout the Rio Grande Valley. High concentrations of naturally occurring arsenic are also found in groundwater samples from some regional aquifer wells and springs. Most other metals found at high concentrations in groundwater samples at LANL result from well sampling and well construction issues rather than from LANL contamination. The use of fluids to assist with well drilling and the use of other materials in well completion has affected the chemistry of some groundwater samples.

Drinking water wells in the Los Alamos area have not been adversely impacted by Laboratory discharges. Well O-1 in Pueblo Canyon contains perchlorate at concentrations that average 1/10th of the EPA's Drinking Water Equivalent Level of 24.5 micrograms per liter ($\mu\text{g/L}$). This well is not used by Los Alamos County for water supply.

- ▶ *Beginning in 1999, LANL made significant upgrades to the Radioactive Liquid Waste Treatment Facility treatment system, which discharges into Mortandad Canyon.*
- ▶ *The facility has met all DOE radiological discharge standards and all NPDES (outfall) requirements for the past eight years.*
- ▶ *The facility has met NM groundwater standards for fluoride, nitrate, and total dissolved solids for seven years except for fluoride in two weekly composite samples in 2003.*

The intermediate groundwater in various locations shows localized tritium, organic chemicals (RDX, chlorinated solvents, dioxane[1,4-]), and inorganic chemicals (hexavalent chromium, barium, boron, perchlorate, fluoride, and nitrate) from Laboratory operations.

The Laboratory uses federal and state drinking water and human health standards as “screening levels” to evaluate radionuclide concentrations in all groundwater, even though many of these standards only apply to drinking water. Only in the alluvial groundwater in portions of Mortandad and DP/Los Alamos Canyons does the total radionuclide activity from LANL discharges exceed the guidance that is applicable to drinking water (4 mrem/yr). The maximum strontium-90 concentrations in Mortandad Canyon and DP/Los Alamos Canyon alluvial groundwater were also above the EPA’s drinking water standard.

Perchlorate is detected in most groundwater samples analyzed from across northern NM. Naturally occurring perchlorate concentrations range from about 0.1 µg/L to 1.8 µg/L. Water samples from most LANL locations show low perchlorate concentrations in this range, but samples from Mortandad Canyon alluvial and intermediate groundwater show values near or above the EPA Drinking Water Equivalent of 24.5 µg/L. Discharge of perchlorate from the Radioactive Liquid Waste Treatment Facility dropped to an undetectable level in 2002 and perchlorate values in alluvial groundwater downstream of the facility’s discharge in Mortandad Canyon have been steadily declining.

Watershed Monitoring

- ▶ *The overall quality of most surface water within the Los Alamos area is very good.*
- ▶ *Of the more than 100 analytes measured, most are within normal ranges or at concentrations below regulatory standards or risk-based advisory levels.*
- ▶ *Nearly every major watershed, however, shows some effect from Laboratory operations.*

Watersheds that drain LANL property are dry for most of the year. Of the more than 80 miles of watercourse, approximately two miles are naturally perennial, and approximately three miles are perennial water created by effluent discharges (most notably in upper Sandia Canyon). Storm water runoff occasionally extends across the Laboratory but is short-lived. The surface water within the Laboratory is not a source of municipal, industrial, or irrigation water, though wildlife does use the water.

Occasional floods can redistribute sediment downstream. None of the streams within the Laboratory boundary average more than one cubic ft per second (cfs) of flow annually. It is unusual for the combined mean daily flow from all LANL canyons to be greater than 10 cfs, although one event in late fall of 2007 (November 30 to December 2, 2007) resulted in an estimated combined mean daily runoff from LANL of about 22 cfs on December 1. By comparison, the average daily flow in the Rio Grande at Otowi Bridge during that event was 800 cfs, or approximately 35 times higher.

- ▶ *Polychlorinated biphenyls (PCBs) are often measured in Sandia and Los Alamos Canyons above screening levels.*
- ▶ *Radioactive elements from past Laboratory operations are being transported by runoff events. All radionuclide levels are well below applicable guidelines or screening levels.*
- ▶ *PCBs, radionuclides, and other contaminants adsorb onto sediment particles and thus overall water concentrations can be reduced by slowing the stream flows, reducing erosion, and allowing suspended sediment to settle out.*

Total runoff leaving the Laboratory in 2007 measured at downstream gages in the canyons was estimated at about 205 ac-ft of which about 91 ac-ft was from snowmelt runoff, 70 ac-ft was from storm water runoff in the summer, and 44 ac-ft was from the late fall event. The volume of storm water runoff in 2007 was the least since the Cerro Grande fire in 2000 and similar to pre-fire runoff volumes. The estimated total volume of snowmelt runoff measured in Los Alamos Canyon at the Laboratory’s eastern boundary was about 91 ac-ft, decreasing to about 29 ac-ft in lower Los Alamos Canyon near the confluence with the Rio Grande.

Table ES-4
Where Can We See LANL Impacts on Surface Water that Result in Values Near or
Above Regulatory Standards or Risk Levels?

| LANL Impact | On-Site | Off-Site | Significance | Trends |
|----------------------------------|--|--|---|---|
| Specific radionuclides | No | No | Exposure potential is limited. Los Alamos Canyon surface water at 40% of DOE biota concentration guide for year; dose mainly from radium-226 that is of natural origin | Steady |
| Gross alpha radioactivity | Mortandad, Pueblo, and Los Alamos Canyons | No | 57% of surface water results greater than screening level; major source is naturally occurring radioactivity in sediments, except in Mortandad, Pueblo, and Los Alamos Canyons where there are LANL contributions | Steady in Mortandad; downward in fire-affected canyons as stream flows recover to pre-fire levels |
| Copper | Multiple watersheds | No | Over screening level in Pajarito, Threemile, and Twomile canyons. Origins uncertain; probably several sources | Steady |
| Lead | Threemile and Water Canyons | No | Elevated in two samples collected at site monitoring locations in Threemile and Water Canyons | Steady |
| Mercury | Various canyons; highest in Sandia Canyon at a site monitoring station | Yes | Above screening level only in unfiltered samples. Also above screening level in canyons near residential areas; not all sources from LANL | Steady |
| Antimony | Several canyons | No | Source is developed areas; highest in stormwater from TA-3 | Steady |
| Barium | Cañon de Valle | No | Source related to high explosive research in Cañon de Valle area; subject of focused investigations on barium and high explosives | Steady |
| Silver | Cañon de Valle | No | Above screening level. From known former photography processing laboratory | Steady |
| Polychlorinated biphenyls (PCBs) | Many canyons | Yes, particularly in Los Alamos and Pueblo Canyons | Above screening levels. Wildlife exposure potential in Sandia Canyon. | Steady |
| RDX | Cañon de Valle | No | Confined to LANL; subject of focused investigations | Steady |

The overall quality of most surface water in the Los Alamos area is good, with low levels of dissolved solutes. Of the more than 100 analytes measured in sediment and surface water within the Laboratory, most are at concentrations far below screening levels. However, nearly every major watershed indicates some effect from Laboratory operations, often for just a few analytes. Table ES-4 shows the locations of Laboratory-impacted surface water. All radionuclide levels are well below applicable guidelines or standards (Table ES-5).

Table ES-5
Estimated Annual Average Unfiltered Surface Water Concentrations of Radionuclides in
Selected Canyons Compared with the Biota Concentration Guides (pCi/L)

| Radionuclide | BCG ^a | Acid Canyon above Pueblo Canyon | Lower Pueblo Canyon | DP Canyon below TA-21 | Los Alamos Canyon between DP Canyon and NM 4 | Los Alamos Canyon at Rio Grande | Mortandad Canyon below Effluent Canyon | Maximum percent of BCG ^a |
|---------------------|------------------|---------------------------------|---------------------|-----------------------|--|---------------------------------|--|-------------------------------------|
| Am-241 | 400 | 0.59 | 0.08 | 0.4 | 0.3 | 0.02 | 0.9 | 0.2% |
| Cs-137 ^b | 20,000 | ND ^c | ND | ND | 2 | ND | 10 | 0.05% |
| H-3 | 300,000,000 | 17 | 1.6 | 23 | 16 | 22 | 853 | < 0.01% |
| Pu-238 | 200 | 0.04 | 0.00 | 0.03 | 0.03 | ND | 1.5 | 0.7% |
| Pu-239/240 | 200 | 5.6 | 22 | 0.2 | 0.6 | 0.2 | 2 | 11% |
| Sr-90 | 300 | 0.5 | 0.02 | 35 | 2 | 0.08 | 1.9 | 12% |
| U-234 | 200 | 1.0 | 3 | 2 | 0.9 | 1.4 | 1.0 | 1% |
| U-235/236 | 200 | 0.06 | 0.01 | 0.01 | 0.05 | 0.09 | 0.05 | 0.1% |
| U-238 | 200 | 0.8 | 2 | 2 | 0.8 | 1.0 | 0.9 | 1% |
| Ra-226 | 4 | 1.0 | 1.1 | ND | ND | ND | 0.6 | 28% |

^a BCG = DOE Biota Concentration Guides

^b The BCG for cesium-137 is a site-specific modified BCG

^c ND indicates no analytical laboratory detection in 2007

Laboratory activities have caused contamination of sediment in several canyons, mainly because of past industrial effluent discharges. These discharges and contaminated sediment also affect the quality of storm water runoff, which carries much of this sediment during short periods of intense flow. In some cases, sediment contamination is present from Laboratory operations conducted more than 50 years ago. However, all measured sediment contaminant levels are below recreational screening levels.

Consistent with previous years, most surface water samples in 2007 had gross alpha radiation greater than the screening level of 15 pCi/L for livestock watering. Of the 330 non-filtered samples analyzed from the Pajarito Plateau, 57% exceeded 15 pCi/L. However, it has been previously shown that the majority of the alpha radiation in surface water on the plateau is due to the decay of naturally occurring isotopes in sediment and soil carried in storm water runoff from uncontaminated areas, and that Laboratory impacts are relatively small. This is supported by the generally positive correlation between gross alpha radiation and suspended sediment in non-filtered surface water samples.

The highest concentrations of several radionuclides in surface water samples were measured in Mortandad Canyon downstream from the TA-50 Radioactive Liquid Waste Treatment Facility (RLWTF) outfall, including americium-241, cesium-137, plutonium-238, plutonium-239/240, and tritium. The highest concentration of strontium-90 was measured in DP Canyon downstream from a former outfall at TA-21, which also released radioactive effluent. The highest concentrations of uranium-234, uranium-235, and uranium-238 were measured at a site-monitoring area location in the Potrillo Canyon watershed at a firing site in TA-15.

The highest concentrations of most radionuclides in sediment were obtained from one fine-grained sample from the Mortandad Canyon sediment traps, including the highest values for americium-241, cesium-137, plutonium-238, plutonium-239/240, and strontium-90. This sediment was deposited by a flood on August 25, 2006, which was the largest flood on record in that canyon since discharges of radioactive effluent began at the TA-50 Radioactive Liquid Waste Treatment Facility in 1963. These values are all less than previous results from the sediment traps and are below recreational screening action levels. The highest concentrations of tritium were measured in drainages below MDA G at TA-54, and are also below recreational screening action levels. No results for uranium isotopes in 2007 are above background levels.

The types of organic compounds tested for varied depending on the location and typically included the following suites: dioxins and furans, explosive compounds, herbicides, pesticides and PCBs, semi-volatile organic compounds (SVOCs), total petroleum hydrocarbons-diesel range organics, and volatile organic compounds. PCBs were the only class of organic chemicals that were frequently detected at concentrations greater than the screening level. Monitoring results show no measurable effects of PCBs from LANL in the Rio Grande.

The high explosive compound RDX was detected in Cañon de Valle watershed above a screening level. This canyon is the subject of ongoing investigations and corrective measures regarding high explosives contamination.

No herbicides were detected in any surface water samples.

Potential impacts to the Rio Grande were assessed in 2007 by comparing contaminant concentrations in sediment at locations upriver and downriver of LANL. All measurements of radionuclides in upriver and downriver sediments collected from the Rio Grande and Cochiti Reservoir were orders of magnitude below recreational or residential screening levels. In river sediment, no radionuclides were detected above background levels either above or below the Laboratory. Concentrations of plutonium-239/240 from Cochiti Reservoir bottom sediment were above background levels in two samples. These concentrations were comparable to those measured in previous years after the Cerro Grande fire and are slightly elevated above regional background levels that result from atmospheric fallout.

Soil Monitoring

Table ES-6 summarizes soil sampling results. Large-scale soil sampling within and around the perimeter of LANL is conducted every three years and the last soil sampling event was in 2006. In general, results of that investigation showed that soil samples from on-site and perimeter areas contained radionuclides at very low (activity) concentrations and most were either not detected or below regional statistical reference levels (RSRLs, equal to the average plus three standard deviations). The few samples with radionuclide concentrations above the RSRLs were collected from near known or expected areas of contamination though the levels are below residential screening levels and thus do not pose a potential unacceptable dose to the public.

Although large-scale soil sampling was not conducted in 2007, we annually collect soil samples from two locations on the Pueblo de San Ildefonso land downwind of TA-54, Area G. Radionuclides and metals in these soil samples were below background or near background and were consistent with levels measured in previous years.

Other soil monitoring sites routinely sampled in 2007 were from around the perimeter of Area G and DARHT. Soil samples from around the perimeter of Area G contain above-background concentrations of tritium, americium-241, plutonium-238, and plutonium-239/24. The highest levels of tritium around Area G were detected at the southern end and the highest levels of the actinides were detected around the northern, northeastern, and eastern sections. One soil sample on the eastern side of Area G and one soil sample collected at the LANL/Pueblo de San Ildefonso boundary northeast of Area G contained plutonium 239/240 concentrations a few times higher than measured the year before, though all levels are well below residential screening levels used to trigger investigations and the amounts decrease rapidly with distance from Area G. At DARHT, levels of uranium in soil are slightly elevated but well below screening levels. Other constituents such as PCBs, high explosives, and SVOCs were not detected.

- ▶ *Soil samples from most off-site locations show radionuclides and metals have not increased over the past years and are mostly at background levels.*
- ▶ *Plutonium-239/240 in a soil sample collected at the LANL/Pueblo de San Ildefonso boundary northeast of Area G was above background.*
- ▶ *Soil samples from most on-site locations show no increases and some decreases of radionuclides and metals from previous years.*
- ▶ *All PCBs, high explosives, and nearly all semi-volatile organics in soil from perimeter and on-site locations are below detection limits.*

Table ES-6
Where Can We See LANL Impacts on Mesa-Top Surface Soil that Result in Values Near or Above Background or Screening Levels?

| LANL Impact | On-Site | Off-Site | Significance | Trends |
|---|--|---|--|--|
| Tritium | Yes, above background at some sites, particularly at TA-54, Area G | No | Far below residential screening levels | Consistently detected in the south sections of Area G, but not increasing |
| Plutonium-239/240 | Yes, above background along State Road 502 at TA-73 (downwind of TA-21) and at TA-54, Area G | Yes, above background along State Road 502 on the west side of the airport (downwind of TA-21) and at LANL/Pueblo de San Ildefonso boundary and Sacred Area northwest of Area G | Far below residential screening levels | Plutonium-239/240 downwind of TA-21 is highly variable from sample to sample but is generally not increasing. Also, consistently detected on the north, northeast, and eastern sections of Area G, mostly not increasing except on the eastern side. |
| Other Radionuclides | Mostly depleted uranium at DARHT | Mostly no | Far below residential screening levels | Uranium-238 at DARHT increased through 2006 but decreased in 2007 likely because of the use of steel containment vessels |
| Inorganic Chemicals | Few detections: beryllium at DARHT is just above background | Few detections | Far below residential screening levels | Steady |
| PCBs | Most samples below detection limits. Aroclor-1260 detected at Los Alamos Weir | No | Far below residential screening levels | Re-sampling around a positive PCB soil result in 2006 at Area G showed no PCB amounts. Steady at Los Alamos Canyon weir. |
| High Explosives | All below detection limits | No | Minimal potential for exposure | None |
| Semi-volatile Organic Compounds (SVOCs) | One sample along State Road 502 at TA-73 in 2006 detected SVOCs | No | Far below residential screening levels; from asphalt (not a LANL source) | None |



At the request of Jemez Pueblo, soil samples were collected along a transect starting from a point east of a LANL explosives firing site to the Valles Caldera. There were no detections of any of 14 different high explosives compounds analyzed.

Foodstuffs Monitoring

In 2007 we collected a wide variety of fruit and vegetable crops at many on-site, perimeter, and regional background locations in an effort to determine the impact of LANL operations on the human food chain. Goat milk and wild edible plants were also collected. We collected 10 fruit and vegetable samples (apples, apricots, cherries, chile, corn, grapes, lettuce, peaches, squash, and tomatoes) from each of four communities surrounding the Laboratory (Los Alamos, White Rock, Pueblo de San Ildefonso, and Cochiti area) and additional fruit samples from within LANL technical areas. The results were compared to past data and levels in fruits and vegetables collected from several background areas as far north as Dixon. No elevated levels of radionuclides were measured in any of the community samples. Only an elevated tritium level was measured in a fruit sample from a technical area that formerly processed tritium. Radionuclides and metal elements in produce from background areas are the result of worldwide fallout and naturally occurring sources. For metals, only selenium and chromium were slightly elevated in two samples from off-site locations and are likely due to fertilizer additions by the small-scale farmer.

Radionuclides in a goat milk sample from the White Rock area were either not detected or consistent with background samples from Pena Blanca, Penasco, and Lumberton, New Mexico.

Wild edible plants were sampled downwind and downgradient from TA-54, Area G in Cañada del Buey at the LANL/Pueblo de San Ildefonso boundary. Only low levels of tritium in the samples closest to the area were detected above background levels.

Biota Monitoring

Table ES-7 summarizes biota sampling results. In plants collected around Area G, only tritium and plutonium were detected in a few samples closest to the boundary fence and adjacent to known sources of these radionuclides.

In vegetation around the DARHT facility, only depleted uranium was detected above background levels; the levels are lower than in previous years which may be because testing is now conducted in metal vessels instead of in the open. Depleted uranium in mice and bees were also detected at DARHT and the bees contained slightly higher levels of barium and copper. Bird monitoring near the DARHT facility over several years showed no adverse impacts to the numbers or types of birds inhabiting the area.

Upgradient of the Los Alamos Canyon Weir, slightly elevated levels of plutonium, uranium, strontium, and americium were measured in plants. Aroclor 1260 (a type of PCB) was detected in both sediment and mice. The concentrations of all radionuclides, metals, and PCBs in all biotic and abiotic media collected upgradient of the weir were below screening levels and do not pose a potential unacceptable dose from radionuclides or risk from non-radionuclides to humans (sediment) or to the biota sampled. Above the Pajarito Canyon Flood Retention Structure, no contaminants were considered significantly elevated.

- ▶ *All radionuclides and most metals in fruits and vegetables from communities surrounding LANL or downstream of LANL were indistinguishable from worldwide fallout and/or natural sources (background).*
- ▶ *Metals in the fruits and vegetables were also not elevated except for chromium and selenium in a few off-LANL samples and is likely from fertilizer use by the small-scale farmer. No LANL fruit samples contained elevated metals.*

- ▶ *Vegetation at Area G contained elevated levels of radionuclides near known sources.*
- ▶ *Biota samples at DARHT contained depleted uranium but the levels were lower than previous years probably because of new contained testing measures.*
- ▶ *Biota and sediment samples collected above the Los Alamos Canyon Weir contained slightly elevated levels of some radionuclides and PCBs but far below screening levels.*

Table ES-7
Where Can We See LANL Impacts on Foodstuffs and Biota that Result in
Values Near or Above Background or Screening Levels?

| Media | LANL Impact | On-Site | Off-Site | Significance | Trends |
|--------------------------------|---------------------|---|--|--|---|
| Wild edible plants | Radionuclides | Tritium in plants from Canada del Buey | Above background concentrations for strontium-90 in plants from Mortandad Canyon on Pueblo de San Ildefonso land in 2006 | Far below screening level. Higher strontium-90 in wild plants is a function of low calcium in the soil and not to increased contamination levels | Steady |
| | Inorganic chemicals | No | No | No data | Steady |
| Native vegetation | Radionuclides | Mostly tritium and plutonium-239,240 at Area G; and depleted uranium at DARHT | Few detections | Far below screening levels | Tritium and plutonium-239/240 are steady at Area G, Uranium-238 in trees at DARHT increased through 2006, decreased in 2007 |
| | Inorganic chemicals | Few detections: arsenic in one plant sample at DARHT | No | No | Steady for most metals |
| Small mammals, bees, and birds | Radionuclides | Depleted uranium at DARHT; some radionuclides in biota upstream of the Los Alamos Canyon Weir and the Pajarito Canyon Flood Retention Structure | None collected | Far below screening levels | Steady for most radionuclides |
| | Inorganic chemicals | Some detections in a bird at DARHT | None collected | One sample out of two | Insufficient data |
| | PCBs | Detected in mice at the Los Alamos Canyon weir | None collected | The toxicity equivalency quotients in mice on LANL property were comparable with the control | Insufficient data |
| | Species diversity | Abundance and species diversity of birds at DARHT during operations are similar to baseline | None collected | No stress to birds at DARHT | Steady |

Environmental Restoration Program

Corrective actions proposed and/or conducted at LANL in 2007 follow the requirements of the Consent Order. The goal of the investigation efforts is to ensure that waste and contaminants from past operations do not threaten human or environmental health and safety. Accomplishments include the completion of investigation activities, approvals of proposed investigation activities, and approvals of the work completed at some sites. The chromium investigations in Sandia and Mortandad canyons continued with the installation of two monitoring wells (R-35a and b) immediately upstream of PM-3, a municipal drinking water well. Numerous sampling activities were conducted in 2007 and included sampling of pore gas at MDA A; drilling of four boreholes at MDA C to characterize the subsurface below former chemical waste disposal pits; sampling and

geophysical, geodetic, and radiological surveying in Bayo Canyon where radioactive materials were used; additional sampling in several locations within TA-21 where the country's original plutonium processing facility was located; additional characterization sampling at MDA V and MDA T (both in TA-21) where liquid wastes were stored and processed; and sediment sampling in Sandia Canyon to determine the amount and extent of chromium migration. After results are received and interpreted, these sampling activities will be documented in reports to the NMED. During 2007, environmental restoration activities collected more than 2,200 samples from more than 4,000 locations and requested more than 710,000 analyses or measurements on these samples.

Previous risk reduction successes include the cleanup of TA-73 (Airport Ashpile), which contained landfills, septic systems, an incinerator and surface disposal area, and other miscellaneous sites; and MDA V at TA-21 where three absorption beds and other contaminated soil and tuff were excavated.

Under the Consent Order, 23 investigation work plans and 23 investigation reports were submitted to NMED. Six Historical Investigation Reports were also submitted as companion documents to some work plans. In 2007, NMED approved a total of 17 investigation work plans and 17 investigation reports, some with modifications or directions. Of the documents approved, LANL submitted nine work plans and 10 reports in 2007; the other approved plans were submitted in previous years. A total of eight SWMUs and areas of concern were granted certificates of completion, which signifies that the investigations have been completed. In addition, NMED was reviewing seven work plans and nine reports as of the end of the calendar year.

- ▶ *Characterization and cleanup of sites contaminated or potentially contaminated by past LANL activities follow the Consent Order.*
- ▶ *Twenty-three investigation work plans and 23 investigation reports were submitted to NMED in 2007.*
- ▶ *Eight sites were granted certificates of completion.*

The investigation activities are designed to characterize SWMUs, areas of concern, consolidated units, aggregate areas, and watersheds. The characterization activities conducted include surface and subsurface sampling, drilling boreholes, geophysical studies, and installation of monitoring wells. Corrective action activities performed included the removal of structures (e.g., buildings, septic systems, sumps, and drainlines), excavation of contaminated media, and confirmatory sampling. These activities defined the nature and extent of contamination and determined the potential risks and doses to human health and the environment.





1. Introduction



contributing authors:

*Pat Gallagher, Denny Hjeresen, John Isaacson, Scot Johnson, Bruce Masse, Terry Morgan, David Rogers***To Read About****Turn to Page**

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A. BACKGROUND AND REPORT PURPOSE**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 require only 100 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. Through May 2006, the Laboratory was managed by the Regents of the University of California (UC) under a contract administered by the National Nuclear Security Administration (NNSA) of the US Department of Energy (DOE) through the Los Alamos Site Office and the NNSA Service Center based in Albuquerque, NM. In June 2006, a new management organization, Los Alamos National Security (LANS), LLC, took over management of the Laboratory.

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. The current mission is to develop and apply science and technology to

- Ensure the safety and reliability of the US nuclear deterrent;
- Reduce global threats; and
- Solve other emerging national security challenges (LANL 2005a).

Los Alamos National Laboratory defines its vision as: "Los Alamos, the premier national security science laboratory." The Laboratory has identified 12 strategic goals to implement its vision and mission:

1. Make safety and security integral to every activity we do.
2. Implement a cyber security system that reduces risk while providing exemplary service and productivity.
3. Establish excellence in environmental stewardship.
4. Assess the safety, reliability, and performance of LANL weapons systems.
5. Transform the Laboratory and the nation's nuclear weapons stockpile to achieve the 2030 vision, in partnership with the [DOE] Complex.
6. Leverage our science and technology advantage to anticipate, counter, and defeat global threats and meet national priorities, including energy security.
7. Be the premier national security science laboratory and realize our vision for a capabilities-based organization.

1. Introduction

8. Provide efficient, responsive, and secure infrastructure and disciplined operations that effectively support the Laboratory mission and its workforce.
9. Implement a performance-based management system that drives mission and operational excellence.
10. Deliver improved business processes, systems, and tools that meet the needs of our employees, reduce the cost of doing business, and improve the Laboratory's mission performance.
11. Communicate effectively with our employees, customers, community, stakeholders, and the public at large.
12. Develop employees and create a work environment to achieve employee and Laboratory success.

Inseparable from the Laboratory's commitment to excellence in science and technology is its commitment to complete all work in a safe, secure, and environmentally responsible manner. The Laboratory uses Integrated Safety Management (ISM) to set, implement, and sustain safety performance and meet environmental expectations. In addition, the Laboratory uses an International Standards Organization (ISO) 14001-2004 registered Environmental Management System (EMS) as part of ISM to focus on environmental performance, protection, and stewardship (see Section D of this chapter for additional information). The foundation of the EMS and the demonstration of the Laboratory's commitment is the LANL environmental policy:

- We approach our work as responsible stewards of our environment to achieve our mission.
- We prevent pollution by identifying and minimizing environmental risk.
- We set quantifiable objectives, monitor progress and compliance, and minimize consequences to the environment, stemming from our past, present, and future operations.
- We do not compromise the environment for personal, programmatic, or operational reasons.

2. Purpose of this Report

As part of the Laboratory's commitment to our environmental policy, we will monitor and report on how Laboratory activities are affecting the environment. The objectives of this environmental surveillance report, as directed by DOE Order 231.1 (DOE 2004), are to

- Characterize site environmental management performance including effluent releases, environmental monitoring, and estimated radiological doses to the public and the environment.
- Summarize environmental occurrences and responses reported during the calendar year.
- Confirm compliance with environmental standards and requirements.
- Highlight significant programs and efforts, including environmental performance indicators and/or performance measures programs.

Over and above the DOE requirements, the Laboratory establishes annual environmental objectives, targets, and key performance indicators through the EMS. The current objectives are to

- Ensure environmental compliance.
- Reduce waste.
- Improve Laboratory-wide energy and fuel conservation.
- Conduct Laboratory-wide cleanout activities to dispose of unneeded equipment, materials, chemicals, and associated waste by October 2011.
- Achieve zero liquid discharge by 2012.

B. ENVIRONMENTAL SETTING

1. Location

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 40-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 streams. Mesa tops range in elevation from approximately 7,800 ft on the flanks of the Jemez Mountains to about 6,200 ft near the Rio Grande Canyon. Most Laboratory and community developments are confined to the 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, the US Bureau of Land Management, Bandelier National Monument, the US General Services Administration, and Los Alamos County. Pueblo de San Ildefonso borders the Laboratory to the east.

2. Geology and Hydrology

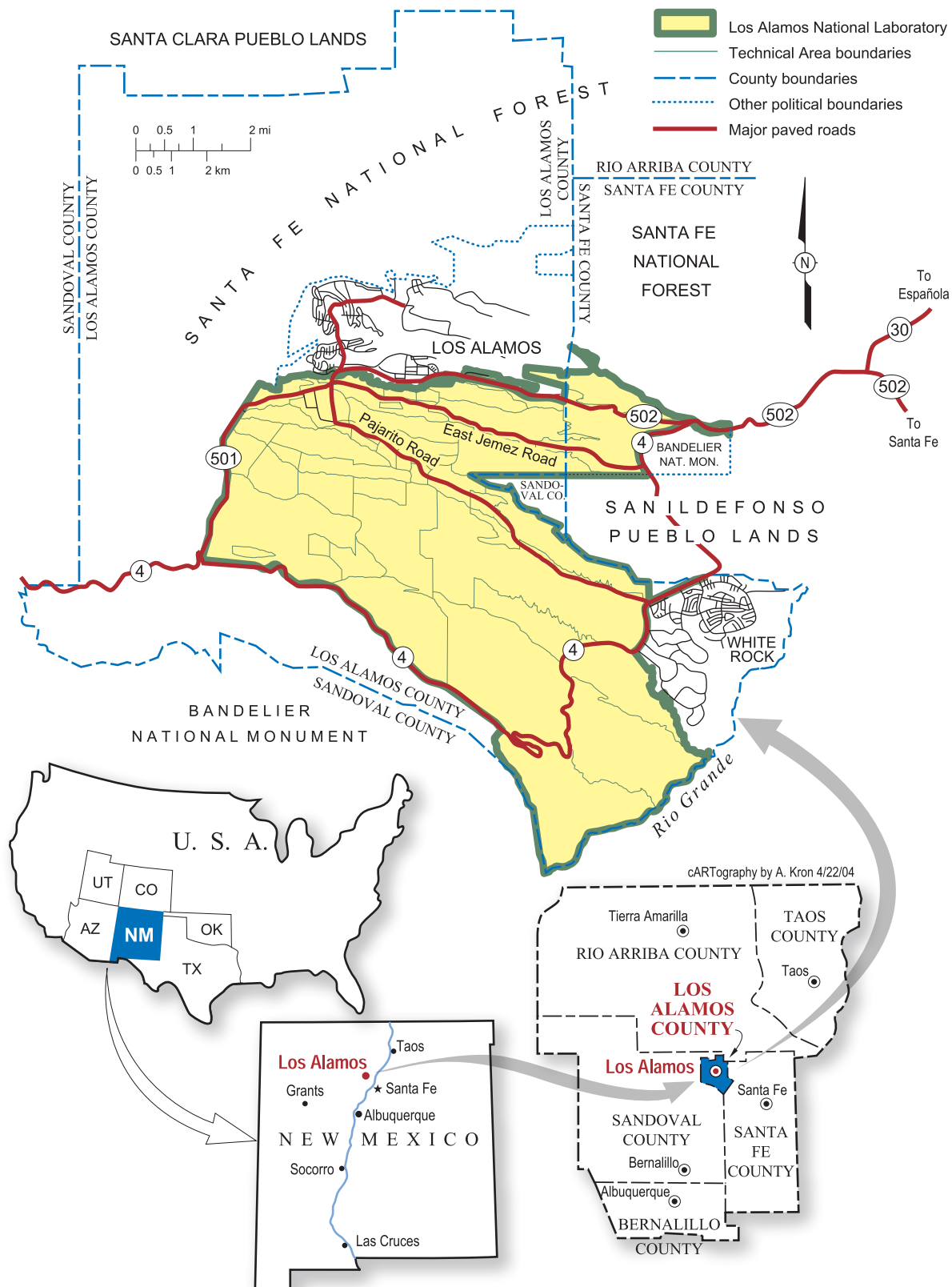
The Laboratory lies at the western boundary of the Rio Grande Rift, a major North American tectonic feature. Three major potentially active local faults constitute the modern rift boundary. Studies indicate that the seismic surface rupture hazard associated with these faults is localized (Gardner et al., 1999). Most of the finger-like mesas in the Los Alamos area (Figure 1-2) are formed from Bandelier Tuff, which includes ash fall, ash fall pumice, and rhyolite tuff. Deposited by major eruptions in the Jemez Mountains volcanic center 1.2–1.6 million years ago, the tuff is more than 1,000 ft thick in the western part of the plateau and thins to about 260 ft eastward above the Rio Grande.

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 ft thick.

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

Groundwater in the Los Alamos area occurs in three modes: (1) water in shallow alluvium in canyons, (2) intermediate 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, which is the only aquifer in the area capable of serving as a municipal water supply. Water in the regional aquifer is in artesian conditions under the eastern part of the Pajarito Plateau near the Rio Grande (Purtymun and Johansen 1974).





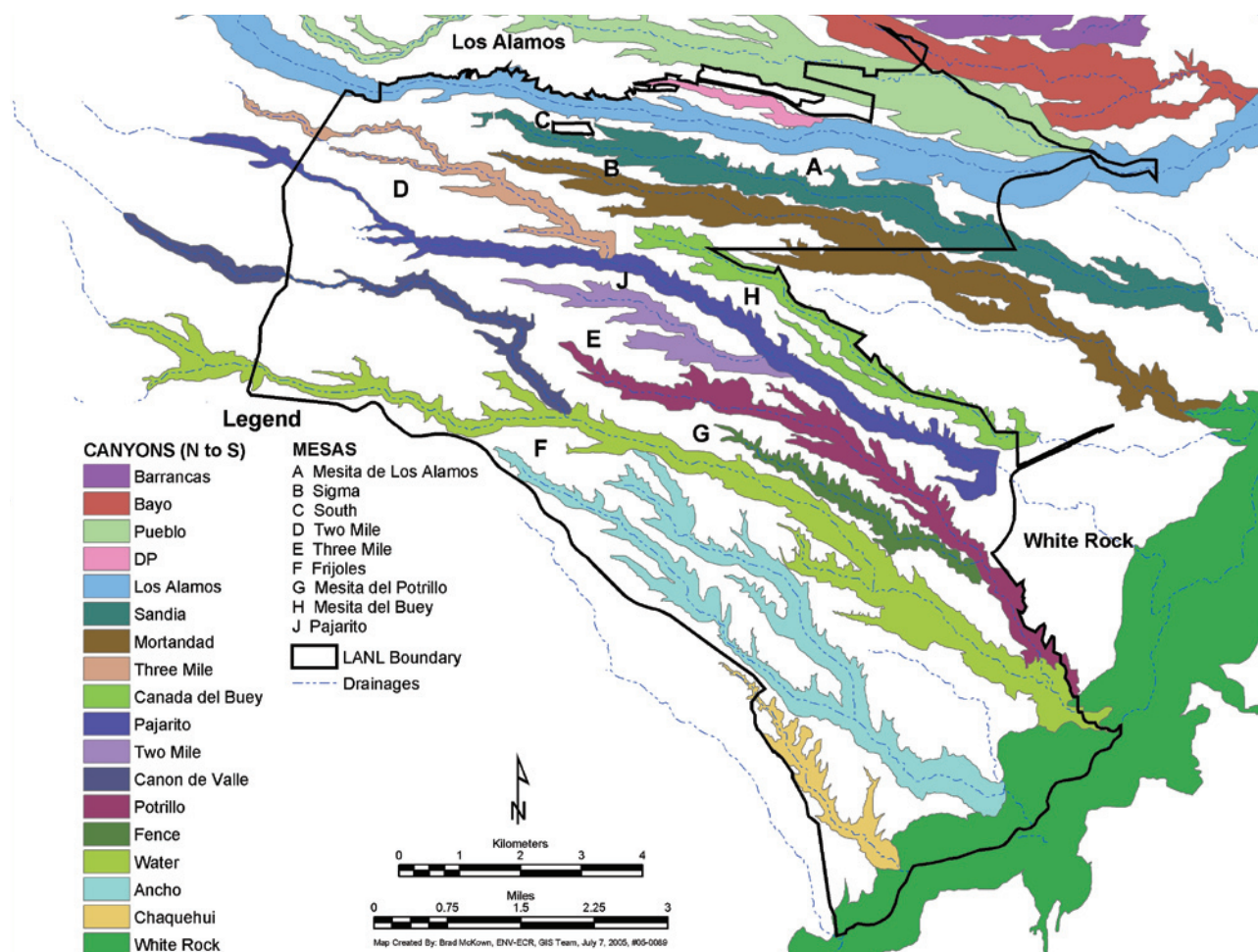


Figure 1-2. Major canyons and mesas on Laboratory land.

The source of most recharge to the regional 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-mi reach of the river in White Rock Canyon, between Otowi Bridge and the mouth of Rio de los Frijoles, receives an estimated 4,300–5,500 ac-ft of water from the regional aquifer.

3. Biological Resources

The Pajarito Plateau, including the Los Alamos area, is biologically diverse. This diversity of ecosystems is due partly to the dramatic 5,000-ft elevation gradient from the Rio Grande on the east of the plateau up to the Jemez Mountains 12 mi (20 km) to the west and also due partly to the many steep canyons that dissect the area. Five major vegetative cover types are found in Los Alamos County. The juniper (*Juniperus monosperma* Engelm. Sarg.)-savanna community is found along the Rio Grande on the eastern border of the plateau and extends upward on the south-facing sides of canyons at elevations between 5,600 and 6,200 ft. The piñon (*Pinus edulis* Engelm.)-juniper cover type, generally between 6,200 to 6,900 ft in elevation, covers large portions of the mesa tops and north-facing slopes at the lower elevations. Ponderosa pine (*Pinus ponderosa* P. & C. Lawson) communities are found in the western portion of the plateau between 6,900 and 7,500 ft in elevation. These three vegetation types predominate the plateau, each occupying roughly one-third of the Laboratory site. The mixed conifer cover type, at an elevation of 7,500 to 9,500 ft, overlaps the Ponderosa pine community in the deeper canyons and on north-facing slopes and extends from the higher mesas onto the slopes of the Jemez Mountains. Spruce (*Picea* spp.)-fir (*Abies* spp.) is at higher elevations of 9,500 to 10,500 ft. Several wetlands and riparian areas enrich the diversity of plants and animals found on the plateau.

In May 2000, the Cerro Grande fire burned more than 43,000 acres of forest in and around LANL. Most of the habitat damage occurred on Forest Service property to the west and north of LANL. Approximately 7,684 acres, or 28% of the vegetation at LANL, was burned to varying degrees by the fire. However, few areas on LANL property were burned severely. Wetlands in Mortandad, Pajarito, and Water Canyons received increased amounts of ash and hydromulch in runoff because of the fire.

The extreme drought conditions prevalent in the Los Alamos area and all of New Mexico from 1998 through 2003 resulted directly and indirectly in the mortality of many trees. Between 2002 and 2005 more than 90% of the piñon trees greater than 10 ft tall died in the Los Alamos area. Lower levels of mortality also occurred in ponderosa and mixed conifer stands. Mixed conifers on north-facing canyon slopes at lower elevations experienced widespread mortality. These changes likely will have long-lasting impacts to vegetation community composition and distribution.

4. Cultural Resources

The Pajarito Plateau is an archaeologically rich area. Approximately 86% of DOE land in Los Alamos County has been surveyed for prehistoric and historic cultural resources, and more than 1,800 sites have been recorded. During fiscal year 2006, sites that have been excavated since the 1950s were removed from the overall site count numbers. Thus, the number of recorded sites is less than in reports from previous years. More than 85% of the resources are Ancestral Pueblo and date from the 13th, 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 ft. Almost three-quarters of all cultural resources are found on mesa tops. Buildings and structures from the Manhattan Project and the early Cold War period (1943–1963) are being evaluated for eligibility for listing in the National Register of Historic Places, and more than 320 buildings have been evaluated to date. In addition, “key facilities” (facilities considered of national historic significance) dating from 1963 to the end of the Cold War in 1990 are being evaluated.

5. Climate

Los Alamos County has a temperate, semiarid mountain climate. Large differences in locally observed temperature and precipitation exist because of the 1,000-ft elevation change across the Laboratory site and the complex topography. Four distinct seasons occur in Los Alamos County. Winters are generally mild, with occasional winter storms. Spring is the windiest season. Summer is the rainy season, with occasional afternoon thunderstorms. Fall is typically dry, cool, and calm.

Daily temperatures are highly variable (a 23°F range on average). On average, winter temperatures range from 30°F to 50°F during the daytime and from 15°F to 25°F during the nighttime. The Sangre de Cristo Mountains to the east of the Rio Grande Valley act as a barrier to wintertime arctic air masses that descend into the central United States, making the occurrence of local subzero temperatures rare. On average, summer temperatures range from 70°F to 88°F during the daytime and from 50°F to 59°F during the nighttime.

From 1971 to 2000, the average annual precipitation (which includes both rain and the water equivalent of frozen precipitation) was 18.95 in., and the average annual snowfall amount was 58.7 in. (Note: By convention, full decades are used to calculate climate averages [WMO 1984].) The months of July and August account for 36% of the annual precipitation and encompass the bulk of the rainy season, which typically begins in early July and ends in early September. Afternoon thunderstorms form as moist air from the Pacific Ocean and the Gulf of Mexico is convected and/or orographically lifted by the Jemez Mountains. The thunderstorms yield short, heavy downpours and an abundance of lightning. Local lightning density, among the highest in the United States, is estimated at 15 strikes per square mile per year. Lightning is most commonly observed between May and September (about 97% of the local lightning activity).

The complex topography of the Pajarito Plateau influences local wind patterns. Often a distinct diurnal cycle of winds occurs. Daytime winds measured in the Los Alamos area are predominately from the south, consistent with the typical upslope flow of heated daytime air moving up the Rio Grande valley. Nighttime winds (sunset to sunrise) on the Pajarito Plateau are lighter and more variable than daytime winds and typically from the west, resulting from a combination of prevailing winds from the west and downslope flow of cooled mountain air. Winds atop Pajarito Mountain are more representative of upper-level flows and primarily range from the northwest to the southwest, mainly because of the prevailing westerly winds.

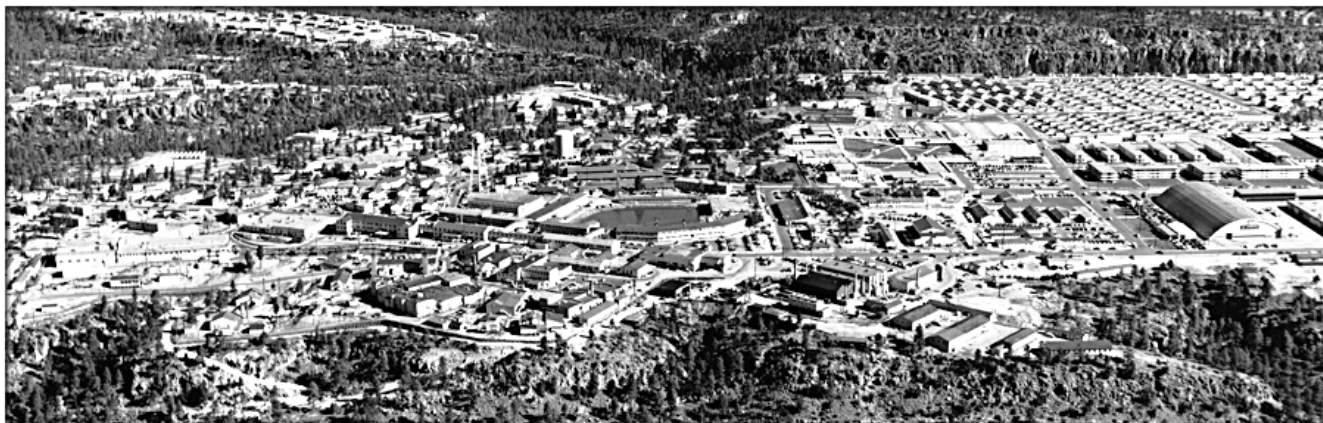
C. LABORATORY ACTIVITIES AND FACILITIES

The Laboratory is divided into technical areas (TAs) used for building sites, experimental areas, support facilities, roads, and utility rights-of-way (Appendix C and Figure 1-3). However, these uses account for only a small part of the total land area; much of the LANL land provides buffer areas for security and safety or is held in reserve for future use. The Laboratory has about 2,000 structures, with approximately 8.6 million square feet under roof, spread over an area of approximately 40 square miles.

In its 1999 Site-Wide Environmental Impact Statement (SWEIS) (DOE 1999), LANL identified 15 Laboratory facilities as “Key Facilities” for the purposes of facilitating a logical and comprehensive evaluation of the potential environmental impacts of LANL operations (Table 1-1). Operations in the Key Facilities represent the majority of exposures associated with LANL operations. In 2005, DOE/NNSA decided to prepare a new SWEIS. The new SWEIS was completed in early 2008, with a Record of Decision (ROD) scheduled to be issued later in 2008. Until a ROD is issued for the new SWEIS, LANL operations continue to be conducted under the existing 1999 SWEIS ROD. The facilities identified as “key” in the 1999 SWEIS are those that house activities critical to meeting work assignments given to LANL and also include the following facilities:

- Those that house operations that could potentially cause significant environmental impacts,
- Those that are of most interest or concern to the public based on SWEIS scoping comments, or
- Those that would be the most subject to change because of programmatic decisions.

In the 1999 SWEIS and in the new SWEIS, the remaining LANL facilities were identified as “Non-Key Facilities” because these facilities do not meet the above criteria. The Non-Key Facilities comprise all or the majority of 30 of LANL’s 48 TAs and approximately 14,224 acres of LANL’s 26,480 acres (Table 1-1). The Non-Key Facilities also currently employ about 42% of the total LANL workforce. The Non-Key Facilities include such important buildings and operations as the Nicholas C. Metropolis Center for Modeling and Simulation (Metropolis Center), the Nonproliferation and International Security Center (NISC), the new National Security Sciences Building (NSSB) that is now the main administration building, and the TA-46 sewage treatment facility.



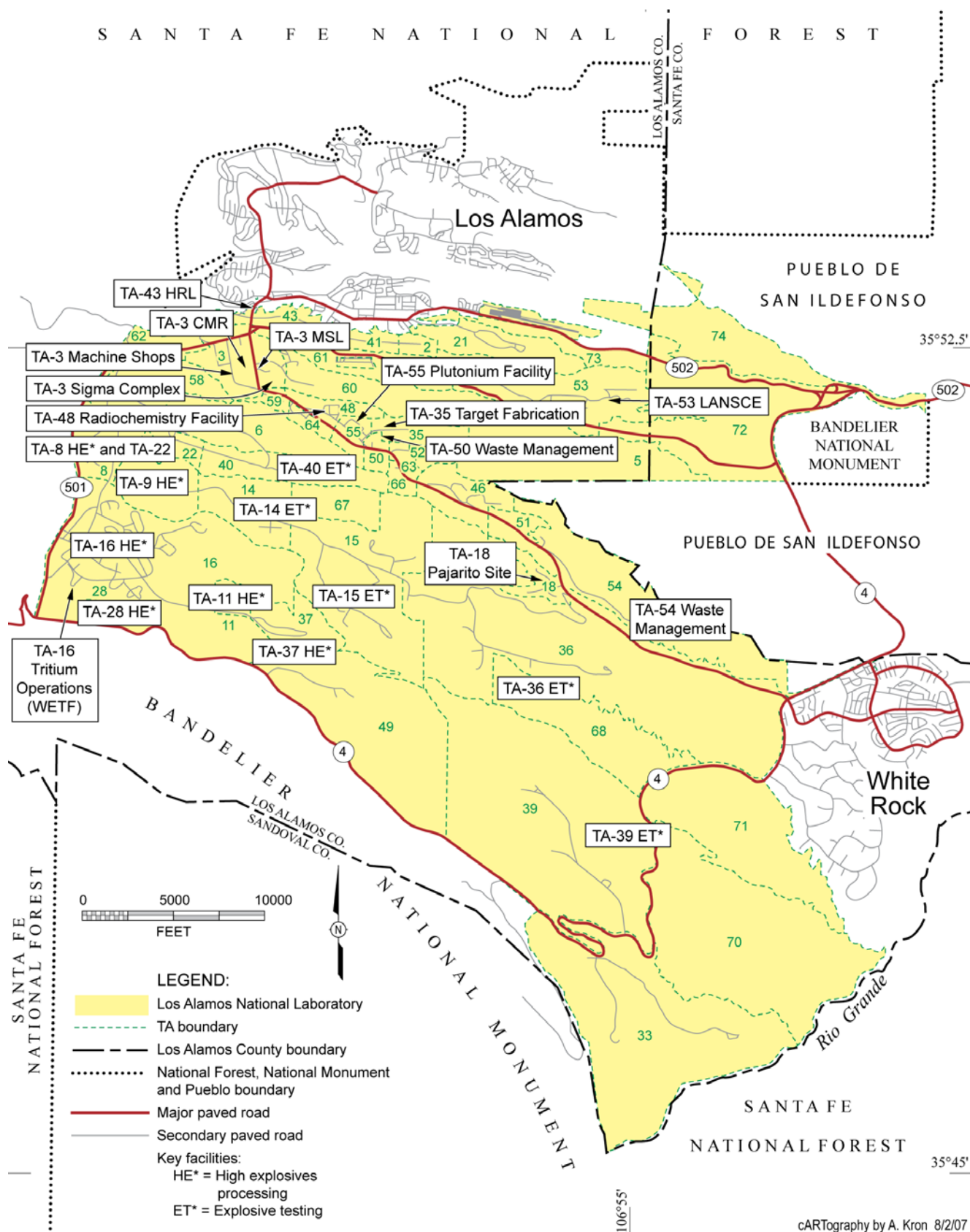


Figure 1-3. Technical Areas (TAs) and key facilities of Los Alamos National Laboratory in relation to surrounding landholdings.

Table 1-1
Key Facilities^a

| Facility | Technical Areas | Size (Acres) |
|--|-------------------------------------|---------------|
| Plutonium Complex | TA-55 | 93 |
| Tritium Facilities | TA-16 & TA-21 | 312 |
| Chemistry and Metallurgy Research (CMR) Building | TA-03 | 14 |
| Pajarito Site | TA-18 | 131 |
| Sigma Complex | TA-03 | 11 |
| Materials Science Laboratory (MSL) | TA-03 | 2 |
| Target Fabrication Facility (TFF) | TA-35 | 3 |
| Machine Shops | TA-03 | 8 |
| High-Explosives Processing | TA-08, -09, -11, -16, -22, -28, -37 | 1,115 |
| High-Explosives Testing | TA-14, -15, -36, -39, -40 | 8,691 |
| Los Alamos Neutron Science Center (LANSCE) | TA-53 | 751 |
| Biosciences Facilities (formerly Health Research Laboratory) | TA-43, -03, -16, -35, -46 | 4 |
| Radiochemistry Facility | TA-48 | 116 |
| Radioactive Liquid Waste Treatment Facility (RLWTF) | TA-50 | 62 |
| Solid Radioactive and Chemical Waste Facilities | TA-50 & TA-54 | 943 |
| Subtotal, Key Facilities | | 12,256 |
| Non-Key Facilities | 30 of 48 TAs | 14,224 |
| LANL Acreage | | 26,480 |

^a Data from SWEIS Yearbook – 2003 (LANL 2004).

The operation of the 15 Key Facilities, together with functions conducted in other Non-Key Facilities, formed the basis of the description of LANL facilities and operations analyzed in the 1999 SWEIS for potential environmental impacts. For the purpose of the impact analysis provided by the new SWEIS, the identity of the LANL Key Facilities has been modified to reflect subsequent DOE decisions that resulted in changes to LANL facilities and operations. The Metropolis Center has been added as a Key Facility because of the amounts of electricity and water it may use. Security Category I and II materials and operations have been moved from the TA-18 Pajarito Site to the Nevada Test Site. Under either of the Action Alternatives evaluated in the new SWEIS, Security Category III and IV materials and operations would be removed from the Pajarito Site, and Pajarito Site would be eliminated as a Key Facility. Under the No Action Alternative, the Pajarito Site would remain a Key Facility. Tritium operations at TA-21 have ceased and both the Tritium Science Test Assembly Facility and Tritium Science and Fabrication Facility are planned for decontamination, decommissioning, and eventual demolition. When the ROD is issued in 2008, TA-21 will no longer be a Key Facility.

D. MANAGEMENT OF ENVIRONMENT, SAFETY, AND HEALTH

Safety, environmental protection, and compliance with environmental, safety, and health (ES&H) laws and regulations are underlying values of all Laboratory work. The Laboratory uses Integrated Safety Management (ISM) to create a worker-based safety and environmental compliance culture in which all workers are committed to safety and environmental protection in their daily work. A seamless integration of ES&H with the work being done is fundamental. ISM provides the Laboratory with a comprehensive, systematic, standards-based performance-driven management system for setting, implementing, and sustaining safety performance and meeting environmental expectations. The term “integrated” is used to indicate that safety, protection of the environment, and compliance with ES&H laws and regulations are an integral part of how the Laboratory

conducts its work. ISM is the way that we meet the ethical commitment to avoid injury to people and the environment and the business imperative to meet the safety and environmental requirements of the contract for managing and operating the Laboratory.

Each Laboratory organization is responsible for its own environmental management and performance. Line management provides leadership and ensures ES&H performance is within the context of the Laboratory's values and mission. Laboratory managers establish and manage ES&H initiatives, determine and communicate expectations, allocate resources, assess performance, and are held accountable for safety performance.

Environmental characterization, remediation, surveillance, and waste management programs are part of the Environmental Programs (EP) Directorate. Environmental permitting is managed within the Environmental Protection Division in the Environment, Safety, Health, and Quality (ESHQ) Directorate. An organizational chart and description is available at <http://www.lanl.gov/organization/>. The major environmental programs and management system are described below.

1. Environmental Management System

The Laboratory is committed to protecting the environment while conducting its important national security and energy-related missions. DOE Order 450.1, Environmental Protection Program, requires all DOE sites to “implement sound stewardship practices that are protective of the air, water, land, and other natural and cultural resources impacted by Department of Energy (DOE) operations and by which DOE cost effectively meets or exceeds compliance with applicable environmental; public health; and resource protection laws, regulations, and DOE requirements.” The order further states this objective must be accomplished by implementing an Environmental Management Systems (EMS) at each DOE site. LANL has implemented a pollution-prevention-based EMS pursuant to DOE Order 450.1. The Laboratory met the DOE Order 450.1 requirement to have an EMS implemented by December 31, 2005. An EMS is a systematic method for assessing mission activities, determining the environmental impacts of those activities, prioritizing improvements, and measuring results. DOE Order 450.1 defines an EMS as “a continuous cycle of planning, implementing, evaluating, and improving processes and actions undertaken to achieve environmental missions and goals.” This DOE order mandates that the EMS be integrated with an existing management system already established pursuant to DOE Policy 450.4. Although it significantly exceeds DOE Order 450.1 requirements, LANL pursued and achieved registration to the ISO 14001-2004 standard in April 2006.

A key feature of the Laboratory EMS is the focus on ensuring that it is integrated with existing procedures and systems wherever possible. The intent is for the EMS to consolidate these existing programs into a systematic process for environmental performance improvement. The ISM provides an important foundation for the five core elements of the EMS:

1. Policy and Commitment
2. Planning
3. Implementation and Operation
4. Checking and Corrective Action
5. Management Review

More information about the EMS may be found at <http://ems.lanl.gov/>.

The EMS met several milestones in 2007. LANL's Implementing Procedures (IMP 401, 402, 403) governing communications, legal and other requirements, and environmental aspects were updated to reflect the new LANS management. These procedures defined EMS roles and responsibilities from the Laboratory Director to individual staff levels. In addition to these institutional policy changes, each Associate Director was asked to sign an EMS charter for his/her Directorate that reiterated commitment to the process.

In 2007, the EMS process was executed by multi-disciplinary teams from each Directorate. These organizations identified their activities, products, and services and their potential environmental aspects. They prioritized these aspects to determine which were significant and developed an Environmental Action Plan designed to prevent or eliminate the environmental risk associated with those aspects. The Directorate teams were aided by a trained support person from the EMS Management Team, whose members were trained in ISO 14001:2004 systems.

All 16 Directorates completed the Directorate Environmental Action Plans. Together, these plans commit to nearly 600 environmental improvement and pollution prevention actions that began in fiscal year 2006.

Registration to the ISO 14001:2004 standard requires extensive management review. External audits of the system have been conducted as follows:

- Kansas City Plant Pre-Audit, September 2004 (three auditors, three days)
- National Sanitation Foundation-International Strategic Registration, Ltd.(NSF-ISR, an independent third-party ISO 14001 registrar) Pre-Assessment, September 2005 (two auditors, three days)
- NSF-ISR Desk Audit, November 2005 (one auditor, two days)
- NSF-ISR Readiness Review, Phase 1 Audit, January 2006 (two auditors, three days)
- NSF-ISR Certification Audit, Phase 2 Audit, March 2006 (five auditors, five days)
- NSF-ISR Surveillance Audit 1, September 2006 (two auditors, three days)
- NSF-ISR Surveillance Audit 2, April 2007 (two auditors, three days)
- NSF-ISR Surveillance Audit 3, October 2007 (two auditors, three days)

These audits covered most of the Directorates and Divisions and all major support contractors and included interviews conducted from the Principal Associate Director level to individual staff and students chosen at random by the auditors. The auditors concluded that the Laboratory's EMS meets all the requirements of the ISO 14001-2004 standard with no major nonconformities and recommended that LANL maintain full certification. On April 13, 2006, LANL received full certification of its EMS to the ISO 14001-2004 standard. LANL was the first NNSA national laboratory and was the first University of California-operated facility to receive this distinction.

NNSA recognized the success of the EMS management and the their unique approach by giving the Laboratory the 2007 NNSA "Environmental Stewardship" Award for EMS-developed projects.

A second important component of the EMS is the institutional environmental stewardship and management support programs. These programs, described in the following sections, assist with the integration of job and work-specific evaluations and ensure natural and cultural resources are managed from a Laboratory-wide perspective.

2. Waste Management Program

Research programs that support the Laboratory's mission generate contaminated waste that must be properly managed to avoid risks to human health, the environment, or national security. Remediation of sites that were contaminated by past Laboratory operations also generates substantial volumes of waste. The Laboratory generates Resource Conservation and Recovery Act regulated waste, Toxic Substances Control Act regulated waste, low-level radioactive waste (both solid and liquid), mixed low-level waste, transuranic waste, administratively controlled waste, medical waste, New Mexico Special Waste, and sanitary solid and liquid waste. Certain wastes are treated and/or disposed of at the Laboratory, but most wastes are shipped off-site for treatment and final disposal.

The Laboratory's goal is to minimize hazardous and nonhazardous waste generation as much as is technically and economically feasible, as discussed in Section 3, Pollution Prevention Program, below. The Laboratory also

1. Introduction

strives to conduct waste management operations in a manner that maintains excellence in safety, compliance, environment, health, and waste management operations. This goal is accomplished through the following program tenets:

- Ensuring a safe and healthy workplace;
- Minimizing adverse impact to the general public;
- Minimizing adverse impact to the environment; and
- Ensuring compliance with all applicable laws, standards, and regulations governing environment, safety, and health.

LANL manages all waste management and disposal operations except sanitary solid and liquid wastes under its Environmental Programs Directorate. TA-54, Area G, managed by the Waste Disposition Project, is the Laboratory's primary solid radioactive and hazardous waste handling site. Thousands of drums of packaged transuranic waste are securely stored at this site awaiting transport to the DOE's Waste Isolation Pilot Plant (WIPP) near Carlsbad, NM. The site also receives, processes, and disposes of approximately 4,000 m³ of low-level radioactive waste per year. In the past, wastes were often buried in or released to pits or trenches around the Laboratory; several of these areas, known as Material Disposal Areas (MDAs), have been remediated and the remainder are either being investigated or undergoing remediation as discussed in Section 4, Environmental Restoration Programs, below.

The Radioactive Liquid Waste Program manages the Radioactive Liquid Waste Treatment Facility (RLWTF) at TA-50. The RLWTF treats approximately 1.6 million gal/year of radioactive liquid waste.

The Water Quality and RCRA Group in the Environmental Protection Division provides guidance and support to Laboratory waste generators on compliance with all waste handling requirements. Within the Environmental Programs Directorate, both the Waste Disposition Project and the Waste and Environmental Services Division provide direct support to waste generators on specific aspects of waste packaging, waste acceptance criteria, and transportation of hazardous and radioactive wastes for proper treatment and disposal.

The Waste Disposition Project also operates the "Green is Clean Program" to reduce low-level radioactive waste generation through a waste segregation and verification program. Generators segregate clean waste from radioactive-contaminated waste and ship it to TA-54 for verification through a very sensitive radioactive measurement system.

3. Pollution Prevention Program

The Pollution Prevention (P2) Program implements waste minimization, pollution prevention, sustainable design, and conservation projects to enhance operational efficiency, reduce life-cycle costs of programs or projects, and reduce risk to the environment. Reducing waste directly contributes to the efficient performance of the Laboratory's national security, energy, and science missions. Specific P2 activities include the following:

- Collecting data and reporting on DOE P2 goals;
- Forecasting waste volume to identify P2 opportunities;
- Conducting P2 opportunity assessments for customer divisions;
- Providing technical support for pollution prevention;
- Funding specific waste reduction projects through the LANL Generator Set-Aside Fund Program;
- Supporting affirmative procurement efforts;
- Conducting an annual LANL P2 awards program to recognize achievements;

- Supporting sustainable design for the construction of new buildings; and
- Communicating P2 issues to the Laboratory community.

The Laboratory's P2 Program continues to be recognized for its accomplishments. The Laboratory received eight national NNSA Pollution Prevention awards for Laboratory projects in fiscal year 2007 (up from seven in the previous fiscal year). Projects in fiscal year 2007 yielded more than \$18.4 million in savings to the Laboratory. The P2 Program was instrumental in incorporating preventive measures into the EMS, and the Laboratory received ISO 14001 certification. The Pollution Prevention received an overall performance rating of "Good" for fiscal year 2007. The P2 projects collectively avoided the generation of more than 1 million liters of radioactive liquid waste, 18 metric tons of hazardous waste, 10 cubic meters of mixed low-level waste, 61 cubic meters of low-level waste, and 4 cubic meters of transuranic waste. Together, the P2 projects were responsible for the recycling of 391 tons of metal.

"Green purchasing" is mandated by an executive order and calls for considering environmental factors in purchasing decisions in addition to traditional factors such as performance, price, health, and safety. Green purchasing, also known as affirmative procurement, is procurement of products or services considered to be environmentally preferable, meaning those products that have a comparatively smaller negative effect on human health and the environment. The aim is to eliminate waste, prevent pollution, and improve the quality of the environment.

4. Environmental Restoration Programs

The environmental restoration and cleanup work at LANL is organized into several projects that have responsibility for different aspects of environmental restoration:

- Water Stewardship Program
- TA-21 Closure Program
- Corrective Actions Program (includes investigations and remediations in canyons)

The goal of these programs is to ensure that residual materials and contaminants from past Laboratory operations do not threaten human or environmental health and safety. To achieve this goal, the Laboratory is investigating and, as necessary, remediating sites contaminated by past Laboratory operations. In calendar year 2007, fieldwork at several sites was either implemented, ongoing, or completed. Much of the work under these projects is subject to the requirements in the Compliance Order on Consent (Chapter 2, Section B.1). Most environmental sample analyses (81%) were for characterization or assessment of sites being investigated or cleaned up at LANL (Table 1-2). Chapter 9 summarizes the cleanup work conducted or completed in calendar year 2007.

After sites have been remediated, long-term monitoring may be required as part of the chosen remedy solution. Such monitoring will eventually become part of the existing environmental surveillance programs and will fulfill DOE requirements for a long-term environmental stewardship program.



Table 1-2
Approximate Numbers of Environmental Samples, Locations, and Analytes collected in 2007

| Sample Type or Media | Locations | Samples | Analytes or Measurements |
|-------------------------------|--------------|---------------|--------------------------|
| Ambient Air ^a | 58 | 2,648 | 10,339 |
| Stack Monitoring | 28 | 2,723 | 23,509 |
| Gas | 42 | 235 | 35,657 |
| Animal | 5 | 12 | 1,579 |
| Rock | 860 | 1,581 | 310,891 |
| Soil | 1,004 | 1,323 | 176,145 |
| Sediment | 197 | 250 | 35,948 |
| Vegetation | 78 | 96 | 2,733 |
| Water | 13 | 31 | 6,000 |
| Groundwater | 326 | 939 | 187,440 |
| Industrial Process Water | 17 | 65 | 2,813 |
| Surface Water Snowmelt | 38 | 52 | 2,209 |
| NPDES Outfalls | 38 | 228 | 3,495 |
| Surface Water Persistent Flow | 45 | 69 | 10,237 |
| Surface Water Base Flow | 51 | 78 | 21,079 |
| Surface Water Storm Runoff | 212 | 1,155 | 34,596 |
| Neutron Radiation | 47 | 188 | 188 |
| Gamma Radiation | 89 | 356 | 356 |
| Other Media | 33 | 68 | 7,005 |
| Totals: | 3,181 | 12,097 | 872,219 |

^a Does not include particulate (in air) measurements made by six Tapered Element Oscillating Microbalance instruments that calculated particulate concentrations every half hour.

Note: Not all the data counted in the table above are reported in this document.

5. Compliance and Surveillance Programs

LANL's environmental compliance and surveillance programs identify possible environmental hazards and impacts by regularly collecting samples and comparing results with previous results and with applicable regulatory standards. The Laboratory routinely collects samples of air particles and gases, water, soil, sediment, foodstuffs, and associated biota from over 3,100 locations (Table 1-2). Monitoring can detect and identify environmental impacts from hazardous and radioactive materials and data from monitoring can be used to help with mitigation of any impacts. To this end, each pathway by which an individual could be exposed is monitored. The sensitivity of environmental surveillance measurements allows for the detection of contaminants during cleanup or normal operations. Additional monitoring may be conducted in places where there is an increased potential for environmental releases. In some cases, immediate actions are warranted because of monitoring results. The various environmental monitoring programs are discussed below.

a. Air Quality Monitoring

The Laboratory maintains a rigorous ambient air surveillance and air quality compliance program for the emissions of both radionuclide and nonradionuclide air pollutants. The air monitoring and compliance efforts consist of three main parts: compliance and permitting, stack monitoring, and ambient air monitoring (AIRNET).

The Laboratory also works with and assists neighboring communities and pueblos in performing ambient air, direct penetrating radiation, and meteorological monitoring.

i. Compliance and Permitting

The Laboratory operates under a number of air emissions permits issued by the New Mexico Environment Department (NMED) and approvals for construction of new facilities/operations by the US Environmental Protection Agency (EPA). These permits and approvals require pollution control devices, stack emissions monitoring, and routine reporting.

LANL is authorized to operate applicable air emission sources at LANL per the terms and conditions as defined in Operating Permit No. P100-M2. LANL received a modification to its original Operating Permit, P100, in 2007 after beryllium operations at the Chemistry and Metallurgy Research (CMR) Building were discontinued. As part of the Title V Operating Permit program, the Laboratory reports emissions from sources included in the Operating Permit twice a year. In 2007, the Laboratory began to write its new Title V permit application to submit in 2008 for a five-year renewal in 2009.

In addition, the Laboratory maintains compliance with Title VI of the Clean Air Act that regulates the use of ozone-depleting substances, such as halons and refrigerants. The Laboratory maintains records on all work that involves refrigerants and the purchase, usage, and disposal of refrigerants.

To ensure compliance with the National Emission Standard for Hazardous Air Pollutants (NESHAP) for asbestos, the Laboratory conducted internal inspections of job sites and asbestos packaging approximately monthly. During 2007, there were 14 major renovation or demolition projects that involved removal of asbestos. LANL also reports emissions from chemical use associated with research and permitted beryllium activities.

In 2007, the Laboratory received a New Source Review air quality permit 2195-P for three generators to be used at TA-33.

Chapter 2 of this report describes in greater detail these permits and the status of compliance; this information is also available online at <http://www.lanl.gov/environment/air/>.

ii. Stack monitoring

As described in greater detail in Chapter 2 and Chapter 4, LANL rigorously controls and monitors stack emissions of radioactivity, as required by the Clean Air Act. Members of the Rad-NESHAP team at LANL evaluate these operations to determine potential impacts of the stack emissions on the public and the environment. This team continuously sampled 27 stacks at LANL for the emission of radioactive material to the ambient air. LANL categorizes its radioactive stack emissions into one of four types: (1) particulate matter, (2) vaporous activation products, (3) tritium, and (4) gaseous mixed activation products (GMAP).

For particulate matter, a continuous sample of stack air is pulled through a glass-fiber filter that captures small particles of radioactive material. Charcoal filters are used to capture radioactive vapors and highly volatile compounds. Tritium emissions are measured with a device called a bubbler, which pulls air through three sequential vials that contain ethylene glycol. GMAP emissions are measured in real time by pulling air through an ionization chamber that measures the total amount of radioactivity in the sample and records the results on a strip chart.

During 2007, the stack emissions were small and the resulting off-site dose from these emissions was about 5% of the Clean Air Act standards.

iii. Ambient Air Monitoring

The Laboratory operates an extensive network of ambient air quality monitoring stations (AIRNET) to detect other possible radioactive emissions (see Chapter 4). The network includes station locations on site, in adjacent communities, and in regional locations. These stations are operated to ensure that air quality meets EPA and DOE standards. These data are published in this report (see Chapter 4) and online at <http://www.lanl.gov/environment/air/>. During 2007, the only releases that the AIRNET system detected did not come from stacks but resulted from the unexpected elevated tritium levels initially observed at TA-54, Area G, in 2006. These slightly elevated levels were detected into April 2007 at which time the tritium-contaminated tank was buried to reduce emissions. Measured tritium concentrations reverted to normal levels.

b. Water Resources Monitoring

The water resources monitoring and compliance efforts consist of three main parts: compliance and permitting, groundwater monitoring, and surface water monitoring.

i. Compliance and Permitting

The Laboratory's Water Quality and Hydrology Group is responsible for all compliance and permitting functions related to the state Water Quality Act and federal Clean Water Act requirements. The group provides institutional expertise and implementation assistance for obtaining regulatory permits and maintaining compliance with all permit requirements. These functions include sampling, processing, and analyzing water and wastewater from treatment facilities; institutional coordination, integration, and communication of all wastewater resource-related monitoring and reporting activities; submitting permit applications, notices of intent to discharge, analytical data, and compliance documentation; interpretation of major state and federal water quality laws and regulations; development of institutional standards and policy regarding water and wastewater with line organizations; and interaction with regulatory agencies, stakeholders, the public, and Indian tribes on water quality or water resource management issues.

ii. Groundwater Monitoring

The LANL Water Stewardship Program manages and protects groundwater and surface water resources (see Chapters 5 and 6). The Laboratory conducts several activities to comply with the requirements of DOE Orders, state and federal regulations, and the Consent Order.

Groundwater resource management and protection efforts at the Laboratory focus on (1) the regional aquifer underlying the plateau, (2) the shallow perched groundwater found within canyon alluvium, and (3) the perched groundwater at intermediate depths above the regional aquifer. The objectives of the Laboratory's groundwater programs are to determine compliance with liquid waste discharge requirements and to evaluate any impact from Laboratory activities on groundwater resources. This program includes environmental monitoring, resource management, aquifer protection, and hydrogeologic investigations.

The Los Alamos County water supply system contains no detected LANL-derived contaminants. At present, the major thrust of the water-monitoring program, being developed in cooperation with NMED, is directed toward estimating the prospective risk from contamination that may enter the drinking water in the future. One such activity is modeling to estimate the possibility of contaminants migrating from the surface through the vadose zone to the aquifer. Data show that plutonium, uranium, cesium, and strontium are tightly bound to the soil matrix and so will not migrate in measurable amounts. Tritium is more mobile, but its migration is slower compared with its approximately 12-year radioactive half-life, so the concentrations of tritium in drinking water will remain far below drinking water standards. Thus, migration of radionuclides is not likely to be a problem, so attention is focused on migration of chemicals such as perchlorate, chromium, and high explosive residues.

LANL has drilled numerous additional monitoring wells over the past several years, and more are planned for 2008. These new wells will provide a better picture of the location and movement of contamination in the groundwater.

iii. Surface Water Monitoring

LANL's surface water protection efforts focus on monitoring surface water and stream sediment in northern New Mexico. The objectives of the surface water program are to address water pollution control compliance, environmental surveillance, watershed management, surface and ground water protection, drinking water quality protection, pesticide protection obligations, and public assurance needs. Samplers at more than 250 sites are set to collect samples when sufficient water is present during storm runoff events. The Laboratory analyzes samples for radionuclides, high explosives, metals, a wide range of organic compounds, and general chemistry.

c. Biological Monitoring

The LANL biological resources program focuses on assisting Laboratory projects and programs to comply with federal and state laws and regulations, DOE Orders, and LANL directives related to biological resources. LANL adopted a Biological Resources Management Plan in 2007. This document, along with LANL's 2005 revision of its Threatened and Endangered Species Habitat Management Plan, provides guidance for biological resources protection at LANL. The presence of federally listed species is monitored annually. In addition, the biological resources program is currently conducting an inventory of riparian habitats at LANL and is initiating a project to monitor State-listed species such as Gray Vireo and Jemez Mountains Salamander.

LANL's Emergency Management and Response Division manages wildland fire, including fuels monitoring and treatment on LANL property. One of the lasting results of past wildfires in and around LANL has been a significant increase in a regional, multi-agency approach to managing wildland fire. In September of 2007, the Lab adopted the Wildland Fire Management Plan which provides a strategic program to manage risk associated with wildland fires (LANL 2007).

d. Soil, Foodstuffs, and Non-foodstuff Biota Monitoring

The Laboratory collects surface soil, foodstuffs, and non-foodstuffs biota from the Laboratory, perimeter communities (Los Alamos, White Rock, and surrounding pueblos), and regional (background) areas to determine whether there is an impact of Laboratory operations on human health via the food chain and the environment. The Laboratory conducts these programs to comply with the requirements of DOE Orders and state and federal regulations. Samples of the various media are collected on a three-year rotating schedule and analyzed for radionuclides, heavy metals, and organic chemicals to determine concentrations and distribution in soil and potential uptake by plants, animals, and humans. Radiation doses to humans and biota (see Chapter 3) and changes in concentrations over time are also measured and analyzed. These data are published in Chapters 7 and 8 of this report and other Laboratory publications.

Monitoring of soil, foodstuffs, and non-foodstuffs biota is an important indication of the health of the environment. Soil and sediment monitoring has established a baseline of known contamination concentrations in selected areas on Laboratory property, in surrounding areas, and regionally. Comparison of known concentrations with future results may indicate movement of contaminants, for example, increases in contaminants in the sediments behind the flood retention structures.

Collection and analysis of foodstuff (crops, game animals, fish, honey, milk, etc.) from the region provides confidence that no unexpected contamination has reached off-site locations. Since the 1990s, the program has identified PCB and mercury levels above EPA and NMED fish advisory levels in some types of fish both upstream and downstream of LANL in the Rio Grande..

Biota monitoring is a non-invasive method of detecting underground materials. The roots of some plants and trees penetrate into subsurface contamination and may bring contaminated material to the surface. For example, vegetation samples collected annually at Area G in TA-54 demonstrate low concentrations of isotopic plutonium (approximately 1 pCi/g or less) in the soil toward the north and east of Area G (Chapter 8). Tree samples indicate an area of underground tritium along the south fence of MDA G. At MDA B, tree samples from 2006 along the northern fence showed above-background plutonium-239 concentrations and cesium-137 concentrations which indicate radioactive materials are within reach of the roots. Also, previous samples of chamisa within the fenced area of Bayo Canyon indicate underground concentrations of cesium on the order of 1,000 pCi/g near the southwest corner (Fresquez et al 1995).

e. Radiation Monitoring

Gamma and neutron radiation is monitored by the direct penetrating radiation monitoring network (DPRNET) described in Chapter 4.

The largest source of direct radiation is TA-54, Area G, and is monitored at 33 DPRNET stations, all of which measure above-background intensities of neutron radiation. As discussed in Chapter 3, the all-pathway maximally exposed individual (MEI) is at the northern boundary of TA-54 and results primarily from neutrons. The neutron radiation is being reduced by removing the sources from Area G.

Though high radiation levels are not expected from TA-21 during the upcoming cleanup at that site, seven new DPRNET stations were installed in 2006 along DP Road and State Road 502, between the potential sources at TA-21 and the public areas to the north and west.

Though not required for compliance purposes, the Laboratory operates several Neighborhood Environmental Monitoring Network (NEWNET) stations that measure gamma radiation levels at 15-minute intervals and post these data to the NEWNET website in near real time (<http://newnet.lanl.gov/>). Stations are located near the Laboratory boundary and in the nearby communities of Los Alamos, Pueblo de San Ildefonso, and Santa Clara Pueblo. The stations at East Gate and Mortandad Canyon are used to check the dose from LANSCE emissions. During 2007, the dose measured by NEWNET was 0.0 ± 0.3 mrem. The data from these stations are available on the NEWNET website and are not discussed further in this report.

f. Cultural Resources Protection

The Laboratory manages the diverse cultural resources according to the requirements of the National Historic Preservation Act and other federal laws and regulations concerned with cultural resources protection. Cultural resources include archaeological sites and associated artifacts, historic buildings and associated artifacts, and traditional cultural properties of importance to Native American and other ethnic groups. Section 106 of the act requires federal agencies to take into account the effects of projects on historic properties and to allow review and comment by the State Historic Preservation Office and the Advisory Council on Historic Preservation. The Section 106 regulations outline a project review process that is conducted on a project-by-project basis.

The Laboratory has adopted a Cultural Resources Management Plan (LANL 2005b) as an institutional comprehensive plan that defines the responsibilities, requirements, and methods for managing its cultural properties. The plan provides an overview of the cultural resources program, establishes a set of procedures for effective compliance with applicable historic preservation laws, addresses land-use conflicts and opportunities, ensures public awareness of DOE's cultural heritage stewardship actions at LANL, and provides a 10-year road map that summarizes and prioritizes the steps necessary to manage these resources.

E. RISK AND HAZARD REDUCTION

The Laboratory is committed to reducing hazards and the associated risk to people and the environment. Current risk depends on the amount of hazardous material that actually reaches a receptor, whereas prospective risk depends on the amount of hazardous material and the probability of *exposure* in the future. It is often given as a range of concentrations and risks (expressed as a dose) rather than a single number or set of numbers due to the uncertainties associated with predicting future concentrations and exposures. Buried hazardous material may have little or no exposure under current conditions but may have an increased probability of exposure over time. In addition, if the material is brought to the surface either now or in the future, the potential for exposure and risk increases substantially.

1. Estimation of Risk

Risk is evaluated either as current (present-day) risk or prospective risk (defined by the EPA as “the future risks of a stressor not yet released into the environment or of future conditions resulting from an existing stressor”). The stressor (also known as a hazard) could be a radionuclide, a chemical, or a combination for which the potential risk is evaluated based on protective assumptions under a reasonable exposure scenario(s), safety analysis, or model.

The terminology used in describing the current risks is that a potential unacceptable risk is present or not. The “acceptable” nature is determined by target levels dictated by the regulatory authorities (NMED or DOE) and are equal to or less than a 10^{-5} (1 in 100,000) probability of cancer, a hazard index equal to 1.0 or less for noncancer-causing chemicals (indicates that no adverse [noncancer] human health effects are expected to occur), and a dose of 15 mrem/yr or less for radionuclides. In keeping with the policy of maintaining all dose and risk as low as reasonably achievable, the Laboratory strives to reduce risk/dose to below these target levels whenever possible. For the MEI reported in Chapter 3 of this report, the calculated cancer risk from the estimated dose in 2007 was approximately 3×10^{-7} (a 3 in 10,000,000 chance of cancer).

To analyze current and prospective risk, LANL uses environmental data, computer evaluation tools, and computer models. A computer program called RACER (<http://www.racernm.com/>) is in development by the Risk Assessment Corporation (<http://www.racteam.com/>) in consultation with LANL and the NMED. The RACER tool will analyze collected environmental data to help estimate risk for a variety of exposure scenarios, such as recreational or residential uses. The Laboratory uses models such as the residual radioactivity (RESRAD) model (<http://web.ead.anl.gov/resrad/>), Hotspot (<http://www.llnl.gov/nhi/hotspot/>), and CAP88 (<http://www.epa.gov/radiation/assessment/CAP88/index.html>) to evaluate potential risk based on material inventory buried or stored at a site or in transport (e.g., from the surface to the regional aquifer).

Prospective risk is also used to aid in the evaluation of remediation and corrective measure options. Probabilistic models account for physical system uncertainties within the context of the decisions under consideration. Prospective risk methods can identify the additional data needed to determine the optimal decision, thus guiding data collection operations.

2. Examples of Risk Reduction

The following are examples where current or past Laboratory operations have resulted in the storage of large quantities of wastes or the release of contaminants to the environment, and where the Laboratory is working to reduce both current and prospective risks. These sites are being addressed by the Laboratory to reduce the potential and current hazards to humans and the environment.

a. TA-54, Area G and MDA G

The transuranic waste disposition program expedites the disposal of legacy transuranic waste to WIPP in Carlsbad, NM, and ensures appropriate facilities and equipment are available to facilitate disposal of current and future transuranic wastes. Area G stores substantial amounts of radioactively contaminated waste and other contaminated materials in above-ground storage. MDA G is a subsurface disposal site containing potentially hazardous and radioactive wastes from operational activities and wastes from environmental restoration and demolition activities at the Laboratory. MDA G was also used for the retrievable storage of transuranic waste. Most of the waste will eventually be transported to permanent storage at WIPP.

As discussed in Chapter 3, the dose to the all-pathway MEI results primarily from neutrons emitted from the transuranic waste at Area G (about 1 mrem/yr in 2007). The primary method to reduce both the current and prospective risk at Area G is to steadily reduce the inventory of transuranic waste by transporting drums of radioactive material to WIPP. Of the approximately 130,000 plutonium equivalent curies (PE Ci) of radioactive materials in secure aboveground storage at Area G, the Laboratory shipped approximately 17,215 PE Ci in 2,988 barrels to WIPP in 2007. Additionally, the Laboratory transported 33 drums of neutron sources, recovered by the Off-Site Source Recovery Program, to WIPP. The shipping strategy for 2008 will continue to concentrate on shipping higher-activity materials. Starting in 2009, waste buried in retrievable forms in MDA G will be excavated and shipped to WIPP. All temporarily-stored radioactive wastes are scheduled to be removed by late 2013.

b. TA-21

TA-21 is the site of the Laboratory's original plutonium processing facility, a tritium processing and handling facility, and several MDAs. The inventories of hazardous and radioactive material at the MDAs are not well characterized because there are few records of waste disposal during the 1940s and the Manhattan Project. MDAs V and U have been remediated; MDAs A and T will undergo corrective measures evaluations to determine the appropriate corrective actions; and MDA B is scheduled to be remediated. In addition, the other sites at TA-21 are being characterized or remediated as part of the DP Site Aggregate Area investigation.

c. Groundwater

As discussed in detail in Chapter 5, Groundwater Monitoring, Laboratory-derived impacts to groundwater have been detected in some monitoring wells. At present, there is no measurable LANL-derived contamination in the drinking water system but there may be a prospective risk because of the potential for contamination to migrate to the drinking water supply wells in the future. For the past several years, efforts have been under way to evaluate groundwater quality and augment the current monitoring network to ensure monitoring activities will detect contamination in groundwater before it can affect the drinking water.

d. Environmental Characterization and Restoration

The objective of the environmental investigation and cleanup activities at the Laboratory is to identify and characterize releases (the nature of the contamination), the location and extent of the contamination, whether it requires remediation (poses a potential unacceptable risk), and what type of remediation is appropriate. Over the past few years the Laboratory has been conducting corrective action activities under the March 1, 2005, Consent Order, which specifies requirements and goals to be met.

In the past several years, the Laboratory has determined where contamination is present and in many cases has reduced the legacy contamination. Where contamination is present, the risk is quantified to determine whether it is unacceptable with respect to human health and the environment. Table 9-3 lists the sites for which corrective actions were completed and approved by NMED in 2007.

The chromium investigations in Sandia and Mortandad Canyons continued with the installation of two monitoring wells (regional wells R-35a and R-35b) immediately upstream of PM-3, a municipal drinking water well.

Numerous sampling activities were conducted in 2007 and included sampling of pore gas at MDA A; drilling four boreholes at MDA C near TA-50 to characterize the subsurface below former chemical waste disposal pits; sampling and geophysical, geodetic, and radiological surveying in Bayo Canyon where radioactive materials and high explosives were used; additional sampling in several locations within TA-21 where the country's original plutonium processing facility was located; additional characterization sampling at MDA V and MDA T (both in TA-21) where liquid wastes were stored and processed; and sediment sampling in Sandia Canyon to determine the amount and extent of chromium migration. After results are received and interpreted, the Laboratory will document these sampling activities in reports to the NMED.

Previous risk reduction successes include the cleanup of the Los Alamos County Airport area at TA-73, which contained landfills, septic systems, an incinerator and surface disposal area (Airport Ashpile), and other miscellaneous sites; and MDA V at TA-21 where three absorption beds and other contaminated soil and tuff were excavated.



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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 US Department of Energy (DOE) requirements by directing employees to protect the environment and meet compliance requirements of applicable federal and state environmental regulations. Federal and state environmental laws address: (1) handling, transporting, releasing, and disposing of contaminants and wastes; (2) protecting ecological, archaeological, historic, atmospheric, soil, and water resources; and (3) conducting environmental impact analyses. Regulations provide specific requirements and standards to ensure maintenance of environmental quality. The US 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 the Laboratory operated under in 2007 and the specific operations and/or sites affected. Table 2-2 lists the various environmental inspections and audits conducted at the Laboratory during 2007. The following sections summarize the Laboratory's regulatory compliance performance during 2007.

B. COMPLIANCE STATUS

The Laboratory continues to meet requirements under the Clean Water Act. The Laboratory was issued a new National Pollutant Discharge Elimination System (NPDES) permit for industrial and sanitary waste water discharges which became effective August 1, 2007. During 2007, none of the 130 samples collected from the SWWS Plant's outfall exceeded Clean Water Act effluent limits. Only three of the 1408 samples collected from industrial outfalls exceeded effluent limits, all due to chlorine exceedances due to either chlorination or dechlorination system malfunctions. Compliance with National Pollutant Discharge Elimination System (NPDES) requirements at permitted construction-sites improved in 2007 to 99% overall (from 94% in 2006).

The Laboratory continues to be well below all Clean Air Act (CAA) permit limits for emissions to the air.

Table 2-1
Environmental Permits or Approvals under Which the Laboratory Operated during 2007

| Category | Approved Activity | Issue Date | Expiration Date | Administering Agency |
|--|--|--|--|---|
| RCRA ^a Permit | Hazardous Waste Facility Permit – Permitted hazardous waste storage units: Technical Areas 50 & 54 40 CFR 265 Standards – Interim Status hazardous waste storage and treatment facilities: Technical Areas 3, 14, 16, 36, 39, 50, 54, & 55. Permit applications submitted to NMED. | November 1989 | November 1999* | NMED ^b |
| HSWA ^c | RCRA corrective activities | March 1990 | December 1999* | NMED |
| Consent Order | Legacy and contaminated waste site investigations, corrective actions, and monitoring | March 1, 2005 | September 20, 2015 | NMED |
| CWA ^d /NPDES ^e | Outfall permit for the discharge of industrial and sanitary liquid effluents MSGP ^g for the discharge of stormwater from industrial activities Federal Facility Compliance Agreement for storm water discharges from Solid Waste Management Units (SWMUs) Construction General Permits (17) for the discharge of stormwater from construction activities | August 1, 2007 October 30, 2000 February 5, 2005 July 1, 2003 | July 31, 2012 October 30, 2005 Upon issuance of the Individual Permit, (pending) June 30, 2008* | EPA ^f EPA EPA EPA |
| CWA Sections 404/401 | COE ^h Nationwide Permits – None issued in 2007 | NA | NA | COE/NMED |
| Groundwater Discharge Plan, TA-46 SWWS Plant ⁱ | Discharge to groundwater | January 7, 1998 | January 7, 2003* | NMED |
| Groundwater Discharge Plan, TA-50, Radioactive Liquid-Waste Treatment Facility | Discharge to groundwater | Submitted August 20, 1996 | Approval pending | NMED |
| Groundwater Discharge Plan, Domestic Septic Systems | Discharge to groundwater | Submitted April 27, 2006 | Approval pending | NMED |

Table 2-1 (continued)

| Category | Approved Activity | Issue Date | Expiration Date | Administering Agency |
|--|---|---|-----------------|---|
| Air Quality Operating Permit (20.2.70 NMAC ^c) | LANL air emissions | April 30, 2004 | April 29, 2009 | NMED |
| | Operating Permit Modification 1 | June 15, 2006 | | |
| | Operating Permit Modification 2 | July 16, 2007 | | |
| Air Quality Construction Permits (20.2.72 NMAC) | Portable rock crusher | June 16, 1999 | None | NMED |
| | Retired and removed from operating permit | June 15, 2006 | | |
| | Permit number will remain active to track exempt sources at LANL | | | |
| | TA-3 Power Plant | September 27, 2000 | None | |
| | Permit revision | November 26, 2003 | | |
| | Permit modification | July 30, 2004 | | |
| | 1600 kW Generator at TA-33 | October 10, 2002 | None | |
| | Two (2) 20 kW Generators and one (1) 225 kW generator at TA-33 | August 8, 2007 | None | |
| | Asphalt Plant at TA-60 | October 29, 2002 | None | |
| | Data disintegrator | October 22, 2003 | None | |
| Air Quality (NESHAP ^k) | Chemistry and Metallurgy Research Replacement (CMRR), Radiological Laboratory, Utility, Office Building | September 16, 2005 | None | EPA |
| | Radiological air emissions at CMRR, Radiological Laboratory, Utility, Office Building | July 14, 2005 | None | |
| | Beryllium machining at TA-3-141 | October 30, 1998 | None | |
| | Beryllium machining at TA-35-213 | December 26, 1985 | None | |
| | Beryllium machining at TA-55-4 | February 11, 2000 | None | |
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| | | | | |
| ^a Resource Conservation and Recovery Act | | | | |
| ^b New Mexico Environment Department | | | | |
| ^c Hazardous and Solid Waste Amendments | | | | |
| ^d Clean Water Act | | | | |
| ^e National Pollutant Discharge Elimination System | | | | |
| ^f Environmental Protection Agency | | | | |
| ^g Multi-Sector General Permit | | | | |
| | | ^h US Army Corps of Engineers | | |
| | | ⁱ Sanitary Wastewater Systems Plant | | |
| | | ^j New Mexico Administrative Code | | |
| | | ^k National Emission Standards for Hazardous Air Pollutants | | |
| | | | | * Permit was administratively continued |

Table 2-2
Environmental Inspections and Audits Conducted at the Laboratory during 2007

| Date | Purpose | Performing Agency |
|-----------------|---|-------------------|
| 1/22/07–1/31/07 | Hazardous waste compliance inspection (closeout 8/7/2007) | NMED ^a |
| 4/10/2007 | CMRR ^b site inspection | NMED |
| 7/17/2007 | Title V Operating Permit compliance inspection | NMED |

No PCB^c; Federal Insecticide, Fungicide, and Rodenticide Act; Section 401/404; Construction General Permit; Groundwater Discharge Plan; or NPDES compliance inspections were conducted in 2007.

^a New Mexico Environment Department

^b Chemistry and Metallurgical Research Replacement building

^c Polychlorinated biphenyls

The Laboratory continued to conduct corrective actions in accordance with the March 2005 Compliance Order on Consent (Consent Order), though the NMED issued a Notice of Violation (NOV) for failing to complete the sampling of all monitoring wells within a single watershed within 21 days of the start of a groundwater sampling event. LANL submitted a proposed corrective action and NMED determined no further action was required. The NMED issued a second NOV regarding storage of hazardous waste. All of the Laboratory deliverables (plans and reports) required by the Consent Order were submitted on time to NMED. Self-inspections of RCRA hazardous and mixed waste compliance found a nonconformance rate of 3.71% (compared to 3.02% in 2006).

1. Resource Conservation and Recovery Act

a. Introduction

The Laboratory produces a wide variety of hazardous wastes as a research facility. These wastes are mostly in small quantities compared to industrial facilities of comparable size. RCRA, as amended by the Hazardous and Solid Waste Amendments (HSWA) of 1984, establishes a comprehensive program to regulate hazardous wastes from generation to ultimate disposal. The EPA has authorized the State of New Mexico to implement the requirements of the program, which it does through the New Mexico Hazardous Waste Act and state regulations found in the New Mexico Administrative Code (NMAC) Title 20, Chapter 4, Part 1, as revised October 1, 2003 (20.4.1 NMAC).

The federal and state laws regulate management of hazardous wastes based on a combination of the facility's status, the quantities of waste generated, and the types of waste management conducted by the facility. Certain operations require a hazardous waste facility permit, sometimes called a RCRA permit. The LANL hazardous waste facility permit was initially granted in 1989 for storage and treatment operations. It expired in 1999 but was administratively continued beyond the expiration date as allowed by 20.4.1.900 NMAC.

The Laboratory has submitted various permit applications for NMED review since 1996 to renew the hazardous waste facility permit. Permit modification packages have also been submitted to revise and upgrade the waste management conditions and facilities contained in the original permit.

b. RCRA Permitting Activities

In 2007, NMED issued the draft renewed hazardous waste facility permit for public comment and the Laboratory submitted several proposed modifications to the original permit. The draft permit was published on August 27, 2007 and the public comment period was eventually extended into 2008 (February 1, 2008). During the fall of 2007, the Laboratory developed and collected numerous facility comments to the draft permit regarding the proposed waste management, unit design, and environmental monitoring conditions for submittal to NMED in early 2008. The review process for this permit is estimated to be complete in early 2010.

On March 2, 2007, the Laboratory submitted a package of four Class 2 permit modifications to the continued LANL hazardous waste facility permit to reflect upgrades for waste management activities. After a public comment period, NMED approved the modifications on July 24, 2007. The first modification requested the ability to store waste containers within heated transportainers and modular buildings on the asphalt pad (Pad 9) surrounding permitted storage domes 229, 230, 231, and 232. The second proposed modification requested the ability to store waste containers that potentially contain liquids in dome 231. The changes supported waste characterization activity and container preparation improvements for the TRU waste disposition program that should result in improved rates of waste transfer to WIPP.

The third permit modification requested expansion of the storage footprint within the fenced asphalt area at TA-54-38. The maximum storage volumes and types of waste allowed for the site were not altered. This change was needed to accommodate recent DOE safety improvements and to allow better staging of Waste Isolation Pilot Plant (WIPP) transport vehicles. The fourth proposed modification requested the relocation of three modular buildings, a temporary modular containment structure, and a canopy at TA-54, Area L. These relocations support the future closure of the northern portion of the container storage unit and corrective action activities for the land disposal units located there.

On March 15, 2007, the Laboratory submitted a Class 1 permit modification request to NMED to revise the permit to show the replacement of two transportainers at TA-50-69. The modification did not change the storage capacity or waste management procedures at the unit but the replacement did improve and upgrade the existing storage capability. A revised and up-to-date listing of the hazardous waste management units at LANL and their history was also submitted to NMED on March 29, 2007.

In addition, on March 29, the Laboratory submitted an air dispersion modeling protocol for the TA-16 open burn units to NMED. The submittal also provided comparative information on the available options for treatment of high explosives waste in support of open burning. On May 31, 2007, further unit-specific information and an expanded modeling scope for the air pathway assessment was submitted to address a notice of deficiency letter for the TA-16 permit renewal application issued by NMED on April 18, 2007. The air pathway assessment report resulting from implementation of the modeling protocol was submitted to NMED on September 5, 2007.



On August 20, 2007, the Laboratory submitted a Class 3 permit modification request for a new waste management facility to be located at TA-52. This was the Transuranic Waste Facility (TRUWF) to be used for the management of newly generated LANL transuranic waste after the closure of TA-54, Area G to meet the requirements of the Consent Order. The Laboratory hosted a public information meeting regarding the new facility on October 2, 2007. NMED issued a response to the permit modification request on December 20, 2007 requiring additional design and waste management procedure information. The proposed use and design conditions for this facility were under further review by the Laboratory and DOE at the end of 2007. The Laboratory also submitted an update to Figure A-5 of the TA-50 Part B permit renewal application regarding regional surface faulting as a result of NMED's review of the TRUWF request.

On December 18, 2007, the Laboratory submitted five Class 1 permit modifications to NMED. These included updates and changes to the permit inspection plan, updated figures to show the removal of sheds at TA-54-38, revisions to the list of emergency managers, organization names, phone numbers and facility location information in the contingency plan, and changes to the figures showing the LANL boundary.

The Laboratory received approval of the TA-54 Area L Waste Treatment/Storage Tanks closure certification report on February 20, 2007. Two closure plans for waste management units were also submitted to NMED in March 2007. These included closure and post-closure conditions for the TA-54 Area L and Area G landfills.

c. Other RCRA Activities

The compliance assurance program performed Laboratory self-assessments to determine whether hazardous and mixed waste is managed to meet the requirements of federal and state regulations, DOE orders, and Laboratory policy. The program communicated findings from these self-assessments to waste generators, waste-management coordinators, and waste managers who help line managers implement appropriate actions to ensure continual improvement in LANL's hazardous waste program. In 2007, the Laboratory completed 1,939 self-assessments with a nonconformance rate of 3.71%.

d. RCRA Compliance Inspection

From January 22, 2007 to January 31, 2007, NMED conducted a hazardous waste compliance inspection at the Laboratory (see Table 2-2). The Laboratory received eight potential findings for this inspection.

e. Site Treatment Plan

In October 1995, the State of New Mexico issued a Federal Facility Compliance Order to the DOE and the University of California (UC), requiring compliance with the Site Treatment Plan. On June 1, 2006, Los Alamos National Security (LANS) replaced UC as the operating contractor at LANL at which time LANS assumed responsibility for compliance with the order. The plan documents the use of off-site facilities for treating and disposing of mixed waste generated at LANL and stored for more than one year. In 2007, the Laboratory shipped more than 74 m³ of low-level mixed waste covered by the Site Treatment Plan. The increase over the 2006 volume (1.2 m³) was due to the reclassification and management of approximately 85 m³ of mixed transuranic waste as mixed low-level waste.

f. Solid Waste Disposal

LANL sends sanitary solid waste (trash) and construction and demolition debris for disposal to the Los Alamos County landfill on East Jemez Road. The DOE owns the property and leases it to Los Alamos County under a special-use permit. Los Alamos County operates this landfill and is responsible for obtaining all related permits for this activity from the State. The landfill is registered with the NMED Solid Waste Bureau. Laboratory trash placed in the landfill in 2007 included 2,158 metric tons of trash and 808 metric tons of construction and demolition debris. Through LANL recycling efforts, 2,751 metric tons of material did not go to the landfill in 2007.

g. Hazardous Waste Report

The Hazardous Waste Report covers hazardous and mixed waste generation, treatment, and storage activities performed at LANL during calendar year 2007 as required by RCRA, under 40 CFR §262.41, Biennial Report. In 2007, the Laboratory generated about 154,175 kg of RCRA hazardous waste, 43,797 kg of which were generated by the Environmental Remediation and Surveillance Program. The waste is recorded for more than 10,000 waste movements, treatment, or storage actions resulting in more than 492 Waste Generation and Management forms in the Hazardous Waste Report. The entire report is available on the web at http://www.lanl.gov/environment/waste/docs/reports/2007_biennial_hwr_LA-UR-08-0766.pdf.

h. Compliance Order on Consent (Consent Order)

The Consent Order is an enforcement document signed by NMED, DOE, and the UC Regents on March 1, 2005, which prescribes the requirements for corrective action at Los Alamos National Laboratory. The purposes of the Consent Order are (1) to define the nature and extent of releases of contaminants at, or from, the facility; (2) to identify and evaluate, where needed, alternatives for corrective measures to clean up contaminants in the environment and prevent or mitigate the migration of contaminants at, or from, the facility; and (3) to implement such corrective measures. The Consent Order supersedes the corrective action

requirements previously specified in Module VIII of the Laboratory's Hazardous Waste Facility Permit and applies to Solid Waste Management Units (SWMUs) and Areas of Concern (AOCs) subject to RCRA and HSWA requirements, but not to sites that are regulated by DOE under the Atomic Energy Act, such as those containing or releasing radionuclides. The Consent Order does not apply to those SWMUs and AOCs that received "no further action" decisions from EPA when it had primary regulatory authority. A description of the Consent Order work done in 2007 may be found in Chapter 9 of this report.

In 2007, the Laboratory submitted all of its deliverables (plans and reports) required by the Consent Order on time to NMED (see Tables 9-1 and 9-2 in Chapter 9 of this report).

i. Notices of Violation

In June 2007, the NMED Hazardous Waste Bureau issued an NOV to DOE and LANS for failing to complete the sampling of all wells within the Water Canyon watershed within 21 days of the start of a groundwater sampling event. LANL made changes to the methods for notifying organizations that must allow access and reassigned responsibility for coordinating and tracking sample scheduling. NMED determined the proposed corrective actions should help ensure future compliance.

In August 2007, NMED's Hazardous Waste Bureau issued LANS and DOE an NOV identifying two alleged violations noted during the 2006 RCRA compliance inspection. The penalty assessed was \$26,613 and was paid on February 25, 2008. The 2007 Hazardous Waste Bureau RCRA compliance inspection was conducted from January 22, 2007 through January 31, 2007, resulting in an NOV dated January 28, 2008, that contained eight alleged violations.

An NOV issued in September 2006 alleged a failure to report the release of a groundwater contaminant (chromium) in accordance with the Consent Order. In 2008, DOE and LANS paid a penalty of \$251,870 to settle without admitting the allegations.

An NOV dated October 25, 2006 alleged improper management of rubble located on Sigma Mesa generated by the decommissioning and demolition of TA-16, Building 340. The settlement agreement to resolve this NOV was signed in April 2007. LANS, DOE, and NMED agreed to settle the matter for \$119,845, which was paid in May 2007. Regular reporting on planned building demolition was also required by the settlement agreement.

j. Other RCRA noncompliances

During 2007, four 55-gallon drums stored in permitted storage area TA-54, Area G, Building 232 contained an EPA Hazardous Waste Number that was not authorized by the LANL Hazardous Waste Facility Permit for storage at that location. All four drums that contained the EPA Waste Number D042 (Trichlorophenol) were stored for a period of time in TA-54-232; two of the drums were also stored for a period in TA-54-229; and one of the drums was stored in TA-54-231 for a period. Upon discovery, the drums were verified to be in or were moved to one of the storage areas at TA-54, Area G authorized for D042.

During a prestart assessment for repackaging activities at TA-50-69, a question was raised as to whether waste containers within the permitted container storage unit at TA-54, Area G, Dome 231, were being remediated for liquids in accordance with the exclusion allowed for at 40 CFR §270.1(c)(2)(vii). The exclusion requires that an absorbent be placed into a container at the time



2. Compliance Summary

waste is first placed into the container. After review of relevant documents, LANL determined that up to 313 of the 442 waste containers treated at Dome 231 between November 2006 and March 2007 were treated for small amounts of liquid by the addition of absorbent to the original container. The treatment process was reassessed to ensure that activities at restart would comply with the exclusion requirements.

An inventory conducted in early 2007 at the TA-54 container storage units did not locate 47 waste containers listed in the inventory. Follow-up included subsequent inventories that located containers on-site and identified containers shipped off-site for treatment and/or disposal.

On September 25, 2007, a visiting permit writer for the NMED's Hazardous Waste Bureau discovered a drum located at the TA-54, Area G, Pad 7, interim status container storage unit with an illegible accumulation start date. The hazardous waste label was fixed and information regarding the label including pictures was submitted to the Hazardous Waste Bureau in October 2007.

No weekly RCRA storage area inspection was conducted for the week of December 24, 2007 through December 30, 2007 at the permitted storage units at TA-50, Building 69. The units did not contain any hazardous wastes during that timeframe and a memorandum to file was generated on January 14, 2008 to document the need for no inspection.

Between July 2004 and May 2007, five containers of hazardous waste were incorrectly placed in TA-54 Dome 375 for varying periods of time. TA-54 Dome 375 is used for storage of low-level and transuranic non-hazardous waste. Upon discovery, the waste containers were moved to a container storage unit authorized for hazardous waste storage.

There were no actual or potential hazards to the environment and human health outside the facility and no material was lost or had to be recovered because of these incidents. None of these incidents required other reporting to the NMED by the LANL Hazardous Waste Facility Permit.

2. Comprehensive Environmental Response, Compensation, and Liability Act

The DOE/NNSA conveyed Tract A-8a, located south of Material Disposal Area B and south of DP Road, to the Los Alamos County School Board on January 19, 2007. No other lands were conveyed from DOE to other entities in 2007 under the Land Conveyance and Transfer Project. Environmental Baseline Survey Reports were initiated for tracts A-18 and A-4 in anticipation of scheduled transfers in 2008. These reports contain the Comprehensive Environmental Response, Compensation, and Liability Act 120(h) information required to convey these properties to private or municipal entities and disclose any environmental liabilities that may exist on these tracts. The Environmental Baseline Survey Reports document remedial actions that were taken to protect human health and the environment for the proposed use of the properties, and identify any restrictions on the use of the property where warranted.

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 Executive Order 13148, *Greening the Government Through Leadership in Environmental Management*. Executive Order 13148 was superseded in January 2007 by Executive Order 13423, *Strengthening Federal Environmental, Energy, and Transportation Management*.

b. Compliance Activities

For 2007, the Laboratory submitted reports to fulfill its requirements under EPCRA, as shown in Table 2-3 and described below.

Table 2-3
Compliance with Emergency Planning and Community Right-to-Know Act during 2007

| Statute | Brief Description | Compliance |
|---|--|---|
| EPCRA Sections 302–303 Planning Notification | Requires emergency planning notification to state and local emergency planning committees. | No changes to the notification have been made since the July 30, 1999 notification and an update in 2000. |
| 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 2007. |
| EPCRA Sections 311–312 Material Safety Data Sheets 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 36 hazardous materials stored at LANL over specified quantities in 2007 required submittal of a hazardous chemical inventory to the State Emergency Response Commission and the Los Alamos County Fire and Police Department. |
| EPCRA Section 313 Annual Toxic Release Inventory | Requires all federal facilities to report total annual releases of listed toxic chemicals used in quantities above reportable thresholds. | Laboratory use of lead and nitric acid exceeded the reporting thresholds in 2007, requiring submittal of Toxic Chemical Release Inventory Reporting Forms (Form Rs) to the EPA and the State Emergency Response Commission. |

i. Emergency Planning Notification.

Title III, Sections 302–303, of EPCRA require 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 (1) if there are any changes at the Laboratory that might affect the local emergency plan or (2) if the Laboratory's emergency planning coordinator changes. No updates to this notification were made in 2007.

ii. Emergency Release Notification

Title III, Section 304, of EPCRA requires facilities to provide emergency release notification of leaks, spills, and other releases of listed chemicals into the environment, if these chemicals exceed specified reporting quantities. Releases must be reported immediately to the 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 2007.

iii. Material Safety Data Sheet/Chemical Inventory Reporting

Title III, Sections 311–312, of EPCRA require facilities to provide an annual inventory of the quantity and location of hazardous chemicals above specified thresholds present at the facility. The inventory includes hazard information and storage location for each chemical. The Laboratory submitted a report to the State Emergency Response Commission and the Los Alamos County Fire and Police Departments listing 36 chemicals and explosives at the Laboratory stored on-site in quantities that exceeded reporting threshold limits during 2007.

iv. Toxic Release Inventory Reporting

Executive Order 13148 requires all federal facilities to comply with Title III, Section 313, of EPCRA. This section requires reporting of total annual releases to the environment of listed toxic chemicals that exceed activity thresholds. Beginning with reporting year 2000, new and lower chemical-activity thresholds were put in place for certain persistent, bioaccumulative, and toxic chemicals and chemical categories. The thresholds for these chemicals range from 0.1 g to 100 lb. Until this change went into effect, the lowest threshold was 10,000 lb. LANL exceeded two thresholds in 2007 and therefore was required to report the uses and releases of these chemicals. The reported materials were lead and nitric acid. The largest use of reportable lead is at the on-site firing range where security personnel conduct firearms training. Table 2-4 summarizes the reported releases for lead and nitric acid in 2007.

Table 2-4
Summary of 2007 Reported Releases under EPCRA Section 313

| | Lead (lb) | Nitric Acid (lb) |
|---------------------------------|-----------|------------------|
| Air Emissions | 8.61 | 219.9 |
| Water Discharges | 0.18 | 0 |
| On-Site Land Disposal | 7,385 | N/A |
| Off-Site Waste Transfers | 3,490 | 337 |

4. Toxic Substances Control Act

Because the Laboratory's activities are research and development (R&D) rather than the manufacture of commercial chemicals, the Laboratory's main concern under the Toxic Substances Control Act (TSCA) is the regulations covering polychlorinated biphenyls (PCBs) and import/export of R&D chemical substances. The PCB regulations govern substances including, but not limited to, dielectric fluids, contaminated solvents, oils, waste oils, heat-transfer fluids, hydraulic fluids, slurries, soil, and materials contaminated by spills.

During 2007, the Laboratory shipped 46 containers of PCB waste off-site for disposal or recycling. The quantities of disposed waste included 60 lb (27 kg) of capacitors and 2795 lb (1268 kg) of fluorescent light ballasts. The Laboratory manages all wastes in accordance with 40 Code of Federal Regulations (CFR) 761 manifesting, record keeping, and disposal requirements. PCB wastes go to EPA-permitted disposal and treatment facilities. Light ballasts go off-site for recycling. The primary compliance document related to 40 CFR 761.180 is the annual PCB report that the Laboratory submits to EPA Region 6. The renewal request for the Area G PCB disposal authorization was withdrawn in 2006. During 2007, EPA did not perform any PCB site inspections. Approximately 21 TSCA reviews were conducted on imports and exports of chemical substances for the Laboratory's Property Management Group Customs Office.

5. Federal Insecticide, Fungicide, and Rodenticide Act

The Federal Insecticide, Fungicide, and Rodenticide Act regulates the manufacturing of pesticides and the protection of workers who use these chemicals. 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 has the primary responsibility to enforce pesticide use under the act. The New Mexico Pesticide Control Act applies to the Laboratory's licensing and certifying of pesticide workers, record keeping, applying of pesticides, inspecting of equipment, storing of pesticides, and disposing of pesticides.

The New Mexico Department of Agriculture did not conduct assessments or inspections of the Laboratory's pesticide application program in 2007. Table 2-5 shows the amounts of pesticides the Laboratory used during 2007.

Table 2-5
Herbicides and Pesticides used at LANL in 2007

| Herbicides | | Insecticides | |
|----------------------|----------|----------------------------|--------|
| VELPAR L (Liquid) | 169 gal. | TEMPO 20 WP | 36 oz |
| Roundup Pro | 1.5 gal. | Maxfource Ant Bait | 10 oz |
| 2-4-D Amine (liquid) | 15 gal. | Maxfource Ant Bait Station | 260 oz |
| VELPAR DF (powder) | 12 lbs | Advion Ant Bait | 4 oz |
| | | Advion Ant Bait Arenas | 21 oz |
| | | TALSTAR F | 11 oz |
| | | Wasp Freeze | 35 oz |
| | | Suspend SC | 20 oz |
| | | P.I. Contact | 207 oz |
| | | Demand CS | 16 oz |

6. Clean Air Act

Pursuant to the federal CAA Amendments and Title 20 of NMAC, Chapter 2, Part 70, Operating Permits (20.2.70 NMAC), LANL is authorized to operate applicable air emission sources at LANL per the terms and conditions as defined in Operating Permit No. P100-M2. The operating permit conditions mirror existing source-specific permit conditions applicable to operating requirements, record keeping, monitoring, and reporting. By complying with the conditions of the Title V Operating Permit, the Laboratory is deemed to be compliance with all applicable air requirements existing at the date of permit issuance.

As part of the Title V Operating Permit program, LANL reports emissions from sources included in the Operating Permit twice a year. These sources include multiple boilers and electric generators, two steam plants, a combustion turbine generator, a data disintegrator, two carpenter shops, a degreaser, and an asphalt plant. LANL also reports emissions from chemical use associated with R&D and permitted beryllium activities.

According to reporting requirements in the Title V Operating Permit's terms and conditions, the Laboratory must submit an Annual Compliance Certification report to NMED. In the 2007 Compliance Certification report, two permit deviations were reported. These deviations consisted of an opacity exceedance at the TA-3 power plant and a reduction in the High Efficiency Particulate Air (HEPA) filter efficiency at TA-35-213. The opacity exceedance occurred on May 1, 2007, when an opacity of 25% was observed at the power plant during a routine change in fuels from natural gas to fuel oil. The opacity observed was slightly above the opacity limit of 20% stated in the permit. An excess emissions report was submitted to NMED identifying the details of this deviation. The second deviation was for a HEPA filter test occurring on March 28, 2007 at one of the permitted beryllium sources located at TA-35-213. The test indicated that the filter did not meet the established efficiency criteria. The filter was subsequently replaced and beryllium operations at this location were ceased until the filter test was passed.

LANL demonstrated full compliance with all other permit applicable terms and conditions and met all reporting requirement deadlines.

In 2007, LANL requested and received a modification to Operating Permit No P100. This permit modification, P100-M2, was issued on July 16, 2007. The modification consisted of an administrative amendment, retiring the beryllium operations at the Chemistry and Metallurgy Research (CMR) Facility at Technical Area TA-3-29.

Also during 2007, the Laboratory sent notification to NMED on the closure of the TA-21 steam plant. The steam plant was officially closed on September 28, 2007 and is being prepared for decontamination and decommissioning. The three boilers located at this facility were last operated in June of 2007.

The construction and air quality emissions testing of the combustion turbine generator, located at the TA-3 power plant, was also completed during the year. The turbine, which will provide emergency back-up power and power during periods of high demand, started operation on September 23, 2007. An emissions test was performed on October 5, 2007, with results showing emissions well below permit limits. The turbine was included in the LANL operating permit in 2006 under modification P100M1.

According to the terms and conditions of New Source Review air quality permit 2195-P, LANL completed start-up of three electrical generators located at TA-33. These generators will supply power for various projects at the TA-33 site. The generators consist of two 20 kW portable diesel generators and one 225 kW portable diesel generator. All three generators were started on October 15, 2007. An air quality emission test was performed on the 225 kW generator on December 4, 2007, with results showing emissions well below permit limits.

The initial LANL operating permit, P100, was issued on April 30, 2004. This permit is effective for five years and will expire on April 29, 2009. LANL will submit an application 12 months prior to the date of expiration, as required by 20.2.70.300 NMAC. The preparation of the permit revision application started in 2007 and will continue until it is submitted in April 2008.

2. Compliance Summary

Under the Title V Operating Permit program, LANL is a major source, based on the potential to emit nitrogen oxides (NO_x), carbon monoxide (CO), and volatile organic compounds (VOCs). In 2006, the TA-3 steam plant and boilers located across the Laboratory were the major contributors of NO_x, CO, and particulate matter (PM). R&D activities were responsible for most of the VOC and hazardous air pollutant emissions. Table 2-6 summarizes these data.

Table 2-6
Calculated Actual Emissions for Regulated Pollutants Reported to NMED
for Operating Permit Compliance 2007

| Emission Units | Pollutants ^a , tons | | | | | |
|--|--------------------------------|-----------------|------------|-------------|-------------|------------|
| | NO _x | SO _x | PM | CO | VOC | HAPs |
| Asphalt Plant | 0.03 | 0.005 | 0.01 | 0.4 | 0.008 | 0.008 |
| TA-21 Steam Plant | 1.5 | 0.02 | 0.1 | 1.3 | 0.08 | 0.03 |
| TA-3 Steam Plant | 17.8 | 0.3 | 2.3 | 12.3 | 1.7 | 0.6 |
| Regulated Boilers | 5.1 | 0.03 | 0.5 | 3.6 | 0.3 | 0.1 |
| R&D Chemical Use | NA | NA | NA | NA | 10.1 | 4.8 |
| Degreaser | NA | NA | NA | NA | 0.01 | 0.01 |
| Data Disintegrator | NA | NA | 0.4 | NA | NA | NA |
| Carpenter Shops | NA | NA | 1.1 | NA | NA | NA |
| Storage Tanks | NA | NA | NA | NA | 0.007 | NA |
| Stationary Standby Generators ^b | 18.4 | 4.1 | 0.9 | 4.1 | 0.9 | 0.005 |
| Miscellaneous Small Boilers ^b | 19.2 | 0.1 | 1.5 | 16.1 | 1.1 | 0.4 |
| TA-33 Generator | 0.09 | 0.01 | 0.003 | 0.07 | 0.002 | < 0.001 |
| TOTAL | 62.1 | 4.6 | 6.8 | 37.9 | 14.3 | 6.0 |

^a NO_x = nitrogen oxides. SO_x = Sulfur oxides. PM = particulate matter. CO = carbon monoxide. VOC = volatile organic compounds. HAPs = hazardous air pollutants.

^b Emissions from these source categories were reported for the first time in 2004, as required by the Title V Operating Permit. Emissions units in these categories are exempt from construction permitting and annual emission inventory reporting requirements and are not included in Figure 2-1.

LANL staff calculates air emissions using emission factors from source tests, manufacturer's data, and EPA documentation. Calculated emissions are based on actual production rates, fuel usage, and/or material throughput. To satisfy requirements set forth in Title 20 of NMAC, Chapter 2, Part 73, Notice of Intent and Emissions Inventory Requirements (20.2.73 NMAC) and the Title V Operating Permit, LANL submits an annual Emissions Inventory Report and semi-annual Emissions Reports, respectively, to NMED. Figure 2-1 depicts a five-year history of criteria pollutant emissions. Emissions from 2004 to present are very similar and remain relatively constant following a sharp emissions decline from 2003 emissions.



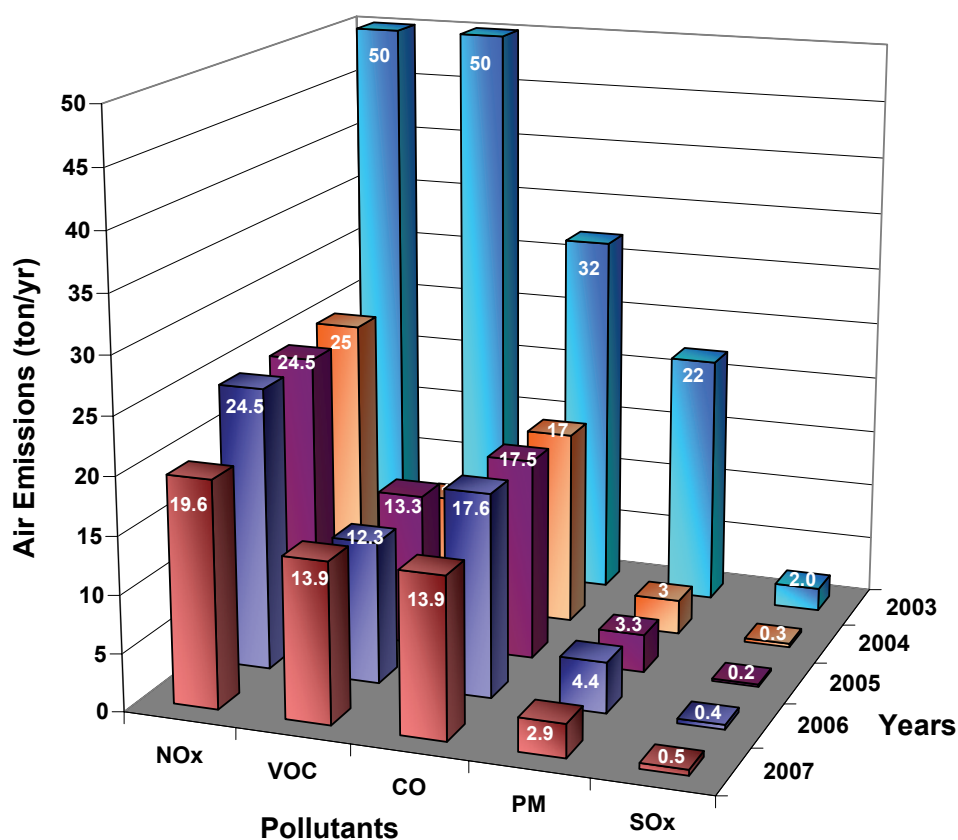


Figure 2-1. LANL criteria pollutant emissions from 2003 to 2007 for emissions inventory reporting.

a. New Mexico Air Quality Control Act

i. Permits

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. During 2007, the Laboratory performed approximately 149 air quality reviews. Also during 2007, LANL received an NSR air quality permit for three generators to be used at TA-33. No NSR permit applications were submitted in 2007. As previously mentioned above, an administrative permit revision was requested and received during 2007, which retired beryllium operations at the CMR Facility at Technical Area TA-3-29. This provided LANL with the new operating permit number P100M2. LANL submitted eight exemption notifications to NMED. The exemptions were primarily for small boilers and small generators. LANL currently operates under the air permits listed in Table 2-1.

ii. Open Burning

LANL may perform open burning under 20.2.60 NMAC (Open Burning) or 20.2.65 NMAC (Smoke Management) to thin vegetation and reduce the threat of fire. LANL did not perform any open burning during 2007.

iii. Asbestos

The National Emission Standard for Hazardous Air Pollutants (NESHAP) for Asbestos requires that LANL provide advance notice to NMED for large renovation jobs that involve asbestos and for 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. Major activities in 2007 included 16 large renovation jobs and demolition projects of which NMED received advance notice. These projects, combined with other smaller activities, generated 310.11 m³ of asbestos waste. All asbestos wastes were properly packaged and disposed of at approved landfills.

To ensure compliance, the Laboratory conducted internal inspections of job sites and asbestos packaging approximately monthly.

b. Federal Clean Air Act

i. Ozone-Depleting Substances

Title VI of the CAA contains specific sections that establish regulations and requirements for ozone-depleting substances (ODS), such as halons and refrigerants. The main sections applicable to the Laboratory prohibit individuals from knowingly venting or otherwise releasing into the environment any refrigerant or refrigerant substitute during maintenance, repair, service, or disposal of halon fire-suppression systems and air-conditioning or refrigeration equipment. All technicians who work on refrigerant systems must be EPA-certified and must use certified recovery equipment. The Laboratory is required to maintain records on all work that involves refrigerants and the purchase, usage, and disposal of refrigerants. The Laboratory's standards for refrigeration work are covered under Criterion 408, "EPA Compliance for Refrigeration Equipment," of the LANL Operations and Maintenance Manual.

The Laboratory continued to work at eliminating the use of Class 1 ODS. In 2007, the Laboratory removed approximately 2,500 pounds of Class 1 ODS from active inventory.

ii. Radionuclides

Under Rad-NESHAP, the EPA limits to 10 mrem/yr the effective dose equivalent of radioactive airborne releases from a DOE facility, such as LANL, to any member of the public. The 2007 dose to the maximally exposed individual (MEI) (as calculated using EPA-approved methods) was 0.52 mrem. The location of the highest dose was along DP Road in eastern Los Alamos. Site preparation activities at Materials Disposal Area B on DP Road contributed about half of this dose; the remainder came from Laboratory stack emissions.

7. Clean Water Act

a. NPDES Industrial Point Source Outfall Self-Monitoring Program

The primary goal of the CWA is to restore and maintain the chemical, physical, and biological integrity of the nation's waters. The act established the requirements for NPDES permits for point-source effluent discharges to the nation's waters. The NPDES outfall permit establishes specific chemical, physical, and biological criteria that the Laboratory's effluent must meet before it is discharged.

From January 1 through May 31, 2007, LANS and the DOE/National Nuclear Security Administration (NNSA) were co-permittees of the NPDES permit covering Laboratory operations. EPA Region 6 in Dallas, Texas, issues and enforces the permit. NMED certifies the EPA-issued permit and performs some compliance-evaluation inspections and monitoring for the EPA. From January 1 through July 31, 2007, the Laboratory's industrial point-source NPDES permit contained 21 permitted outfalls that include one sanitary outfall and 20 industrial outfalls. In July 2007, EPA Region 6 issued the final NPDES point source outfall permit with an effective date of August 1, 2007. This new permit contains 15 permitted outfalls that include one sanitary outfall and 14 industrial outfalls (Table 2-7). In order to meet the requirements in the new permit, the Laboratory initiated a feasibility study to eliminate outfalls and to add additional treatment technologies. To view the Laboratory's NPDES permit, go online to <http://www.lanl.gov/environment/h2o/permits.shtml>.

Table 2-7
Volume of Effluent Discharge from NPDES Permitted Outfalls in 2007

| Outfall Number | TA-bldg | Description | Watershed (Canyon) | 2007 Discharge (gal.) |
|---------------------|------------------|---|--------------------|-----------------------|
| 02A129 | 21-357 | TA-21 Steam Plant | Los Alamos | 17,741,700 |
| 03A047 ^a | 53- ^b | LANSCE Cooling Tower | Los Alamos | 0 |
| 03A048 | 53-963/978 | LANSCE Cooling Tower | Los Alamos | 14,798,050 |
| 03A049 ^a | 53- ^b | LANSCE Cooling Tower | Los Alamos | 0 |
| 03A158 ^a | 21-209 | TA-21 Cooling Tower | Los Alamos | 392,375 |
| 051 | 50-1 | TA-50 Radioactive Liquid Waste Treatment Facility | Mortandad | 1,210,466 |
| 03A021 | 3-29 | CMR Building Air Washers | Mortandad | 599,378 |
| 03A022 | 3-2238 | Sigma Cooling Tower | Mortandad | 1,477,924 |
| 03A160 | 35-124 | National High Magnetic Field Laboratory Cooling Tower | Mortandad | 19,767,226 |
| 03A181 | 55-6 | Plutonium Facility Cooling Tower | Mortandad | 2,247,895 |
| 13S | 46-347 | Sanitary Wastewater Treatment Plant | Sandia | 89,354,000 |
| 001 | 3-22 | Power Plant | Sandia | 3,311,398 |
| 03A024 ^a | 3-187 | Sigma Press Cooling Tower | Sandia | 0 |
| 03A027 | 3-2327 | Strategic Computing Complex Cooling Tower | Sandia | 11,102,489 |
| 03A113 | 53-293/952 | LANSCE Cooling Tower | Sandia | 303,365 |
| 03A199 | 3-1837 | Laboratory Data Communications Center | Sandia | 15,067,339 |
| 03A028 ^a | 15-202 | PERMEX Cooling Tower | Water | 0 |
| 03A130 | 11-30 | TA-11 Cooling Tower | Water | 1,573 |
| 03A185 | 15-312 | DARHT Cooling Tower | Water | 845,207 |
| 05A055 | 16-1508 | High Explosives Wastewater Treatment Facility | Water | 8,799 |
| 05A097 ^a | 11-52 | TA-11 Drop Pad/HE Testing | Water | 0 |
| 2007 Total: | | | | 178,229,184 |

^a Not included in permit effective August 1, 2007

^b Structure removed

The Laboratory's new NPDES outfall permit requires weekly, monthly, and quarterly sampling to demonstrate compliance with effluent quality limits. The Laboratory reports analytical results to EPA and NMED at the end of the monitoring period for each respective outfall category. During 2007, none of the 130 samples collected from the SWWS Plant's outfall exceeded effluent limits; however, three of the 1408 samples collected from industrial outfalls exceeded effluent limits (see discussion below). Monitoring data obtained from sampling at NPDES permitted outfalls are in data supplement [Table S2-1](#) (on included compact disc) and available online at <http://wqdbworld.lanl.gov/>.

The following is a summary of the Laboratory's corrective actions taken by the Laboratory during 2007 to address the NPDES outfall permit noncompliance cited above.

- **TA-53 Los Alamos Neutron Science Center (LANSCE) Outfall 03A048.** On June 13, 2007, at 11:36 a.m., a total residual chlorine concentration of 510 µg/L exceeded the NPDES daily maximum limit of 11 µg/L in NPDES Permit NM0028355. The discharge was immediately halted, all systems were checked by facility personnel, and all systems were found to be operating correctly. A second compliance sample collected at 12:05 p.m. showed no chlorine detected.

- **TA-3 Strategic Computing Complex Outfall 03A027.** On August 1, 2007, a total residual chlorine concentration of 150 µg/L exceeded the NPDES daily maximum limit of 11 µg/L in NPDES Permit NM0028355. The pump that injects chlorine neutralizer into the discharge lost power due to a tripped ground fault circuit interrupter. The device was reset and operational samples showed no chlorine in the blowdown. Administrative controls were implemented to improve detection of system breakdowns.
- **TA-3 Laboratory Data Communications Center.** On August 29, 2007, a total residual chlorine concentration of 390 µg/L exceeded the NPDES daily maximum limit of 11 µg/L in NPDES Permit NM0028355. A closed pinch valve on the blowdown line was leaking, allowing treated cooling tower water into the effluent pipe without being dechlorinated. The internal rubber sleeve of the valve was replaced on August 29, 2007, and the system was again operating properly.

b. NPDES Sanitary Sewage Sludge Management Program

The Laboratory's TA-46 SWWS Plant is an extended-aeration, activated-sludge sanitary wastewater treatment plant. The activated-sludge treatment process requires periodic disposing of excess sludge (waste-activated sludge) from the plant's clarifiers to synthetically lined drying beds. After air-drying for a minimum of 90 days to reduce pathogens, the dry sludge is characterized and disposed of as a New Mexico Special Waste. Monitoring data obtained from routine characterization of SWWS Plant sludge is available online at <http://wqdbworld.lanl.gov/>. During 2007, the SWWS Plant generated approximately 24 dry tons (48,033 dry lb) of sewage sludge. All of this sludge was disposed of as a New Mexico Special Waste at a landfill authorized to accept this material.

c. NPDES Industrial Point Source Permit Compliance Evaluation Inspection

There were no Compliance Evaluation Inspections performed in 2007.

d. NPDES Storm water Construction Permit Program

The NPDES Construction General Permit (CGP) Program regulates storm water discharges from construction activities disturbing one or more acres, including those construction activities that are part of a larger common plan of development collectively disturbing one or more acres.

LANL and the general contractor apply individually for NPDES CGP coverage and both are permittees at most construction-sites. Compliance with the NPDES CGP includes the development and implementation of a Storm water Pollution Prevention Plan (SWPPP) before soil disturbance can begin and site inspections once soil disturbance has commenced. A SWPPP describes the project activities, site conditions, best management practices (BMPs), and permanent control measures required for reducing pollution in storm water discharges and protecting endangered or threatened species and critical habitat. Compliance with the NPDES CGP is demonstrated through periodic inspections that document the condition of the site and also identify corrective actions required to keep pollutants from moving off the construction-site. Data collected from these inspections is tabulated weekly, monthly, and annually in the form of Site Inspection Compliance Reports.

During 2007, the Laboratory implemented and maintained as many as 53 construction-site SWPPPs and addendums to SWPPPs and performed 544 storm water inspections. The Laboratory uses a geographic information system to manage project information and generate status reports that facilitate reporting under the Director's Portfolio Reviews. The overall CGP compliance record in 2007 was 99% for all inspections compared to 94% in 2006. During the summer months, when most high-intensity precipitation events occur, 275 out of 276 inspections were compliant. At the end of 2007, 100% of the Laboratory's permitted sites were in compliance with the CGP.

The LANL storm water team continued to develop new methods to improve storm water compliance. Improvements were made in precipitation measurement by increasing the number of precipitation stations and by creating subsequent “Thiessen Polygons” that overlay the Pajarito Plateau and associate individual construction projects with specific precipitation stations. Because storm water inspections are triggered by precipitation amounts, using more accurate and site-specific precipitation data result in a more strategic and compliant inspection program.

To further reduce future CGP non-compliances and to increase awareness of CGP requirements, the storm water team revised subcontractor document language and briefed subcontractors on CGP requirements at pre-bid and pre-construction meetings. Storm water requirements were included in subcontract requirements so all bidders are provided project specific environmental requirements to assist pre-planning for storm water requirements. Presentations were also given to Subcontractor Technical Representatives (STR) and work planners to increase awareness on CGP requirements. A standing weekly meeting was instituted with LANL Project Management Division personnel to review the storm water compliance status of projects.

e. NPDES Industrial Storm water Program

The NPDES Industrial Storm water Permit Program regulates storm water discharges from identified regulated industrial activities (including SWMUs) and their associated facilities. These activities include metal fabrication; hazardous waste treatment, storage, and disposal; landfill operations; vehicle and equipment maintenance; recycling activities; electricity generation; warehousing activities; and asphalt manufacturing.

UC and the DOE were co-permittees under the EPA 2000 NPDES Storm water Multi-Sector General Permit for Industrial Activities (MSGP-2000). MSGP-2000 expired October 30, 2005, without EPA issuing a new permit. Administrative continuance of the MSGP-2000, which requires continued compliance with the expired permit requirements, was granted to existing permit holders. This continuance will remain in effect until a new permit is issued. There is currently no identified date for issuance of a new permit.

On December 1, 2005, EPA issued a draft MSGP. Proposed changes to the permit include increased storm water monitoring requirements, changes in benchmark monitoring parameters, increased inspection frequencies, additional SWPPP content requirements, and increased requirements for BMP selection, implementation, and maintenance.

MSGP-2000 required the development and implementation of site-specific SWPPPs, which must include identification of potential pollutants and activities and the implementation of BMPs. Permit requirements also include the monitoring of storm water discharges from permitted sites. In 2007, LANL implemented and maintained 15 SWPPPs under the MSGP-2000 requirements, covering 26 facilities and site-wide SWMUs. Compliance with the MSGP-2000 requirements for these sites is achieved primarily by implementing the following:

- Identifying potential contaminants and activities that may impact surface water quality and identifying and providing structural and non-structural controls (BMPs) to limit the impact of those contaminants.
- Developing and implementing facility-specific SWPPPs.
- Monitoring storm water runoff at facility gauging stations for industrial sector-specific benchmark parameters and visually inspecting storm water runoff to assess color; odor; floating, settled, or suspended solids; foam; oil sheen; and other indicators of storm water pollution.

Several additional facilities met the requirements for a MSGP-2000 “No Exposure Certification,” which identified the facility as having a regulated industrial activity but did not require permit authorization for its storm water discharges due to the existence of a condition of no exposure. Such facilities were not covered under or subject to the requirements of a SWPPP.

f. Federal Facility Compliance Agreement/ Administrative Order

On February 3, 2005, DOE entered into a compliance agreement with EPA to protect surface water quality at the Laboratory through a Federal Facilities Compliance Agreement. The FFCA establishes a compliance program for the regulation of storm water discharges from SWMUs and AOCs until such time as those sources are regulated by an individual storm water permit pursuant to the NPDES Permit Program. Certain SWMUs and AOCs (collectively, Sites) are covered by this agreement. On March 30, 2005, EPA issued an Administrative Order (AO) to the Laboratory that coincides with the FFCA.

The FFCA/AO establishes a schedule for monitoring and reporting requirements and requires the Laboratory to minimize erosion and the transport of pollutants or contaminants from Sites in storm water runoff. The Laboratory also complies with the requirements of the Multi-Sector General Permit (MSGP).

The FFCA/AO requires two types of monitoring at specified sites, pursuant to two monitoring management plans, including: 1) watershed sampling at approximately 60 automated gauging stations at various locations within the canyons pursuant to a Storm water Monitoring Plan (SWMP), and 2) site-specific sampling at approximately 294 sites, on a rotating basis pursuant to a SWMU SWPPP over a four-year period. The purpose of storm water monitoring is to determine if there is a release or transport of contaminants into surface water that could cause or contribute to an exceedance of applicable surface water quality standards. If a release or transport occurs, it may be necessary to implement BMPs to reduce erosion or to re-examine, repair, or modify existing BMPs to reduce erosion. The SWMU/SWPPP must also describe an erosion control program to control and limit contamination migration and transport from sites and to monitor the effectiveness of controls at the sites.

In 2007, the Laboratory completed the following tasks:

1. Submitted the annual modification of the SWPPP for SWMU/AOCs that describes watershed-scale monitoring, site-specific monitoring, and the erosion control program at SWMU/AOCs;
2. Continued negotiations with EPA and NMED on the development of an individual permit for storm water discharges from SWMUs;
3. Submitted all monthly water screening action level exceedance reports and quarterly status reports required by the FFCA on schedule;
4. Completed the following fieldwork:
 - ▣ Installed 38 new site-specific samplers to bring the total to 122;
 - ▣ Collected 538 storm water samples at site-specific locations;
 - ▣ Collected 213 storm water samples at gage locations;
 - ▣ Conducted 1193 inspections at 279 sites;
 - ▣ Completed maintenance of BMPs at all FFCA sites;
 - ▣ Completed 290 Annual Comprehensive Site Compliance Evaluation inspections.

The Annual Comprehensive Site Compliance Evaluation inspections were conducted by qualified personnel as required under the MSGP to assess the presence of existing industrial materials, leaks and spills, off-site tracking of sediment, tracking/blowing of industrial materials, and evidence of pollutants entering into receiving waters. The annual inspections also included an evaluation of the existing structural BMPs at each site.

The Laboratory provided supplemental information submittals in support of the Individual Permit application for storm water discharges from certain SWMUs/AOCs. A draft permit is expected to be issued by EPA in early 2008 for public comment.

g. Aboveground Storage Tank Compliance Program

The Laboratory's Aboveground Storage Tank (AST) Compliance Program is responsible for ensuring compliance with the requirements established by EPA (CWA, 40 CFR, Part 112) and NMED Petroleum Storage Tank Bureau (PSTB) Regulations (20.5 NMAC). During 2007, the Laboratory was in full compliance with both EPA and NMED requirements.

Spill Prevention Control and Countermeasures (SPCC) Plans fulfill the federal requirements for the AST Compliance Program, as required by the CWA (40 CFR, Part 112, Oil Pollution Prevention Regulations). Comprehensive SPCC Plans are developed to meet EPA requirements that regulate water pollution from oil spills.

EPA proposed additional extensions to compliance deadlines for meeting new regulatory requirements under the federal Clean Water Act (40 CFR, Part 112). Proposed new regulations will require the Laboratory to modify and implement its SPCC Plans by July 1, 2009. The primary modifications address AST storage capacity, inspection frequency, integrity testing requirements, and equipment. The Laboratory continued the process of completing all modifications to existing and new SPCC Plans and implementing those modifications.

The Laboratory maintained and operated 27 ASTs in compliance with 20.5 NMAC of the NMED-PSTB Regulations. In July 2007, the Laboratory paid annual AST registration fees of \$100 per AST.

During 2007, four removed and decommissioned ASTs from TA-53 (LANSCE) and three from TA-3-316 were closed out with NMED-PSTB pursuant to 20.5 NMAC.

On February 21, 2002, the Laboratory notified EPA, NMED, and the National Response Center of a discharge of approximately 48,000 gallons of diesel fuel into the environment from a tank at TA-21-57. Soil removal and sampling were performed in accordance with Laboratory, state, and federal regulatory requirements to determine the extent of the leak. The Laboratory completed characterization of the release in December 2003 and is continuing to work with NMED on a path forward for mitigation efforts. In 2007, the Laboratory continued efforts to implement a Sampling and Analysis Plan to conduct additional characterization of the TA-21-57 diesel release site to further evaluate subsurface diesel contamination. Additional characterization will provide information needed for establishing current conditions for the subsurface diesel contamination. Upon evaluation of additional characterization, the Laboratory intends to develop applicable processes for site mitigation or monitoring.

On April 3, 2003, the Laboratory notified NMED of the discovery of diesel-contaminated soil near the TA-3 Power Plant AST (TA-3-26). The Laboratory completed initial characterization of the diesel-contaminated soil in April 2004 and is continuing to work with NMED on a path forward for additional characterization and mitigation efforts. In 2007, the Laboratory completed characterization work at TA-3-26. The Laboratory plans to implement the Tier 1 Evaluation in 2008 pursuant to 20.5 NMAC of NMED-PSTB Regulations to evaluate the need for mitigation.

h. Dredge and Fill Permit Program

Section 404 of the CWA requires the Laboratory to obtain permits from the US Army Corps of Engineers to perform work within perennial, intermittent, or ephemeral watercourses. Section 401 of the CWA requires states to certify that Section 404 permits issued by the Corps 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 may include additional permit requirements to meet state stream standards for individual Laboratory projects. In addition, the Laboratory must comply with 10 CFR 1022, which specifies how DOE sites comply with Executive Order 11988, Floodplain Management, and Executive Order 11990, Protection of Wetlands.

2. Compliance Summary

During 2007, no Section 404/401 permits were issued to the Laboratory.

In addition, LANL reviewed 622 excavation permits and 47 project profiles for potential impacts to watercourses, floodplains, or wetlands. No Floodplain/Wetland Assessments were prepared in 2007. No violations of the DOE Floodplains/Wetlands Environmental Review Requirements were recorded. NMED and the Corps of Engineers did not inspect any sites permitted under the Section 404/401 regulations during 2007.

8. Safe Drinking Water Act

Los Alamos County, as owner and operator of the Los Alamos water supply system, is responsible for compliance with the requirements of the federal Safe Drinking Water Act (SDWA) and the New Mexico Drinking Water Regulations (NMEIB 2007). The SDWA requires Los Alamos County to collect samples from various points in the water distribution systems at the Laboratory, Los Alamos County, and Bandelier National Monument to demonstrate compliance with SDWA maximum contaminant levels (MCLs). EPA has established MCLs for microbiological organisms, organic and inorganic constituents, and radioactivity in drinking water. The State has adopted these standards in the New Mexico Drinking Water Regulations. EPA has authorized NMED to administer and enforce federal drinking water regulations and standards in New Mexico. Information on the quality of the drinking water from the Los Alamos County water supply system is in the County's annual Consumer Confidence Report, available online at: <http://www.losalamosnm.us/>.

In 2007, the Laboratory conducted additional confirmation monitoring of the Los Alamos County water supply system for quality assurance purposes. Chapter 5 presents these data.

9. Groundwater

a. Groundwater Protection Compliance Issues

Under requirements of DOE Order 450.1 the Laboratory prepared a groundwater protection management plan to protect groundwater resources in and around the Los Alamos area and ensure that all groundwater-related activities comply with applicable federal and state regulations. The Consent Order requires the Laboratory to establish a groundwater monitoring system, conduct investigations to determine the nature and extent of contamination in the groundwater, and remediate the groundwater if necessary. Characterization wells in the intermediate and regional aquifers are shown in Figure 2-2.

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

In 2007, the Laboratory had one approved groundwater discharge plan (see Table 2-1) for the TA-46 SWWS Plant and two groundwater discharge plans pending NMED approval for the TA-50 Radioactive Liquid Waste Treatment Facility (RLWTF) and the Laboratory's 21 domestic septic systems. On August 27, 2002, the Laboratory submitted a renewal application for the SWWS Plant groundwater discharge plan; NMED approval was pending at the end of 2007. On August 20, 1996, the Laboratory submitted a groundwater discharge plan application for the RLWTF at TA-50. On April 27, 2006, the Laboratory submitted a groundwater discharge plan application for the discharge of domestic wastewater from 21 domestic septic systems. Approval of these two discharge plan applications were still pending at the end of 2007.



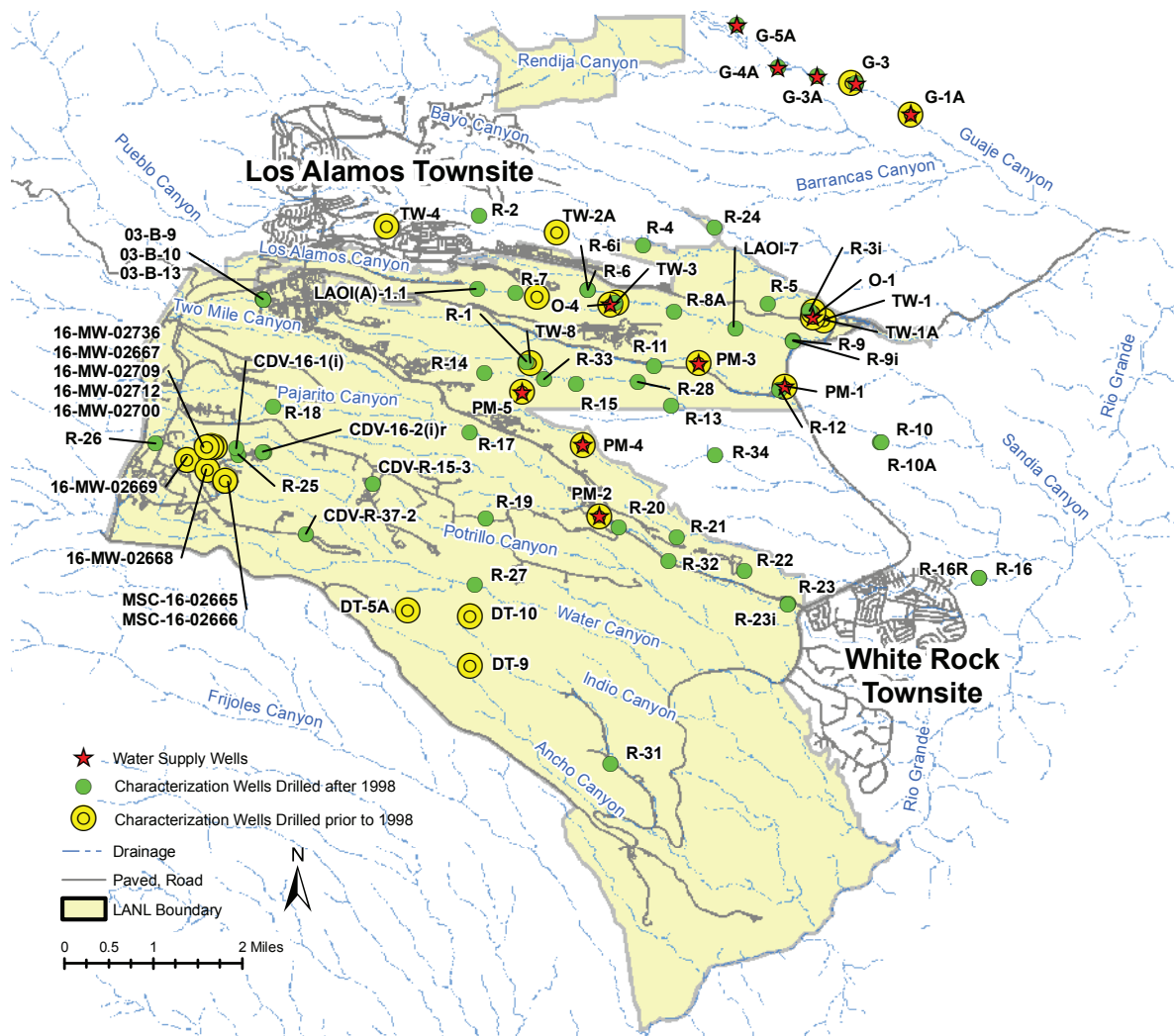


Figure 2-2. Intermediate-perched and regional aquifer characterization wells at and near LANL.

b. Compliance Activities

The Laboratory performed most groundwater compliance work in 2007 pursuant to the Consent Order. These activities included groundwater monitoring, groundwater investigations, and groundwater well construction.

Sample analytical, water-level, well construction, and other groundwater data can be reviewed online on the Laboratory's Water Quality Database website, <http://wqdbworld.lanl.gov/>. Periodic monitoring reports can be found on the Laboratory's Environment website, <http://www.lanl.gov/environment/h2o/reports.shtml>.

In 2007, LANL installed two regional monitoring wells (Table 2-8) in Sandia Canyon as part of the Interim Measures Work Plan for Chromium Contamination in Groundwater (LANL 2006). Wells R-35a and R-35b were installed adjacent to municipal supply well PM-3 and downgradient of monitoring well R-28 where elevated chromium levels are present. Well R-35a is screened at the same elevation as the top of the screen louvers at PM-3. Well R-35b is screened near the top of the regional aquifer. Together, this well pair is designed to act as an early warning monitoring point for the potential migration of chromium detected at monitoring well R-28 located in Mortandad Canyon to the south.

Table 2-8
Wells and Boreholes Installed in 2007

| Type ^a | Identifier | Watershed (Canyon) | Total depth (ft bgs) | Screened interval (ft bgs) | Water level (ft bgs) | Comments |
|-------------------|------------|--------------------|----------------------|----------------------------|----------------------|---|
| R | R-35a | Sandia | 1086.2 | 1013.1–1062.2 | 792.1 | Lower Sandia Canyon, immediately southwest of municipal supply well PM-3. |
| R | R-35b | Sandia | 872.2 | 825.4–848.5 | 786.9 | Lower Sandia Canyon, immediately southwest of municipal supply well PM-3. |

^a R = regional aquifer well

10. National Environmental Policy Act

The intent of the National Environmental Policy Act (NEPA) (42 U.S.C. 4331 et seq.) is to promote productive harmony between humans and the environment. Federal agencies such as DOE/NNSA must consider the environmental impacts of proposed projects and ensure public participation as part of the decision-making process. The Laboratory's Risk Reduction Office devotes considerable resources to assist NNSA in compliance with the NEPA, pursuant to DOE Order 451.1B. Proposed projects and actions at LANL are reviewed to determine if there are resource impacts, and the appropriate coverage under NEPA, and these recommendations are provided to NNSA. The NEPA analysis in the new LANL Site-Wide Environmental Impact Statement (SWEIS) was prepared in 2007.

DOE NEPA implementing regulations (10 CFR Part 1021.330[d]) require a SWEIS to be reviewed at least every five years and a Supplemental Analysis performed to examine whether the SWEIS still adequately covers site operations. The local DOE site office produced a Supplement Analysis in September 2004 that was reviewed by DOE headquarters. In October 2004, DOE headquarters made the decision to expand the Supplement Analysis to a Supplemental SWEIS. In April 2005, DOE headquarters decided to convert the Supplemental SWEIS to a full SWEIS and consider three alternatives for future operations at LANL. The new SWEIS, issued in May 2008, considers operations for a period of five years, 2008–2012. NNSA considered comments received during the scoping period (January 19 to February 17, 2005) and during the public comment period on the Draft SWEIS (July 7 to September 20, 2006). Public hearings on the Draft SWEIS were held in Los Alamos, Española, and Santa Fe, New Mexico. Comments on the Draft SWEIS were requested during a period of 75 days following publication of the EPA's Notice of Availability in the Federal Register. The three SWEIS alternatives considered are as follows:

- **The No Action Alternative:** This alternative would continue operations at current levels. This alternative considers the levels of operation covered in the 1999 SWEIS Record of Decision Expanded Operations Alternative. This alternative would include updates on the operations of the 15 Key Facilities defined in the 1999 SWEIS to anticipate operational levels over the next five years and consideration of new facilities proposed for construction over this period.
- **The Expanded Operations Alternative:** This alternative would include the No Action Alternative plus new or enhanced facilities for ongoing operations. Actions would be implemented to upgrade or replace aging facilities and systems, improve security, and remediate obsolete buildings and contaminated lands. Selected operations would increase, including plutonium pit production.

- **The Reduced Operations Alternative:** This alternative would include operational reductions at certain facilities while enhancing some facilities for ongoing operations. The major changes considered in this alternative are the closing of LANSCE, stopping construction of the nuclear facility portion of the CMRR Facility, and reducing operations of approximately 20% for Dual-Axis Radiographic Hydrodynamic Test (DARHT) and reducing firing site operations by 20%.

The three alternatives were analyzed and the Expanded Operations Alternative was selected as the preferred alternative. A Record of Decision on the new SWEIS is expected to be issued in late 2008.

11. Endangered Species Act

The Endangered Species Act requires federal agencies to protect populations and habitats of federally listed threatened or endangered species. The Laboratory contains potential habitat for two federally endangered species (Southwestern willow flycatcher, *Empidonax traillii extimus*, and black-footed ferret, *Mustela nigripes*), one federally threatened species (Mexican spotted owl, *Strix occidentalis lucida*), and two candidate species (yellow-billed cuckoo, *Coccyzus americanus*), and New Mexico meadow jumping mouse, *Zapus hudsonius luteus*). The Southwestern willow flycatcher, black-footed ferret, and New Mexico meadow jumping mouse have not been observed on Laboratory property. In addition, there are several federal species of concern and state-listed species potentially occurring within LANL (Table 2-9).

The Laboratory meets its requirements for threatened and endangered species protection through implementation of its Threatened and Endangered Species Habitat Management Plan and review of excavation permit requests and project profiles. During 2007, LANL reviewed 636 excavation permits and 107 project profiles for potential impacts to threatened or endangered species. The Laboratory conducted annual surveys for Mexican spotted owl, Southwestern willow flycatcher, Jemez Mountains salamander and grey vireo. During 2007, LANL prepared biological assessments for one project, CMRR Laydown Area, which required consultation with the US Fish and Wildlife Service regarding potential impacts on federally-listed threatened or endangered species.



Table 2-9
Threatened, Endangered, and Other Sensitive Species Occurring or Potentially Occurring at LANL

| Scientific Name | Common Name | Protected Status ^a | Potential to Occur ^b |
|---|---------------------------------|-------------------------------|---------------------------------|
| <i>Empidonax traillii extimus</i> | Southwestern Willow Flycatcher | E | Moderate |
| <i>Mustela nigripes</i> | Black-footed Ferret | E | Low |
| <i>Strix occidentalis lucida</i> | Mexican Spotted Owl | T | High |
| <i>Coccyzus americanus</i> | Yellow-billed Cuckoo | C | Moderate |
| <i>Zapus hudsonius luteus</i> | New Mexico meadow jumping mouse | C | Moderate |
| <i>Haliaeetus leucocephalus</i> | Bald Eagle | NMT, S1 | High |
| <i>Gila pandora</i> | Rio Grande Chub | NMS | Moderate |
| <i>Plethodon neomexicanus</i> | Jemez Mountains Salamander | NME, FSOC | High |
| <i>Falco peregrinus anatum</i> | American Peregrine Falcon | NMT, FSOC | High |
| <i>Falco peregrinus tundrius</i> | Arctic Peregrine Falcon | NMT, FSOC | Moderate |
| <i>Accipiter gentiles</i> | Northern Goshawk | NMS, FSOC | High |
| <i>Lanius ludovicianus</i> | Loggerhead Shrike | NMS | High |
| <i>Vireo vicinior</i> | Gray Vireo | NMT | Moderate |
| <i>Plegadis chihi</i> | White-faced Ibis | S1 | Moderate |
| <i>Myotis ciliolabrum melanorhinus</i> | Western Small-footed Myotis Bat | NMS | High |
| <i>Myotis volans interior</i> | Long-legged Bat | NMS | High |
| <i>Euderma maculatum</i> | Spotted Bat | NMT | High |
| <i>Plecotus townsendii pallescens</i> | Townsend's Pale Big-eared Bat | NMS, FSOC | High |
| <i>Nyctinomops macrotis</i> | Big Free-tailed Bat | NMS | High |
| <i>Myotis thysanodes thysanodes</i> | Fringed Bat | NMS | High |
| <i>Myotis yumanensis yumanensis</i> | Yuma Bat | NMS | High |
| <i>Myotis evotis evotis</i> | Long-eared Bat | NMS | High |
| <i>Bassariscus astutus</i> | Ringtail | NMS | High |
| <i>Vulpes vulpes</i> | Red Fox | NMS | Moderate |
| <i>Ochotona princeps nigrescens</i> | Goat Peak Pika | NMS, FSOC | Low |
| <i>Lilium philadelphicum var. andinum</i> | Wood Lily | NME | High |
| <i>Cypripedium calceolus var. pubescens</i> | Greater Yellow Lady's Slipper | NME | Moderate |
| <i>Speyeria Nokomis nitocris</i> | New Mexico Silverspot Butterfly | FSOC | Moderate |

^a E = Federal Endangered; T = Federal Threatened; C = Federal Candidate Species; NMS = New Mexico Sensitive Taxa (informal); S1 = Heritage New Mexico: Critically Imperiled in New Mexico; NMT = New Mexico Threatened; NME = New Mexico Endangered; FSOC = Federal Species of Concern.

^b Low = No known habitat exists on LANL; Moderate = Habitat exists, though the species has not been recorded recently; High = Habitat exists and the species occurs at LANL.

12. Migratory Bird Treaty Act

Under the provisions of the Migratory Bird Treaty Act, it is unlawful “by any means or manner to pursue, hunt, take, capture [or] kill” any migratory birds except as permitted by regulations issued by the US Fish and Wildlife Service. LANL biologists developed and published “Migratory Bird Best Management Practices Source Document, Version 0” during 2007 to document best management practices to mitigate impacts to migratory birds at LANL. LANL biologists also began self-reporting of bird electrocutions on power lines to US Fish and Wildlife Service.

13. Cultural Resources

The goal of the National Historic Preservation Act (NHPA) of 1990 is to have federal agencies act as responsible stewards of the nation's resources when their actions affect historic properties. NHPA Section 106 requires federal agencies to take into account the effects projects may have on historic properties and to allow for comment by the Advisory Council on Historic Preservation. Section 106 regulations outline a project review process conducted on a project-by-project basis.

In 2007, the Laboratory conducted 32 projects that required some field verification of previous survey information. Four new archaeological sites were identified in 2007; however, no new historic buildings were identified. Fifteen archaeological sites and zero historic buildings were determined eligible for the National Register of Historic Places.

The Laboratory began the sixth year of a multiyear program, which included archaeological excavation in support of the Land Conveyance and Transfer project. The DOE/NNSA is in the process of conveying to Los Alamos County approximately 2,000 acres of Laboratory lands. Thirty-nine archaeological sites were excavated during the 2002 to 2005 field seasons, with more than 200,000 artifacts and 2,000 samples collected. The artifacts are currently stored at LANL but will be transferred for curation to the Museum of New Mexico. Together, these sites provide new insights into past activities on the Pajarito Plateau from 5000 BC to AD 1943. From a compliance perspective, these excavations resolve the anticipated adverse effects to archaeological sites from the future development of lands to be acquired by Los Alamos County. These sites are also ancestral places to the Pueblo people and representatives from the pueblos of San Ildefonso and Santa Clara acted as tribal consultants and monitors on the project. During fiscal year 2007, all analyses were completed and nearly all of the report was written.

In support of LANL's decontamination and decommissioning program, square footage reduction, and laboratory consolidation activities during fiscal year 2007, the Laboratory conducted historic building assessments and other documentation work related to six proposed projects as required under the provisions of the NHPA. Buildings included in these projects are located at TAs-3, 11, 16, 36, and 37. This work included field visits to historic properties (including interior and exterior inspections), digital and archival photography, and architectural documentation (using standard LANL building recording forms). Additional documentation included the production of location maps for each of the evaluated projects. Historical research was also conducted using source materials from the LANL archives and records center, historical photography, the Laboratory's public reading room, and previously conducted oral interviews.

The long-term monitoring program at the ancestral pueblo of Nake'muu was completed in 2006 as part of the DARHT Facility Mitigation Action Plan (DOE 1996). Nake'muu is the only pueblo at LANL that still contains its original standing walls. During the nine-year monitoring program, the site has experienced a 0.9% displacement rate of chinking stones and 0.3% displacement of masonry blocks. Statistical analyses indicate these displacement rates are significantly correlated with annual snowfall, but not with annual rainfall or explosive tests at the DARHT facility.

Native American consultation is ongoing with respect to identifying and protecting traditional cultural properties, human remains, and sacred objects in compliance with the NHPA and Native American Graves Protection and Repatriation Act (NAGPRA). Work for the Land Conveyance and Transfer Project included consultation with the Pueblos of San Ildefonso and Santa Clara for project monitoring, the implementation of a NAGPRA intentional excavation agreement, identification of potential reburial locations, protection of Traditional Cultural Properties, and student internships. Other projects include completion of the management plans for the TA-3 University House Traditional Cultural Property, the TA-72 NAGPRA management area, and the Cerro Grande Rehabilitation Project.

C. UNPLANNED RELEASES

1. Air Releases

There was one unplanned air release during 2007:

- An opacity of 25% was observed at the TA-3 power plant on May 1, 2007. The visible emission observed was slightly above the limit of 20% stated in the permit. The duration of this visible emission was less than 10 minutes.

2. Water Releases

There were no unplanned releases of radioactive liquids in 2007. There were 18 unplanned releases of non-radioactive liquids in 2007:

- Approximately 5,000 gal. of fire suppression water into upper Sandia Canyon.
- Approximately 1,000 gal. of domestic wastewater onto the ground near TA-18.
- Approximately 100 gal. of domestic wastewater onto the ground near TA-49-113.
- Approximately 1 quart of motor oil into a storm drain system near TA-3-38.
- Approximately 100 gal. of domestic wastewater into a storm drain near TA-33-114.
- Approximately 30 gal. of concrete washout water into a storm drain near TA-3-39.
- Approximately 20 gal. of storm water onto a roadway from a waste storage container.
- Approximately 10,000 gal. of potable water into upper Mortandad Canyon.
- Over 20,000 gal. of potable water into Los Alamos Canyon and DP Canyon.
- Approximately 1,700 gal. of potable water into a storm water drainage system near TA-33-114.
- Approximately 2,200 gal. of fire suppression water into a storm water drainage system near TA-54-412.
- Approximately 500 gal. of fire suppression water into upper DP Canyon near TA-21-209.
- Over 4,000 gal. of potable water into Water Canyon.
- Approximately 2,000 gal. of steam condensate into a storm water drainage system near TA-3-39.
- Approximately 5,000 gal. of potable water into upper Sandia Canyon.
- Approximately 40 gal. of domestic wastewater onto the ground near TA-3-316.
- Approximately 6,750 gal. of potable water into upper Sandia Canyon.

The Laboratory investigated all unplanned releases of liquids as required by the NMWQCC Regulations 20.6.2.1203 NMAC. Upon cleanup, the NMED and the DOE Oversight Bureau inspected the unplanned release sites to ensure adequate cleanup. In 2007, the Laboratory was in the process of administratively closing out all releases for 2007 with the DOE Oversight Bureau and anticipates these unplanned release investigations will be closed out after final inspections.

D. REFERENCES

DOE 1996: "Dual-Axis Radiographic Hydrodynamic Test Facility Final Environmental Impact Statement Mitigation Action Plan," United States Department of Energy report USDOE/EIS-0228 (January 1996).

LANL 2006: "Interim Measures Work Plan for Chromium Contamination in Groundwater," Los Alamos National Laboratory document LA-UR-06-1961, Los Alamos, New Mexico. (LANL 2006, 091987) (March 2006).

NMEIB 2007: New Mexico Environmental Improvement Board, State of New Mexico, "Drinking Water Regulations" (as amended through April 2007), found at 20.7.10 NMAC.



3. Radiological and Non-Radiological Dose Assessment



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A. INTRODUCTION

This chapter presents the results of the calculation of doses to the public and biota from Laboratory operations in 2007 and reports whether the doses are below specified limits. This chapter also provides a measure of the significance of environmental radioactivity in the context of its importance to humans and biota. In this respect, the human dose assessment provides a different perspective from the biota dose assessment. The calculated human dose is received near the publicly accessible Laboratory boundaries, whereas the biota dose is potentially received throughout the interior of the Los Alamos National Laboratory (LANL or the Laboratory) property, usually at locations rarely visited by humans. In addition, the potential risks from nonradiological materials detected during 2007 and previous years' sampling activities are summarized.

As defined by US Department of Energy (DOE) Standard 1153-2002 (DOE 2002), biota are divided into plants and animals. Plants receive the highest dose because they live in one location. Most animals range over a wider area, which usually minimizes their dose. Humans receive the lowest dose because they limit their time in areas with residual contamination and do not typically eat the vegetation or drink the water in these areas. Therefore, locations with no significant human dose may have a higher biota dose.

B. HUMAN DOSE ASSESSMENT

1. Overview of Radiological Dose Equivalents

Radiological dose equivalents presented are calculated using standard methods specified in guidance documents (DOE 1988a, 1988b, 1991; EPA 1988, 1993, 1997, 1999; ICRP 1996; NRC 1977). The “effective dose equivalent,” referred to here as “dose,” is calculated using radiation weighting factors and tissue weighting factors to adjust for the various types of radiation and the various tissues in the body. The final result, measured in millirem (mrem), is a measure of the overall dose to an individual, whether from external radiation or contact with radioactive material. For example, 1 mrem of direct gamma radiation is effectively equivalent to 1 mrem from inhalation of plutonium.

Federal government standards limit the dose that the public may receive from Laboratory operations. The DOE public dose limit to any individual is 100 mrem/yr (DOE 1993) received from all pathways (i.e., all ways in which a person can be exposed to radiation, such as inhalation, ingestion, and direct radiation). Furthermore, doses to members of the public must be reduced to low levels consistent with a documented as low as reasonably achievable (ALARA) process and generally not exceeding a dose constraint of one-quarter of the primary dose limit, or 25 mrem/yr (DOE 1999). The dose received from airborne emissions of radionuclides is further restricted by the US Environmental Protection Agency (EPA) dose standard of 10 mrem/yr (EPA 1986), also known as the RAD-NESHAP (National Emission Standards for Hazardous Air Pollutants) dose limit.

These doses are in addition to exposures from natural background, consumer products, and medical sources. Doses from community drinking water supplies are limited in accordance with the Clean Water Act, either by established maximum contaminant levels (MCLs) for some radionuclides or by dose (4 mrem/yr for man-made radionuclides) (DOE 1993; EPA 2000).

2. Public Dose Calculations

a. Scope

The objective of our public dose calculations is to report incremental (above-background) doses caused by LANL operations. Therefore, we don't include dose contributions from radionuclides present in our natural environment or from radioactive fallout.

Annual radiation doses to the public are evaluated for three principal exposure pathways: inhalation, ingestion, and direct (or external) radiation. We calculate doses for the following cases:

1. The entire population within 80 km of the Laboratory
2. The maximally exposed individual (MEI) who is not on LANL property for the airborne pathway dose only and compared to the EPA RAD-NESHAP dose limit of 10 mrem/year
3. The MEI not on LANL property for the all-pathways dose and compared to the DOE Order 5400.5 dose limit of 100 mrem/year
4. Residents in Los Alamos and White Rock

b. General Considerations

We began with environmental measurements of air, water, soil, foodstuffs, sediment, and non-foodstuffs biota and convert these measurements to dose using the standard methods specified above.

As discussed in Section B.4, the dose rate from naturally occurring radioactivity is approximately 450 mrem/yr (additional man-made sources of radiation, such as medical/dental uses of radiation and building products such as stone walls, raise the total background dose to 500 mrem/yr on average). It is extremely difficult to measure doses from LANL less than 0.1% (one one-thousandth) of natural doses. As the dose rates become smaller, the estimates become less certain and less significant. Generally, we conclude that a dose rate less than 0.1 mrem/yr is essentially zero and cannot be distinguished from natural background radiation.

i. Direct Radiation Exposure

The Laboratory monitors direct radiation from gamma photons or neutrons at about 100 locations in and around LANL (Chapter 4, Section C). Direct radiation doses above natural background are measured near Technical Area (TA) -54, but elsewhere there are no other sources of external radiation to off-site areas.

To receive a measurable dose, a member of the public must be within a few hundred meters of the source of external radiation. At distances more than one kilometer, the decrease in radiation dose rate with increasing distance from the radiation source (inverse-square law), combined with scattering and attenuation or shielding in the air, reduces the dose to much less than 0.1 mrem/yr, which cannot be distinguished from natural background radiation. This means the only significant above-background doses from direct radiation are measured near TA-54 (Section B.3.c of this chapter).



To estimate the dose to the public near TA-54, we combined the measurements of gamma and neutron dose with an occupancy factor of 1/16 (NCRP 1976). The direct radiation measurements reported in Chapter 4 would apply to an individual who is at a particular location continuously (i.e., 24 hours/day and 365 days/yr). We followed standard guidance and assumed continuous occupancy for residences and places of business. For all other locations, we multiplied the measured dose by the 1/16 occupancy factor.

ii. Airborne Radioactivity (Inhalation Pathway)

At distances more than a few hundred meters from LANL sources, the dose to the public is almost entirely from airborne radioactive material. Whenever possible, we used the direct measurements of airborne radioactivity concentrations measured by the Ambient Air Sampling Network (AIRNET) and reported in Chapter 4, Section A. Where local concentrations are too small to measure, we calculated the doses using the CAP88 model (EPA 2007a), an atmospheric dispersion and dose calculation computer code that combines stack radionuclide emissions information with meteorological data to estimate where the released radioactive material went and the dose from that radioactive material. The estimation of dose for this chapter was performed using CAP88-PC Version 3.0 (EPA 2007a).

In particular, some of the radionuclide emissions from the Los Alamos Neutron Science Center (LANSCE) are not measured by AIRNET. These emissions are measured at the stacks (Chapter 4, Section B), and the resulting doses are calculated with CAP88. These doses decrease substantially with distance from the stack because the radioactive half-lives are short (mostly 20 minutes or less).

iii. Water (Ingestion Pathway)

The majority of radionuclides detected in groundwater samples collected from known or potential drinking water sources (i.e., Los Alamos County drinking water supply wells and natural springs) in 2007 resulted from the presence of natural radioactivity in these sources. These radionuclides include natural uranium and its decay products, such as radium-226. However, several radionuclides attributable to Laboratory operations were measured in samples from an on-site alluvial spring in upper Los Alamos Canyon (DP Spring), which is not a recognized drinking water source. Strontium-90 and tritium were measured in DP Spring samples at maximum concentrations of 62 pCi/L and 191 pCi/L, respectively. The maximum dose from ingesting one liter of water from this spring would be approximately 0.02 mrem. The highest concentration of tritium detected in a Los Alamos County drinking water supply well was 14 pCi/L in a sample collected from the Otowi-1 well located in Pueblo Canyon and is well within the range of tritium concentrations found in rain water (16 to 35 pCi/L) (Holloway 1993). This concentration is far below the EPA MCL of 20,000 pCi/L and would result in a dose of less than 0.001 mrem/yr if this water were to be ingested for an entire year (assumes 730 L ingested for the year). However, this well was not used by Los Alamos County as a drinking water source during 2007.

iv. Soil (Direct Exposure Pathway)

We reported measurements of radionuclide concentrations in surface soil in Chapter 7. As described in Chapter 7, Section C.1, soil samples were collected on the perimeter of the Laboratory and at regional and on-site locations. No regional samples had radionuclide concentrations above the Regional Statistical Reference Levels (RSRLs). RSRLs represent background radionuclide concentrations plus three standard deviations in media, such as soil, sediment, and crops, collected or harvested in regional areas far from the influence of the Laboratory averaged over a period of five years.



Soil concentrations measured in samples from previous years are above the RSRL at some perimeter locations. For example, plutonium-239/240 is above the RSRL at locations near TA-1 in the Los Alamos town site, near TA-21 along DP Road, and at TA-73 along State Route 502. In Chapter 7, Section D.2.b, new data are reported at the Laboratory boundary between TA-54 and the San Ildefonso sacred area. At this location, the plutonium-239/240 concentration was 0.2 pCi/g, which corresponds to a dose of 0.01 mrem/year.

In summary, we conclude that the LANL contribution to the dose from soil around the perimeter of the Laboratory is less than 0.1 mrem/yr, and the majority of the radionuclides detected are primarily due to world-wide fallout and historical operations at the Laboratory.

v. Food (Ingestion Pathway)

We report measurements of the radioactive content of foods, mostly crops, in Chapter 8. Most concentrations in crops were below the RSRLs and are consistent with results from previous years. For the few cases above the RSRL, the dose is much less than 0.1 mrem/year, which is very small relative to the all-pathways dose limit of 100 mrem/yr and the 25 mrem/yr dose constraint.

vi. Release of Items

The Laboratory releases miscellaneous surplus items of salvageable office and scientific equipment to the general public. The requirements for release of such items are found in LANL 2006a. All items destined for release from known or potentially contaminated areas are screened for radioactive contamination in accordance with procedures of LANL's Health Physics Operations Group. Any items with surface contamination or dose levels above the authorized release limits for uncontrolled use are not released to the public. Items from a known or potentially contaminated area that cannot be completely surveyed are also not released. The authorized release limits for items (LANL 2006a) are the limits in Figure IV-1 of DOE requirements (DOE 1993, DOE 1995). In 2007, no items were released to the public with contamination or dose levels approaching the authorized release limits. Therefore, the dose to the public from this pathway is negligible.

The transfer of real property (land) from DOE to the public is allowed if the modeled dose is no greater than 15 mrem/yr. In January of 2007, the transfer of Tract A8a (located south of MDA B and DP Road) to Los Alamos County was finalized. In addition to ensuring that the modeled dose was less than the authorized release limit of 15 mrem/yr, an ALARA (as low as reasonably achievable) dose optimization analysis was performed to determine if further remediation efforts were warranted from a cost-benefit perspective. The highest dose rate calculated for an individual residing on the land was estimated to be 4.1 mrem/yr (0.0041 rem/yr). This was a very conservative estimate, as the measured radionuclide concentrations used to perform the dose calculation were not background-corrected and were the maximum concentrations measured on the land tract. Assuming a dose integration period of 200 years and that 500 persons would reside on the tract at any one time, the collective dose was estimated to be 410 person-rem ($0.0041 \text{ rem/yr} \times 200 \text{ years} \times 500 \text{ persons} = 410 \text{ person-rem}$). Assuming \$2,000 as the nominal value recommended by DOE (DOE 1997) that should be spent to avert one person-rem, the total funds that should be spent to avert the collective dose of 410 person-rem were estimated to be \$820,000. The estimated cost of remediating the tract of land down to fallout background levels was approximately \$25 million. Because the projected cost of remediation far exceeds the funds that should be spent to avert the collective dose, the projected collective dose had been optimized and no further action was needed.

3. Dose Calculations and Results

a. Population within 80 Kilometers

We used the local population distribution to calculate the dose from 2007 Laboratory operations to the population within 80 km (50 miles) of LANL. Approximately 280,000 persons live within an 80-km radius of the Laboratory. We used county population estimates provided by the University of New Mexico Bureau of Business and Economic Research (available at <http://www.unm.edu/~bber/>).

The collective dose from Laboratory operations is the sum of the estimated doses for each member of the public within an 80-km radius of LANL. For example, if two persons each receive three mrem, the collective dose is six person-mrem. This dose results from airborne radioactive emissions. Other potential sources, such as direct radiation, are essentially zero. We calculated the collective dose by modeling the transport of radioactive air emissions using CAP88.

The 2007 collective population dose attributable to Laboratory operations to persons living within 80 km of the Laboratory was 0.36 person-rem, which is slightly lower than the dose of 0.6 person-rem reported for 2006. Tritium contributed 42% of the dose, and short-lived air activation products such as carbon-11 from LANSCE contributed 54% of the dose. The decrease in the 2006-2007 collective population dose compared to 2005 (2.46 person-rem) is primarily attributable to the repair of a leak at LANSCE in December 2005 and to an additional delay line installed at LANSCE in 2005. LANSCE has historically been the major contributor to the collective population dose. Collective population doses for the past 14 years have generally declined from a high of four person-rem in 1994 to less than one person-rem in 2007 (Figure 3-1). It is expected that future collective population doses will be less than one person-rem. No observable health effects in the local population are expected from this dose.

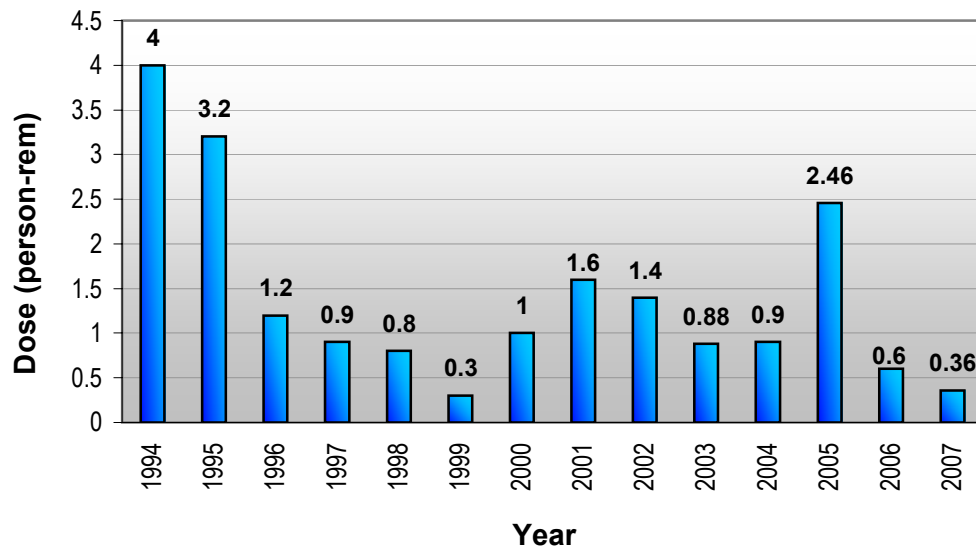


Figure 3-1. Annual collective dose (person-rem) to the population within 80 km of LANL.

b. Maximally Exposed Individual

The MEI is a hypothetical member of the public who, while not on DOE/LANL property, receives the greatest dose from LANL operations. For most of the past 14 years, the airborne pathway (RAD-NESHAP) MEI location has been at 2470 East Road, usually referred to as “East Gate.” East Gate has normally been the location of greatest exposure because of its proximity to LANSCE and the prevailing wind direction. During LANSCE operations, short-lived positron emitters, such as carbon-11, nitrogen-13, and oxygen-15, are released from the stacks and diffuse from the buildings. These emitters release photon radiation as they decay, producing a potential radiation dose.

i. Airborne Pathway (RAD-NESHAP) MEI Dose

We modeled the dose at East Gate from LANSCE and from the LANL stacks using CAP88. The CAP88-modeled doses (Stavert 2007) were 0.11 mrem/yr from LANSCE and 0.29 mrem/yr from other LANL stacks. We added 0.01 mrem/yr calculated from the airborne radionuclide concentrations measured at the East Gate AIRNET station, though this dose includes tritium, which was also in the CAP88 modeled doses (thus, tritium dose is conservatively included twice). Therefore, the total dose at East Gate was approximately 0.41 mrem/yr.

Because the LANSCE emissions for 2007 were reduced compared to previous years (Figure 3-2), the location of the 2007 MEI was not as readily apparent as in the past and required more detailed calculations, as described below.

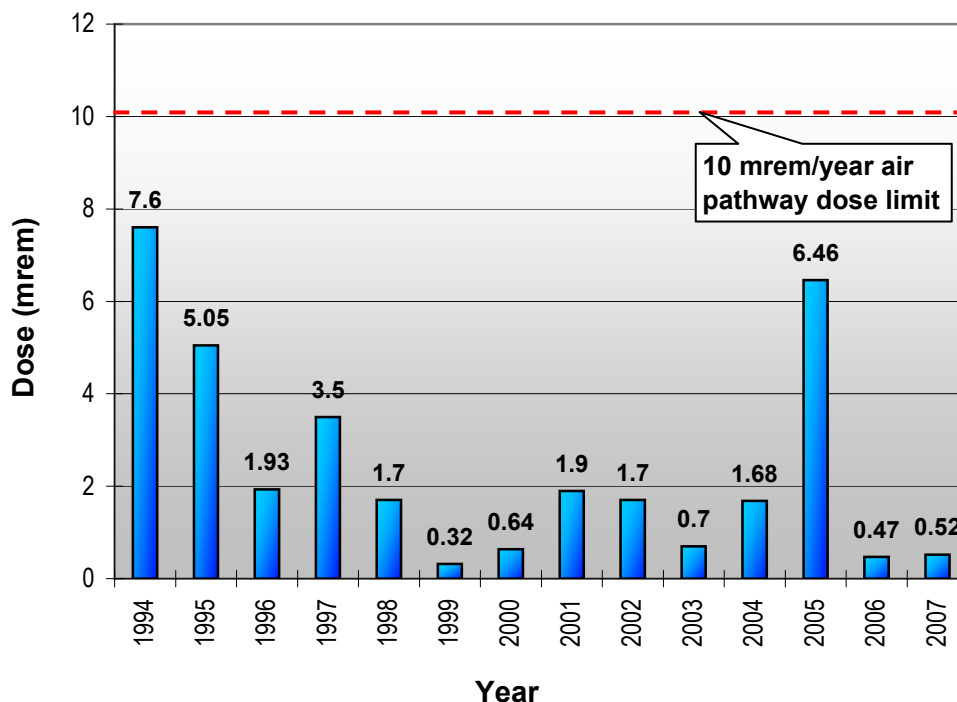


Figure 3-2. Annual airborne pathway (RAD-NESHAP) dose (mrem) to the maximally exposed individual off-site over the past 14 years.

To determine the RAD-NESHAP MEI location, we compared the dose at East Gate with doses at other locations. At AIRNET station #71 on DP Road (Figure 4-3 in Chapter 4) the LANSCE dose was 0.01 mrem/yr, the dose from other stacks was 0.29 mrem/yr, and the AIRNET dose was 0.22 mrem/yr, for a total of 0.52 mrem/yr, which is larger than the dose at East Gate. At 26 other locations, the AIRNET and LANSCE doses were smaller while the dose from other stacks was essentially the same, so the total dose was smaller than the dose measured at AIRNET station #71.

AIRNET station #71 is adjacent to Material Disposal Area B (MDA B), which is a Manhattan-Project-era waste disposal site being prepared for cleanup. The AIRNET dose was primarily the result of plutonium re-suspended during these preparations. There are two buildings adjacent to this AIRNET station, so to be conservative we are using the location of the station itself as the location of the MEI. Thus, the air-pathway MEI location in 2007 was AIRNET station #71 on DP Road with a total dose of 0.52 mrem/yr (Figure 3-2).

ii. All-Pathways MEI Dose

The location evaluated in 2007 as the potential all-pathways MEI is the Laboratory boundary near the Pueblo de San Ildefonso sacred area north of TA-54, Area G. Transuranic waste at Area G awaiting shipment to the Waste Isolation Pilot Plant (WIPP) emits neutrons. The measured neutron dose at the boundary was 14 mrem/yr. After subtracting a 2-mrem/yr neutron background dose and applying the standard occupancy factor of 1/16 (NCRP 1976), the individual neutron dose was $12 \text{ mrem}/16 = 0.75 \text{ mrem/yr}$. The gamma dose was calculated to be less than 0.01 mrem and was not included because it cannot be distinguished from the much larger gamma background measured at this and the other nearby monitoring locations. To estimate the contributions from airborne radionuclides at this location, we used CAP88 to model the dose contribution from the LANL stacks as $0.02 \text{ mrem}/16 = 0.001 \text{ mrem/yr}$. We added the dose derived from measurements at the AIRNET station along the northern boundary of Area G (0.02 mrem/yr) close to where the neutron dose was measured and applied the occupancy factor of 1/16 to obtain a dose of 0.001 mrem/yr. This resulted in a dose at this location of approximately 0.8 mrem/yr, which is greater than the airborne pathway MEI dose at DP Road.

iii. Dose Summary

The airborne pathway MEI dose of 0.52 mrem/yr at DP Road is below the 10 mrem/yr EPA airborne emissions dose limit for the public (40 CFR 61, EPA 1986), and based on previous studies, we conclude it causes no observable health effects (BEIR 1990). The all-pathways MEI dose of 0.8 mrem/yr at the Laboratory boundary of the Pueblo de San Ildefonso sacred area north of Area G is below the 100 mrem/yr DOE limit for all pathways and the 25 mrem/yr dose constraint (DOE Order 5400.5, DOE 1993, DOE 1999), and, again, we conclude it causes no observable health effects.

In most past years, LANSCE has been the major contributor to the MEI dose. Future operations of the facility and associated emissions are expected to stay consistent with 2007 levels. Because stack emissions are expected to remain low, the major contributor to the air pathway MEI dose will most likely be from the suspension of low levels of transuranic radionuclides in soil from environmental remediation projects.

c. Doses in Los Alamos and White Rock

We used background-corrected AIRNET data (reported in Chapter 4, Section A) and the factors in EPA guidance (EPA 1986) to calculate an annual dose at each of the perimeter AIRNET stations that represent the Los Alamos resident and the White Rock resident. To these doses, we added the contributions from LANSCE and other stacks, calculated using CAP88 for two representative locations: 5 km northwest of LANSCE in Los Alamos and 6.8 km southeast of LANSCE in White Rock.

i. Los Alamos

During 2007, the Laboratory contributions to the dose at an average Los Alamos residence were 0.006 mrem/yr from tritium, 0.013 mrem/yr from uranium, and 0.003 mrem/yr from LANSCE. Other radionuclides contributed less than 0.001 mrem/yr. This results in a total dose to an average Los Alamos resident of approximately 0.022 mrem/yr.

ii. White Rock

During 2007, the Laboratory contributions to the dose at an average White Rock residence were 0.013 mrem/yr from tritium, 0.006 mrem/yr from uranium, and 0.003 mrem/yr from LANSCE. Other radionuclides contributed 0.002 mrem/yr. This results in a total dose to an average White Rock resident of approximately 0.024 mrem/yr.

iii. Dose Summary

The contributions from direct radiation, food, water, and soil are discussed in Section B.2 of this chapter; each contribution is considered to be essentially a zero dose. In summary, the total annual dose in 2007 to an average Los Alamos/White Rock resident from all pathways was about 0.02 mrem and is well below the all-pathways dose limit of 100 mrem/yr and the 25 mrem/yr dose constraint. No observable health effects are expected from this dose.

4. Estimation of Radiation Dose Equivalents for Naturally Occurring Radiation

In this section, we discuss the LANL contribution relative to natural radiation and radioactive materials in the environment (NCRP 1975, 1987a, 1987b).

External radiation comes from two sources that are approximately equal: cosmic radiation from space and terrestrial gamma radiation from naturally occurring radionuclides. Doses from cosmic radiation range from 50 mrem/yr at lower elevations near the Rio Grande to about 90 mrem/yr in the higher elevations west of Los Alamos (Bouville et al 1988). In addition, as reported in Chapter 4, Section C, doses from terrestrial radiation range from about 50 to 150 mrem/yr.

The largest dose from radioactive material is from the inhalation of naturally occurring radon and its decay products. Nationwide, the average dose from radon is about 200 to 300 mrem/yr (NCRP 1987b.) In northern New Mexico, the radon concentrations and doses are higher than average. For more information, refer to the radon section of the EPA website (<http://www.epa.gov/radon/>) and the map of radon zones (<http://www.epa.gov/radon/zonemap.html>). An additional 40 mrem/yr results from naturally occurring radioactive materials in the body, primarily potassium-40, which is present in all food and living cells.

3. Radiological Dose Assessment

In addition, members of the US population receive an average dose of 50 mrem/yr from medical and dental uses of radiation, 10 mrem/yr from man-made products, such as stone or adobe walls, and less than 1 mrem/yr from global fallout from nuclear-weapons tests (NCRP 1987a). Therefore, the average total annual dose from sources other than LANL is approximately 500 mrem. Refer to Figure 3-3 for a comparison of the natural radiation background (and other sources) in Los Alamos to the United States average background. The estimated LANL-attributable 2007 all-pathways MEI dose, 0.8 mrem/yr, is about 0.2% of this dose.

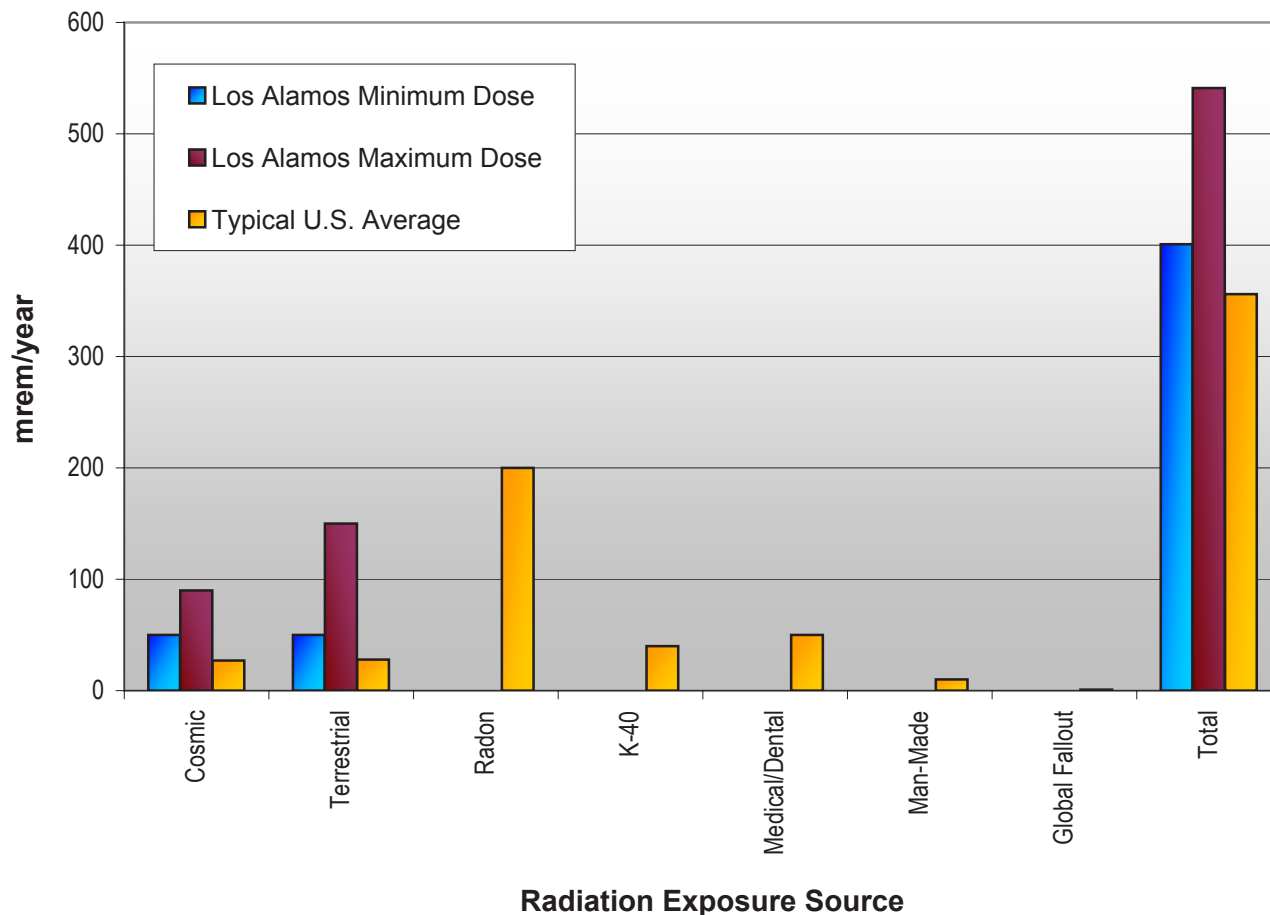


Figure 3-3. Los Alamos County radiation background compared to average US background. Los Alamos County-specific background doses have not been determined for radon, potassium-40, medical/dental exposures, man-made radiation, and global fallout and are assumed to be the same as the US average in this figure.



5. Effect to an Individual from Laboratory Operations

Health effects from radiation exposure have been observed in humans at doses in excess of 10 rem (10,000 mrem) (BEIR 1990). However, doses to the public from LANL operations are much smaller (Table 3-1). According to the 1996 Position Statement of the Health Physics Society (HPS 1996), “Below 10 rem, risks of health effects are either too small to be observed or are nonexistent.” Therefore, the doses presented in this chapter are not expected to cause observable health effects.

Table 3-1
LANL Radiological Dose for Calendar Year 2007

| Pathway | Dose to Maximally Exposed Individual mrem/yr | % of DOE 100 mrem/year Limit | Estimated Population Dose person-rem | Population within 80 km | Estimated Background Radiation Population Dose person-rem |
|---|--|------------------------------|--------------------------------------|-------------------------|---|
| Air | 0.52 ^a | 0.52% | 0.36 | NA ^b | NA |
| Water | <0.1 | <0.1% | 0 | NA | NA |
| Other Pathways (foodstuffs, soils) | <0.1 | <0.1% | 0 | NA | NA |
| All Pathways | 0.8 ^c | 1% | 0.36 | ~280,000 | ~140,000 ^d |

^a This is the RAD-NESHAP MEI dose measured at AIRNET station #71 on DP Road.

^b NA = Not applicable. Pathway-specific populations are not specified, and pathway-specific background doses have not been determined, as allowed by DOE guidance.

^c This is the all-pathways MEI dose at the boundary of the Pueblo de San Ildefonso sacred area north of Area G.

^d Based on 200–300 mrem/yr from inhalation of radon and its decay products, 70 mrem/yr from cosmic radiation, 100 mrem/yr from terrestrial radiation, 40 mrem/yr from potassium-40, 50 mrem/yr from medical and dental uses of radiation, and 10 mrem/yr from man-made products (see Section B.4).

C. BIOTA DOSE ASSESSMENT

1. Biota Dose Assessment Approach

a. Overview

The biota dose assessment methods are described in detail in the DOE Standard 1153-2002 (DOE 2002) and in the computer program RESRAD-BIOTA (<http://web.ead.anl.gov/resrad/home2/biota.cfm>). The DOE methods are general in nature and allow specific parameters to be adjusted according to local conditions because the calculations apply to all types of biota and all types of ecosystems. The site-specific methods used at LANL are specified in the quality assurance project plan for Biota Dose Assessment (available at <http://www.lanl.gov/environment/air/qa.shtml?2>), and McNaughton 2005 describes in detail the application of these methods to specific locations at LANL.

We calculate the dose to selected plants and animals following the guidance of DOE Standard 1153-2002 (DOE 2002) and LANL (LANL 2004). Trees of the pine family (pinaceae) are representative of terrestrial plants because they are radiosensitive (UNSCEAR 1996), and because their deep roots might tap into buried contamination (Foxy et al. 1984a, b; Tierney et al. 1987). Deer mice are representative of terrestrial animals because of their relatively small home range, which means the maximally exposed mouse might spend a large fraction of its time in the most contaminated location. These plants and animals are common and widespread at LANL and the surrounding area. Other plants and animals (including aquatic plants and animals) may be collected and analyzed to estimate biota dose depending on availability and locations of interest.

b. Biota Dose Limits

The DOE biota dose limits (DOE 2002) are applied to representative biota populations rather than to the maximally exposed individuals because it is the goal of DOE to protect populations, especially with respect to preventing the impairment of reproductive capability within the population. For animals, we used the population area for deer mice of 3 ha (30,000 m²) (Ryti et al. 2004; LANL 2004). We also averaged the dose to plants over this same area (McNaughton 2005).

The DOE dose limits to biota populations are

- Terrestrial animals: 0.1 rad/day (100 mrad/day)
- Terrestrial plants: 1 rad/day (1,000 mrad/day)
- Aquatic animals: 1 rad/day (1,000 mrad/day)

c. Methods

To ensure that the assessment is comprehensive, we began with an initial screening (DOE 2002) comparing the maximum radionuclide concentrations in soil, sediment, and surface water with the DOE Biota Concentration Guides (BCGs). The DOE Standard (DOE 2002) states, “An important point is that exceeding the BCGs should not force a mandatory decision regarding remediation of the evaluation area, but rather is an indication that further investigation is likely necessary.” If the BCGs are exceeded, a site-specific assessment is conducted that uses average concentrations and incorporates site-specific bioaccumulation factors. Following the guidance of the DOE Standard (DOE 2002), we did not include external-radiation dose from experimental facilities such as the Dual Axis Radiographic HydroTest (DARHT) facility and LANSCE. As described in DOE 2002, we began with a general screening. Any case that fails the general screening was subjected to a site-specific screening or analysis.

2. Biota Dose Results

As reported in Chapters 5 through 8, we collected water, soil, sediment, vegetation (overstory and/or understory), and small mammals in 2007 from several locations. All radionuclide concentrations in vegetation sampled were far below the plant 0.1 rad/day biota dose screening level (10% of 1 rad/day dose limit), and all radionuclide concentrations in terrestrial animals sampled were far below the terrestrial animal 0.01 rad/day biota dose screening level (10% of 0.1 rad/day dose limit). As previously mentioned in the soil pathway section of this chapter (Section B.2.iv.), certain perimeter and on-site sample locations had soil radionuclide concentrations above RSRLs attributable to historical Laboratory operations. However, none of these concentrations exceeded the limiting terrestrial animal BCG screening levels.

As reported in Chapter 6, there were two cases for which surface water concentrations failed the general screening. These are discussed in the following section.

In Potrillo Canyon at storm-water monitoring station PT-SMA-1 south of the TA-15 firing sites, the maximum uranium concentration in unfiltered water, 945 pCi/L, exceeded the DOE-default BCG of 200 pCi/L for aquatic systems. Similarly, in Three Mile Canyon at 3M-SMA-0.6, northeast of the TA-15 firing sites, the maximum unfiltered concentration was 790 pCi/L. These data fail the general screening and so trigger a site-specific biota dose assessment.

Following the guidance of the DOE Standard, DOE-STD-1153-2002, Module 2, Section 4, we considered the intersection of the contaminated area and the various types of habitat. The stream types are shown in Figure 6-3 and the monitoring stations are shown in Figure 6-7 in Chapter 6. The DOE standard is designed to assess chronic dose so, following New Mexico State guidance (Table 6-1), ephemeral and intermittent streams were assessed for dose from livestock watering but only perennial streams were assessed for chronic dose to aquatic animals.

The nearest aquatic habitat is at the perennial stream several miles from the contaminated areas, so there is no intersection between the contaminated areas in Potrillo and Three Mile Canyons and the aquatic habitat. The nearest riparian habitat in Three Mile Canyon is 1 km upstream and there are no nearby riparian areas in Potrillo Canyon, so there is no intersection between the contaminated areas and riparian habitat. The only habitat that intersects the contaminated area is terrestrial.

In New Mexico, storm water runoff generally flows for less than an hour. Furthermore, if the runoff water accumulates in pools, the sediment will settle and the concentration will quickly approach that of filtered water. Therefore, the concentrations reported above are available to biota for only a small fraction of the time. Nevertheless, to be conservative, we used the maximum concentrations for a terrestrial assessment. The resulting doses are 0.5 mrad/day to terrestrial animals and 0.1 mrad/day to terrestrial plants, mostly from uranium. These doses are less than 1% of the DOE Standard 1153-2002 limits (DOE 2002).

For a complete assessment, we include both water and soil concentrations. The worst-case soil concentrations at TA-15 were assessed in 2005 (the most recent data available) (McNaughton 2005) and the worst-case doses were at a TA-15 firing site (called EF-site) where the doses were 100 mrad/day to the maximally-exposed plant, 70 mrad/day to the maximally-exposed mouse, and 20 mrad/day to an average individual representative of either the mouse or plant population. As a result, the worst-case doses are less than the DOE Standard 1153-2002 limits (DOE 2002) and the storm-water monitoring locations in TA-15 pass the site-specific screening.

D. NON-RADIOLOGICAL DOSE ASSESSMENT

1. Overview

We have concluded that dose to members of the public and the environment from LANL radiological hazards is well understood and extensively documented. We place equal emphasis on the risk to members of the public and the environment from non-radiological hazards present at LANL, such as heavy metals and organic compounds.

This section assesses the potential human health risk from non-radiological materials released from LANL either during 2007 or during the previous 64 years of operations at LANL. Non-radiological air pollutants are regulated by the Clean Air Act, as discussed in Chapter 2, Section 6. The applicable standards for other media are summarized in Table 5-1, Table 6-1, Table 8-1, and Appendix A. Air emissions data are reported in Chapter 2, ambient air data are reported in Chapter 4, and the data for other environmental media are reported in Chapters 5 through 8. The resulting potential public health risks are summarized below.

2. Results

a. General Considerations

The emissions from LANL and the associated off-site concentrations of non-radiological contaminants in air, water, soil, and food are well below the applicable standards or risk-based concentrations (EPA 2007b, NMED 2006). Nevertheless, members of the public could potentially be exposed to hazardous materials from each of the environmental media discussed in the following sections.

i. Air (Inhalation Pathway)

The assessment of the ambient air impacts of high explosives testing, reported in Chapter 4 Section D.5, indicates no adverse impacts to the public. The beryllium concentrations reported in Chapter 4, Section D.6, appear to be of natural origin.

ii. Groundwater (Ingestion)

Groundwater results are reported in Chapter 5. The only Laboratory impact on a potential drinking water supply is at well Otowi-1 in Pueblo Canyon. For 2007, groundwater samples from this well had an average perchlorate

concentration of 2 µg/L, which is about 1/10 of EPA's Drinking Water Equivalent Level of 24.5 µg/L. However, this well is not used by Los Alamos County for its drinking water supply and therefore does not present a potential risk to human health.

LANL has detected hexavalent chromium in the Mortandad Canyon regional aquifer monitoring well samples at levels above the New Mexico groundwater standard and at about 70% of the standard in a Sandia Canyon regional aquifer monitoring well. However, hexavalent chromium has not been detected in Los Alamos County and Santa Fe Buckman drinking water supply wells above natural levels, so there is no health risk from ingestion of water from the drinking water supply wells.

iii. Surface Water and Sediment

The concentrations of chemicals in surface water and sediment are reported in Chapter 6. No potentially hazardous chemicals of LANL origin were detected off-site, and we conclude there is no current hazard to the public from surface water and sediment exposure.

Polychlorinated biphenyls (PCBs) are present in the on-site sediment, especially in the upper portion of Sandia Canyon, but there is no pathway for ingestion by humans. The usual pathway to humans is ingestion of fish, but there are no fish in Sandia Canyon. More generally, there are no aquatic organisms within the LANL boundaries that are part of a food ingestion pathway to humans.

PCBs are carried in sediment by storm water runoff to the Rio Grande. However, the PCB concentrations in fish (sampled in 2005) are not measurably different upstream (e.g., Abiquiu Reservoir, Rio Grande above Otowi bridge) and downstream of LANL (e.g., Cochiti Reservoir, Rio Grande below Otowi bridge).

iv. Soil

Soil concentrations are reported in Chapter 7. The concentrations are far below their soil screening levels and, therefore, do not pose a potential human health risk.

v. Foodstuffs (Ingestion)

The concentrations of nonradioactive materials in foodstuffs are reported in Chapter 8. The data show that there are no potentially hazardous materials from LANL detected in off-site foodstuffs, so there is no potential human health risk.

vi. Potential Future Risks

The possibility of hexavalent chromium and perchlorate entering the drinking-water supply in the future is being evaluated. Our goal is to assess both present and future risk. Models to calculate future risks are being developed.

3. Conclusion

The environmental data collected in 2007 show that there is no potential public-health risk from non-radiological materials released from LANL.

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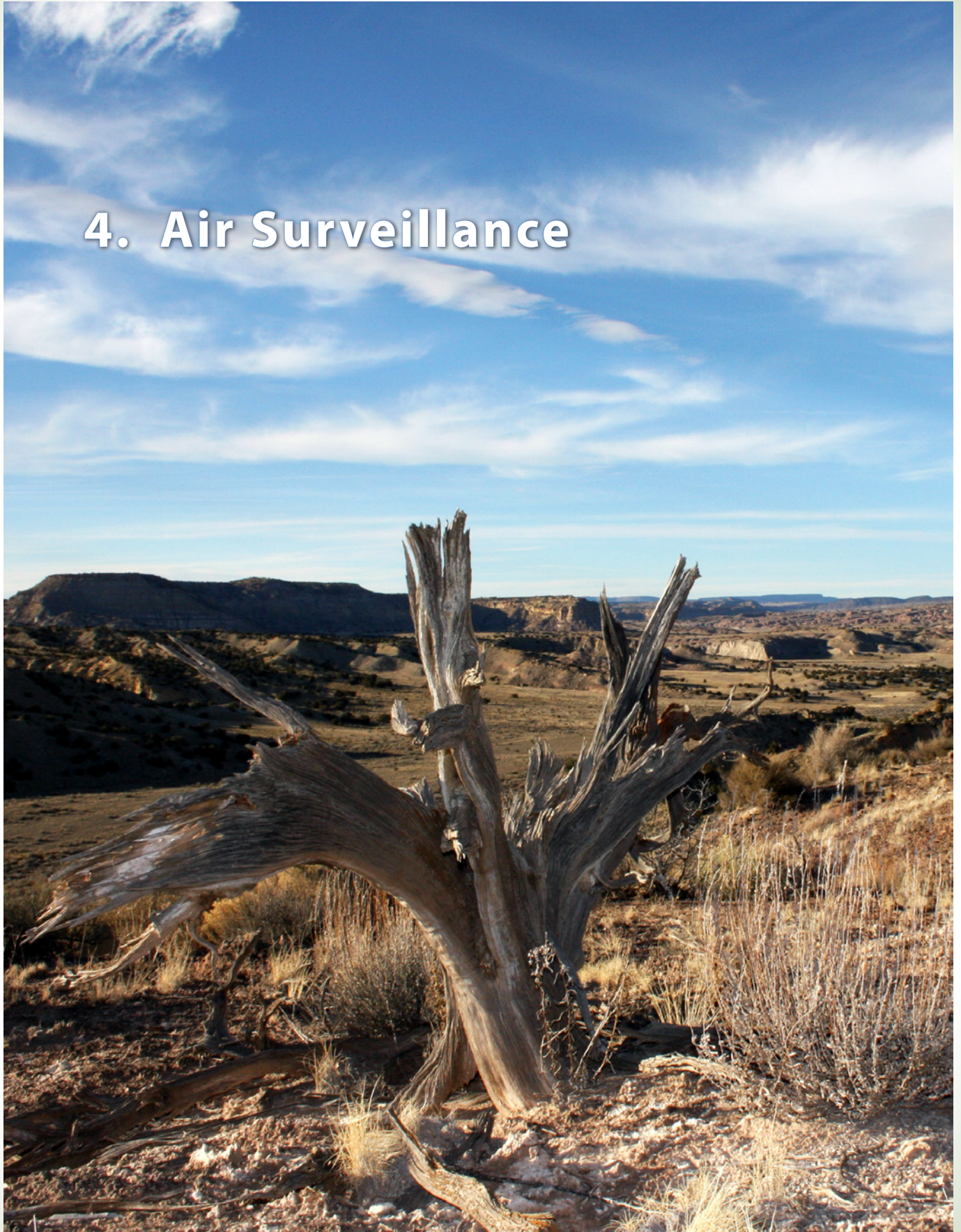
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4. Air Surveillance



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A. AMBIENT AIR SAMPLING**1. Introduction**

The radiological ambient air sampling network, referred to as AIRNET, measures environmental levels of airborne radionuclides, such as plutonium, americium, uranium, tritium, and some activation products, that may be released from Los Alamos National Laboratory (LANL or the Laboratory) operations. Natural atmospheric and fallout radioactivity levels can vary and affect measurements made by LANL's air sampling program. Most of the regional airborne radioactivity comes from the following sources: (1) fallout from past atmospheric nuclear weapons tests conducted by several countries, (2) natural radioactive constituents in particulate matter, such as uranium and thorium, (3) terrestrial radon diffusion out of the earth and its subsequent decay products, and (4) material formation from interactions with cosmic radiation, such as natural tritiated water vapor produced by interactions of cosmic radiation and common atmospheric gases. Table 4-1 summarizes regional levels of radioactivity in the atmosphere for the past five years, which can be useful in interpreting current air sampling data.

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

| Analyte | Units | EPA Concentration Limit ^b | Annual Averages ^c | | | | |
|----------------------|--------------------|--------------------------------------|------------------------------|------|------|------|------|
| | | | 2003 | 2004 | 2005 | 2006 | 2007 |
| Alpha | fCi/m ³ | NA ^d | 0.8 | 1.1 | 0.9 | 1.0 | 1.0 |
| Beta | fCi/m ³ | NA | 13.9 | 18.3 | 16.3 | 17.0 | 19.1 |
| Tritium ^e | pCi/m ³ | 1500 | -0.1 | 0.1 | 0.1 | -0.2 | 0.2 |
| Pu-238 | aCi/m ³ | 2100 | 0.0 | 0.1 | 0.0 | 0.1 | -0.3 |
| Pu-239 | aCi/m ³ | 2000 | -0.2 | -0.1 | 0.1 | 0.2 | 0.6 |
| Am-241 | aCi/m ³ | 1900 | -0.8 | -0.5 | 0.1 | -0.3 | -0.1 |
| U-234 | aCi/m ³ | 7700 | 21.4 | 17.7 | 12.4 | 16.6 | 15.3 |
| U-235 | aCi/m ³ | 7100 | 2.2 | 1.2 | 1.2 | 0.8 | 0.8 |
| U-238 | aCi/m ³ | 8300 | 21.4 | 17.4 | 13.2 | 16.1 | 14.7 |

^a Data from regional air sampling stations operated by LANL during the last five years (locations can vary by year).

^b Each EPA Concentration Limit is from 10 CFR 40 and corresponds to 10 mrem/year.

^c Gross alpha and beta annual averages are calculated from gross air concentrations. All other annual averages are calculated from net air concentrations.

^d NA = Not available.

^e Tritium annual averages have been corrected for the tritium lost to bound water in the silica gel.

Particulate matter in the atmosphere is primarily caused by aerosolized soil. Windy, dry days can increase soil entrainment, but precipitation can wash particulate matter out of the air. Meteorological conditions often cause large daily and seasonal fluctuations in airborne radioactivity concentrations. Forest fires can dramatically increase short-term ambient concentrations of particulate matter.

LANL's air quality personnel compared ambient air concentrations, as calculated from the AIRNET sample measurements, with environmental compliance standards for publicly accessible locations or with workplace exposure standards for on-site locations. We compare concentrations in areas accessible to the public with the 10-mrem annual dose equivalent concentration established by the US Environmental Protection Agency (EPA) (EPA 1989). Concentrations in controlled access areas are compared with Department of Energy (DOE) Derived Air Concentrations (DACs) for workplace exposure (DOE 1988a).

2. Air Monitoring Network

During 2007, LANL operated at least 60 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, waste site (Technical Area [TA] –54), decontamination and decommissioning (D&D) at MDA B, or other on-site locations.

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 airflow rates of about 0.11 m³ per minute. These filters are analyzed using gamma spectroscopy for various radionuclides.

Vertically mounted canisters that contain about 135 grams of silica gel, with an airflow rate of about 0.0002 m³ per minute, are used to collect water vapor samples. We dry this silica gel in a drying oven to remove most residual water before use in the field. The silica gel is a desiccant that removes moisture from the sampled air. After use in the field, the silica gel is removed from the canister and shipped to the analytical laboratory where the moisture is distilled, condensed, and collected as a liquid. This liquid is analyzed for the presence of tritium. The AIRNET quality assurance project plan 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

In the field, personnel record the sampling data on a palm-held microcomputer, including timer readings, volumetric airflow rates at the start and end of the sampling period, and comments pertaining to these data. Personnel transfer these data to an electronic table within the AIRNET database.

c. Analytical Chemistry

A commercial laboratory analyzed each particulate-matter filter for gross alpha and gross beta activities. These filters were also grouped by region across sites, designated as “clumps,” and analyzed for gamma-emitting radionuclides. Clumps usually ranged from four to nine filters. To prepare a quarterly composite for isotopic gamma analyses for each AIRNET station, half-filters from the six or seven sampling periods at each site were combined. Analysts at the laboratory dissolved these composites, separated them chemically, and analyzed them for isotopes of americium, plutonium, and uranium using alpha spectroscopy. After a two week collection period, water was distilled from the silica gel that had been used to collect water vapor in the field. A commercial laboratory used liquid scintillation spectrometry to analyze this distillate for tritium. All analytical procedures met the requirements of Title 40 Code of Federal Regulations (CFR) Part 61, Appendix B. The AIRNET quality assurance project plan provides a summary of the target minimum detectable activity for the biweekly and quarterly samples.

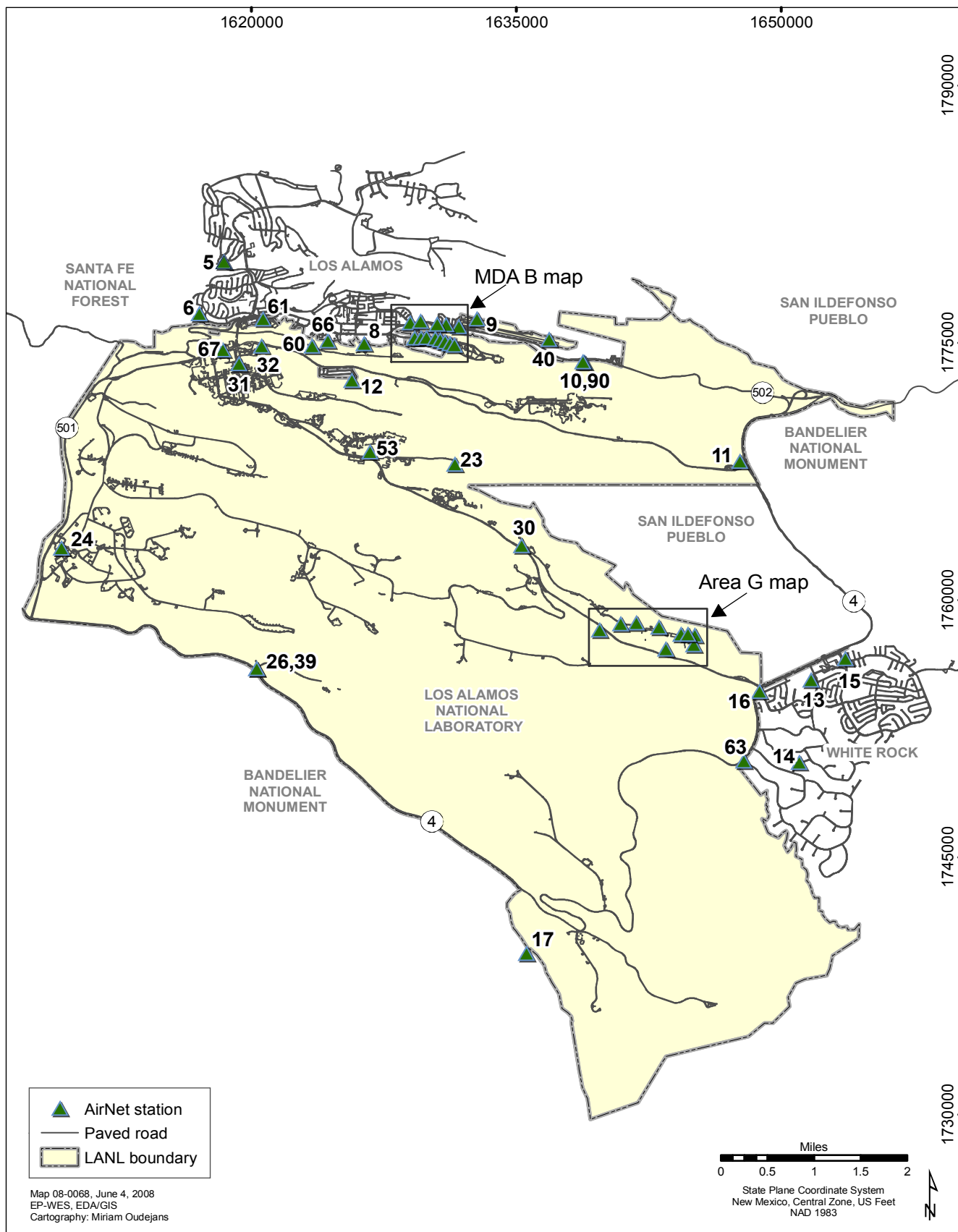


Figure 4-1. Off-site perimeter and on-site LANL AIRNET locations.

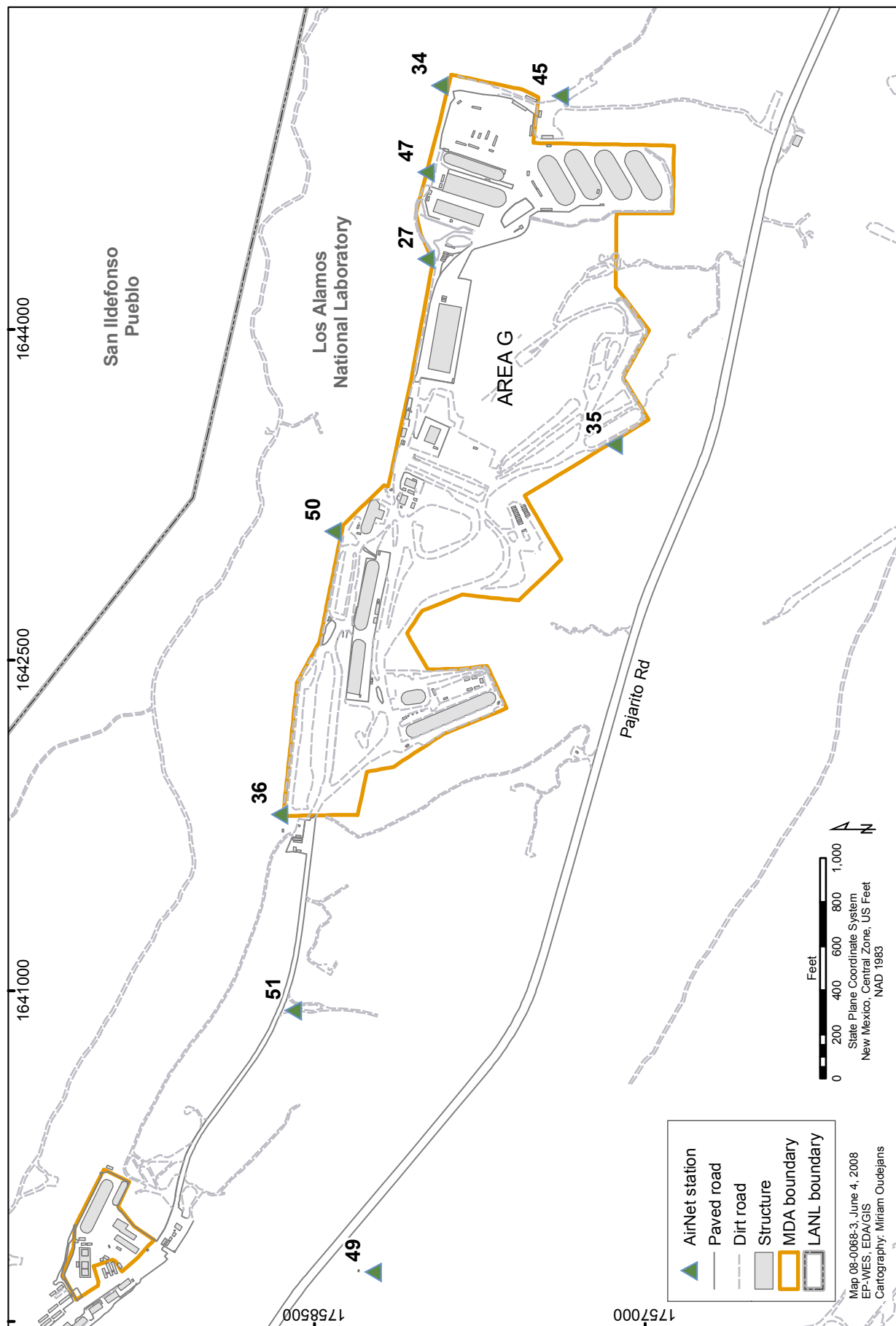


Figure 4-2. AIRNET station locations at TA-54, Area G.

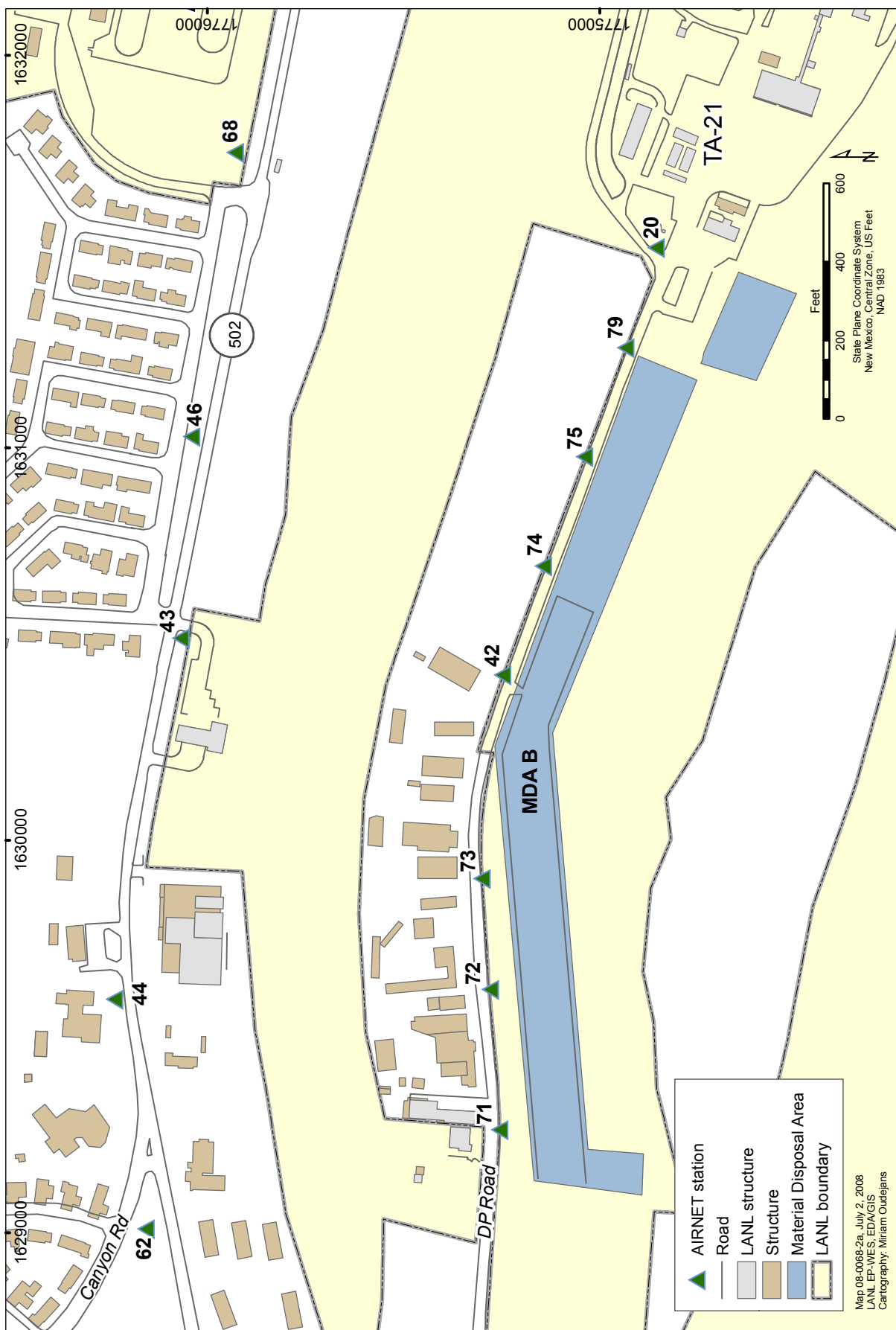


Figure 4-3. AIRNET station locations at TA-21, MDA-B.

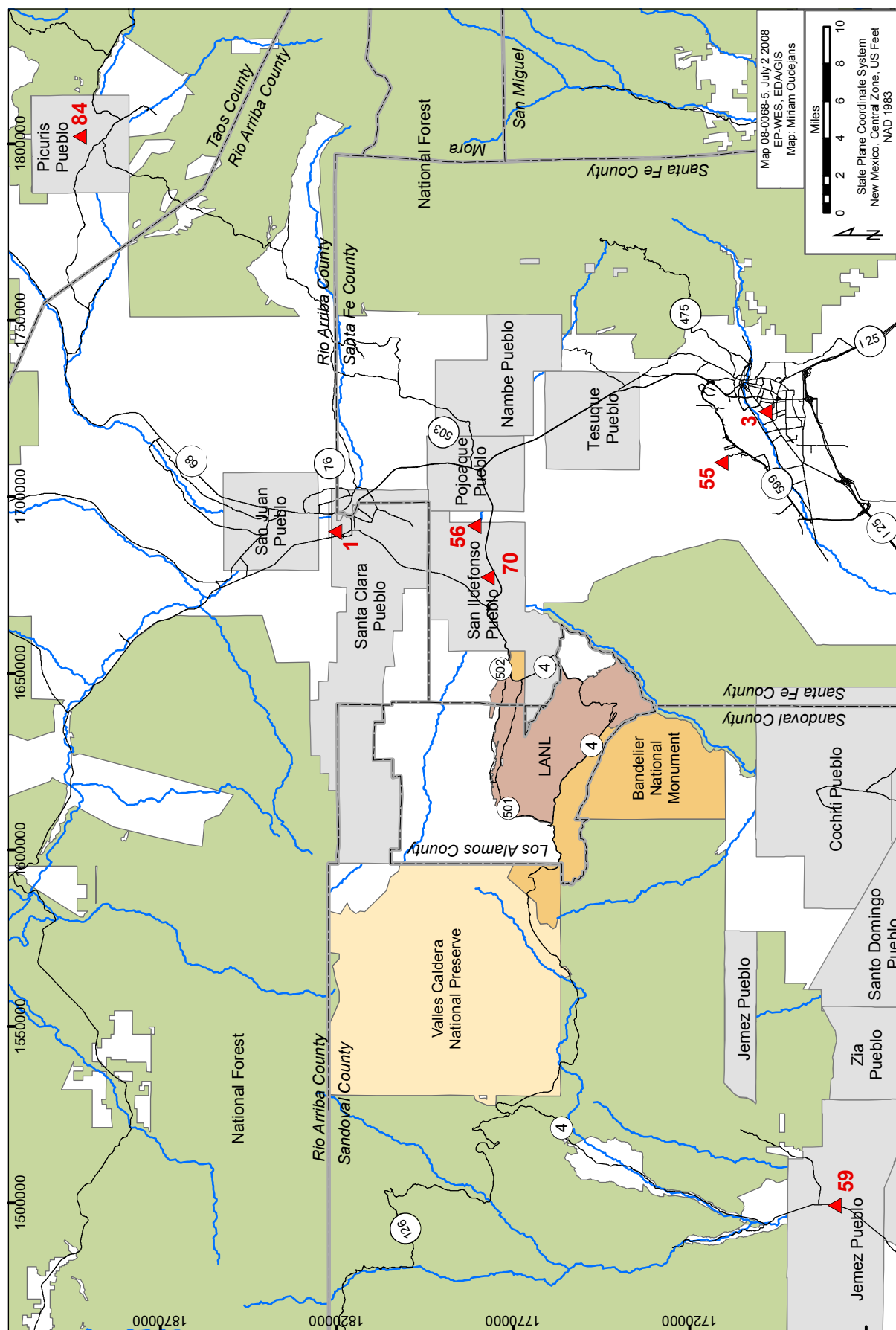


Figure 4-4. Regional and pueblo AIRNET locations.

d. Laboratory Quality Control Samples

The air sampling team and the analytical laboratories maintain a program of blank, spike, duplicate, and replicate analyses. This program provides information on the quality of the data received from analytical laboratories. These data are reviewed by technical staff to ensure the sample data met all quality assurance requirements.

4. Ambient Air Concentrations

a. Explanation of Reported Concentrations

Tables 4-2 through 4-10 summarize the 2007 ambient air concentrations calculated from the field and analytical data. In the Data Supplement, [Tables S4-1 through S4-9](#) provide data from individual sites. The number of measurements is normally equal to the number of samples analyzed. Measurements containing measurable amounts of the material of interest are those in which the value is greater than three times the standard deviation (s = standard deviation, or sigma) of the measurement's uncertainty. The minimum detectable activities are the levels that the instrumentation could detect under ideal conditions. All AIRNET concentrations are total measurements without any type of regional background subtractions. However, the air concentrations include corrections for radioactivity from the filter material and the analytical process. The net concentrations are usually somewhat lower than the gross because small amounts of radioactivity are present in the filter material, the acids used to dissolve the filter, and the tracers added to determine recovery efficiencies. The net uncertainties include the variation added by correcting for the blank measurements.

Table 4-2
Airborne Long-Lived Gross Alpha Concentrations for 2007 — Group Summaries

| Station Grouping | Number of Biweekly Samples | Number of samples exceeding uncertainty | | 95% Confidence | | Maximum Annual Concentration | |
|------------------|----------------------------|---|-----|----------------------------|---|------------------------------|-----------------------|
| | | >2s | >3s | Mean (fCi/m ³) | Interval ^a (fCi/m ³) | Station | (fCi/m ³) |
| Regional | 104 | 104 | 104 | 1.0 | ±0.1 | 01 | 1.09 |
| Pueblo | 72 | 72 | 72 | 1.0 | ±0.1 | 59 | 1.26 |
| Perimeter | 702 | 702 | 702 | 0.9 | ±0.0 | 44 | 1.05 |
| Waste Site | 208 | 208 | 208 | 0.9 | ±0.0 | 51 | 1.01 |
| On-Site | 132 | 132 | 132 | 0.9 | ±0.1 | 30 | 0.95 |
| D&D | 112 | 112 | 112 | 1.1 | ±0.1 | 72 | 1.38 |

^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 2007 — Group Summaries

| Station Grouping | Number of Biweekly Samples | Number of samples exceeding uncertainty | | 95% Confidence | | Maximum Annual Concentration | |
|------------------|----------------------------|---|-----|----------------------------|---|------------------------------|-----------------------|
| | | >2s | >3s | Mean (fCi/m ³) | Interval ^a (fCi/m ³) | Station | (fCi/m ³) |
| Regional | 104 | 104 | 104 | 19.1 | ±1.1 | 01 | 20.7 |
| Pueblo | 72 | 72 | 72 | 18.7 | ±1.3 | 70 | 19.3 |
| Perimeter | 702 | 702 | 702 | 17.7 | ±0.4 | 44 | 19.0 |
| Waste Site | 208 | 208 | 208 | 17.8 | ±0.7 | 51 | 18.3 |
| On-Site | 132 | 132 | 132 | 17.8 | ±0.7 | 30 | 18.5 |
| D&D | 112 | 112 | 112 | 19.0 | ±1.2 | 73 | 20.9 |

^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 2007 — Group Summaries

| Station Grouping | Number of Biweekly Samples | Number of samples exceeding uncertainty | | 95% Confidence | | Maximum Annual Concentration | |
|-------------------------|----------------------------|---|-----|----------------------------|---|------------------------------|-----------------------|
| | | >2s | >3s | Mean (pCi/m ³) | Interval ^a (pCi/m ³) | Station | (pCi/m ³) |
| Regional ^b | 104 | 9 | 4 | 0.2 | ±0.2 | 56 | 0.3 |
| Pueblo ^b | 77 | 4 | 1 | 0.5 | ±0.2 | 59 | 0.8 |
| Perimeter ^b | 697 | 95 | 46 | 0.7 | ±0.1 | 16 | 3.5 |
| Waste Site ^c | 208 | 197 | 192 | 170 | ±95 | 35 | 1107 |
| On-Site ^c | 131 | 43 | 23 | 4.0 | ±2.6 | 53 | 14.4 |
| D&D | 110 | 17 | 7 | 1.3 | ±0.3 | 75 | 3.7 |

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

^b EPA 40 CFR Part 61 Appendix E Concentration Limit is 1,500 pCi/m³.

^c DOE Derived Air Concentration (DAC) Guide for workplace exposure is 20,000,000 pCi/m³.

Table 4-5
Airborne Plutonium-238 Concentrations for 2007 — Group Summaries

| Station Grouping | Number of Biweekly Samples | Number of samples exceeding uncertainty | | 95% Confidence | | Maximum Annual Concentration | |
|-------------------------|----------------------------|---|-----|----------------------------|---|------------------------------|-----------------------|
| | | >2s | >3s | Mean (aCi/m ³) | Interval ^a (aCi/m ³) | Station | (aCi/m ³) |
| Regional ^b | 16 | 0 | 0 | -0.3 | ±0.3 | 55 | -0.14 |
| Pueblo ^b | 12 | 0 | 0 | -0.2 | ±0.3 | 70 | -0.1 |
| Perimeter ^b | 108 | 0 | 0 | -0.1 | ±0.1 | 17 | 0.4 |
| Waste Site ^c | 32 | 2 | 0 | 0.4 | ±0.2 | 34 | 1.0 |
| On-Site ^c | 21 | 0 | 0 | 0.1 | ±0.2 | 52 | 0.4 |
| D&D ^c | 20 | 1 | 1 | -0.2 | ±0.5 | 71 | 1.2 |

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

^b EPA 40 CFR Part 61 Appendix E Concentration Limit is 2,100 aCi/m³.

^c DOE Derived Air Concentration (DAC) Guide for workplace exposure is 3,000,000 aCi/m³.

Table 4-6
Airborne Plutonium-239/240 Concentrations for 2007 — Group Summaries

| Station Grouping | Number of Biweekly Samples | Number of samples exceeding uncertainty | | 95% Confidence | | Maximum Annual Concentration | |
|-------------------------|----------------------------|---|-----|----------------------------|---|------------------------------|-----------------------|
| | | >2s | >3s | Mean (aCi/m ³) | Interval ^a (aCi/m ³) | Station | (aCi/m ³) |
| Regional ^b | 16 | 4 | 1 | 0.6 | ±0.4 | 56 | 0.8 |
| Pueblo ^b | 12 | 4 | 0 | 0.5 | ±0.6 | 84 | 1.1 |
| Perimeter ^b | 108 | 26 | 10 | 1.5 | ±1.0 | 66 | 18.9 |
| Waste Site ^c | 32 | 17 | 12 | 5.5 | ±3.8 | 36 | 16.3 |
| On-Site ^c | 21 | 4 | 1 | 3.4 | ±7.0 | 30 | 17.7 |
| D&D | 20 | 14 | 12 | 8.4 | ±6.7 | 71 | 33.1 |

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

^b EPA 40 CFR Part 61 Appendix E Concentration Limit is 2,000 aCi/m³.

^c DOE Derived Air Concentration (DAC) Guide for workplace exposure is 2,000,000 aCi/m³.

Table 4-7
Airborne Americium-241 Concentrations for 2007 — Group Summaries

| Station Grouping | Number of Biweekly Samples | Number of samples exceeding uncertainty | | 95% Confidence | | Maximum Annual Concentration | |
|-------------------------|----------------------------|---|-----|----------------------------|---|------------------------------|-----------------------|
| | | >2s | >3s | Mean (aCi/m ³) | Interval ^a (aCi/m ³) | Station | (aCi/m ³) |
| Regional ^b | 16 | 4 | 1 | -0.1 | ±0.5 | 01 | 0.5 |
| Pueblo ^b | 12 | 5 | 2 | 0.3 | ±0.9 | 84 | 0.9 |
| Perimeter ^b | 108 | 32 | 4 | 0.2 | ±0.2 | 64 | 1.7 |
| Waste Site ^c | 32 | 12 | 5 | 0.9 | ±0.4 | 36 | 1.8 |
| On-site ^c | 21 | 6 | 1 | 1.5 | ±1.5 | 52 | 6.4 |
| D&D | 20 | 7 | 1 | 1.2 | ±0.9 | 71 | 4.1 |

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

^b EPA 40 CFR Part 61 Appendix E Concentration Limit is 1,900 aCi/m³.

^c DOE Derived Air Concentration (DAC) Guide for workplace exposure is 2,000,000 aCi/m³.

Table 4-8
Airborne Uranium-234 Concentrations for 2007 — Group Summaries

| Station Grouping | Number of Biweekly Samples | Number of samples exceeding uncertainty | | 95% Confidence | | Maximum Annual Concentration | |
|-------------------------|----------------------------|---|-----|----------------------------|---|------------------------------|-----------------------|
| | | >2s | >3s | Mean (aCi/m ³) | Interval ^a (aCi/m ³) | Station | (aCi/m ³) |
| Regional ^b | 16 | 16 | 16 | 15.3 | ±4.7 | 03 | 25.2 |
| Pueblo ^b | 12 | 11 | 11 | 14.3 | ±5.9 | 59 | 24.2 |
| Perimeter ^b | 108 | 106 | 99 | 7.2 | ±1.2 | 32 | 28.7 |
| Waste Site ^c | 32 | 32 | 32 | 12.0 | ±3.9 | 51 | 23.6 |
| On-Site ^c | 21 | 20 | 19 | 5.9 | ±2.7 | 53 | 13.9 |
| D&D | 20 | 20 | 19 | 10.7 | ±2.5 | 75 | 13.7 |

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

^b EPA 40 CFR Part 61 Appendix E Concentration Limit is 7,700 aCi/m³.

^c DOE Derived Air Concentration (DAC) Guide for workplace exposure is 20,000,000 aCi/m³.

Table 4-9
Airborne Uranium-235 Concentrations for 2007 — Group Summaries

| Station Grouping | Number of Biweekly Samples | Number of samples exceeding uncertainty | | 95% Confidence | | Maximum Annual Concentration | |
|-------------------------|----------------------------|---|-----|----------------------------|---|------------------------------|-----------------------|
| | | >2s | >3s | Mean (aCi/m ³) | Interval ^a (aCi/m ³) | Station | (aCi/m ³) |
| Regional ^b | 16 | 3 | 0 | 0.8 | ±0.6 | 03 | 1.6 |
| Pueblo ^b | 12 | 2 | 0 | 0.5 | ±0.5 | 59 | 1.3 |
| Perimeter ^b | 108 | 23 | 3 | 0.6 | ±0.2 | 11 | 2.8 |
| Waste Site ^c | 32 | 7 | 2 | 0.8 | ±0.5 | 51 | 2.2 |
| On-Site ^c | 21 | 6 | 2 | 0.9 | ±0.8 | 53 | 1.7 |
| D&D | 20 | 2 | 2 | 0.5 | ±0.6 | 71 | 2.5 |

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

^b EPA 40 CFR Part 61 Appendix E Concentration Limit is 7,100 aCi/m³.

^c DOE Derived Air Concentration (DAC) Guide for workplace exposure is 20,000,000 aCi/m³.

Table 4-10
Airborne Uranium-238 Concentrations for 2007 — Group Summaries

| Station Grouping | Number of Biweekly Samples | Number of samples exceeding uncertainty | | 95% Confidence | | Maximum Annual Concentration | |
|-------------------------|----------------------------|---|-----|----------------------------|---|------------------------------|-----------------------|
| | | >2s | >3s | Mean (aCi/m ³) | Interval ^a (aCi/m ³) | Station | (aCi/m ³) |
| Regional ^b | 16 | 16 | 16 | 14.7 | ±4.1 | 03 | 23.9 |
| Pueblo ^b | 12 | 11 | 11 | 14.7 | ±5.7 | 59 | 23.4 |
| Perimeter ^b | 108 | 107 | 102 | 9.6 | ±1.6 | 32 | 30.4 |
| Waste Site ^c | 32 | 32 | 32 | 14.4 | ±4.3 | 51 | 30.7 |
| On-Site ^c | 21 | 20 | 20 | 9.5 | ±4.1 | 53 | 15.0 |
| D&D | 20 | 20 | 20 | 14.4 | ±5.0 | 20 | 21.9 |

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

^b EPA 40 CFR Part 61 Appendix E Concentration Limit is 8,300 aCi/m³.

^c DOE Derived Air Concentration (DAC) Guide for workplace exposure is 20,000,000 aCi/m³.

All data in this ambient air sampling section, whether in the tables or the text, that are expressed as a value plus or minus (\pm) another value represent a 95% confidence interval. Because the confidence intervals are calculated with data from multiple sites and throughout the year, they include not only random measurements and analytical errors but also seasonal and spatial variations. As such, the calculated 95% confidence intervals are overestimated for the average concentrations and probably represent confidence intervals approaching 100%. All ambient concentrations are activities per cubic meter of sampled air. Some values in the tables are negative. See Appendix B for an explanation of negative values.

Air concentrations greater than their 3s uncertainties are used to identify samples of interest or detected concentrations. Other multiples of uncertainties could be used, but 3s is consistent with the widely accepted practice of using 3s control limits for statistical quality control charts (Duncan 1986, Gilbert 1987). It also eliminates most of the false positives or detections that occur about 5% of the time at 2s, but less than 0.3% of the time at 3s.

b. Gross Alpha and Gross Beta Radioactivity

We use gross alpha and gross beta analyses primarily to (1) evaluate general radiological air quality, (2) identify potential trends, and (3) detect sampling problems. If the gross analytical results appear to be elevated, analyses for specific radionuclides may be performed to investigate a potential problem, such as an unplanned release.

The National Council on Radiation Protection and Measurements (NCRP) estimated the national average concentration of long-lived gross alpha activity in air to be two femtocuries (fCi)/m³. Polonium-210, a decay product of radon, and other naturally occurring radionuclides are the primary sources of alpha activity (NCRP 1975, NCRP 1987a). The NCRP also estimated the national average concentration levels of long-lived gross beta activity in air to be 20 fCi/m³. The presence of lead-210 and bismuth-210, also decay products of radon, and other naturally occurring radionuclides are the primary sources of this activity.

In 2007, we collected and analyzed approximately 1,350 air samples for gross alpha and gross beta activity. The annual mean for all of the stations is about half of the NCRP's estimated average for gross alpha concentrations (Table 4-2). At least two factors contribute to these lower concentrations: (1) the use of actual sampled air volumes instead of standard temperature and pressure volumes and (2) the burial of alpha emitters in the filter that are not measured by front-face counting. Gross alpha activity is dependent on variations in natural conditions, such as atmospheric pressure, atmospheric mixing, temperature, and soil moisture.

Table 4-3 shows gross beta concentrations within and around LANL. These data show variability similar to the gross alpha concentrations. The annual average is below the NCRP-estimated national average, but the gross beta measurements include little if any lead-210 because of its low-energy beta emission. We calculate the gross beta measurements on the actual sampled air volumes instead of standard temperature and pressure volumes. The primary source of measured gross beta activity in particulate matter is the bismuth-210 in the radon-222 decay chain.

Figures 4-5 and 4-6 show the temporal variability of gross alpha and beta activities in air, respectively. Variability among sites within AIRNET is usually much less than variability over time. For example, in winter, at lower elevations around LANL, the radon may be trapped below an inversion layer, resulting in higher levels of radon near the ground and, therefore, higher gross alpha and gross beta count rates.

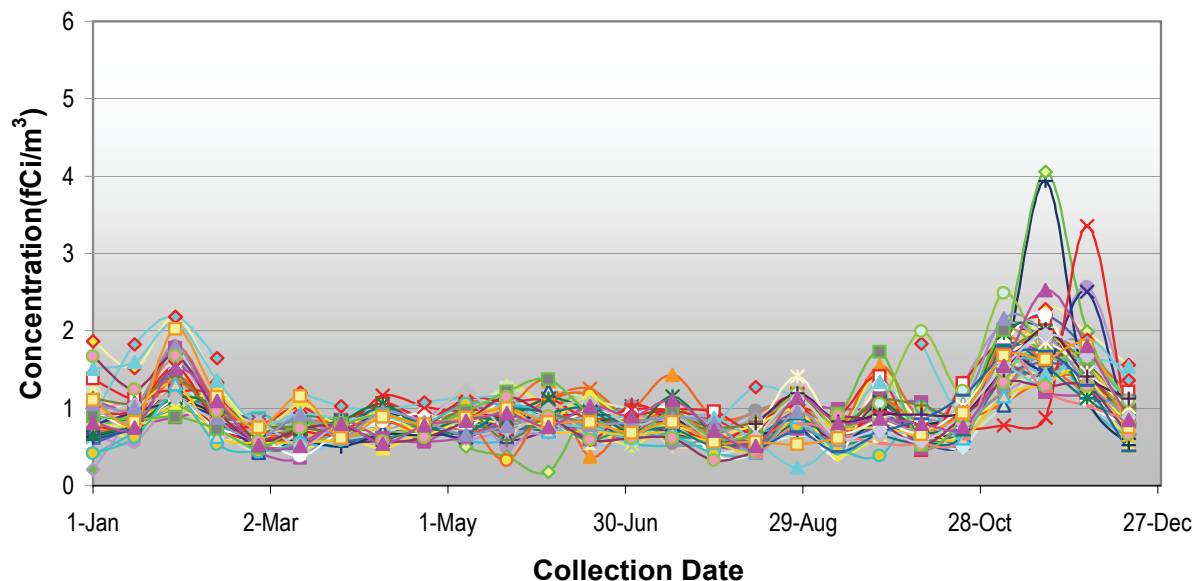


Figure 4-5. Gross alpha measurements (fCi/m³) for all sampling sites by date collected in 2007.

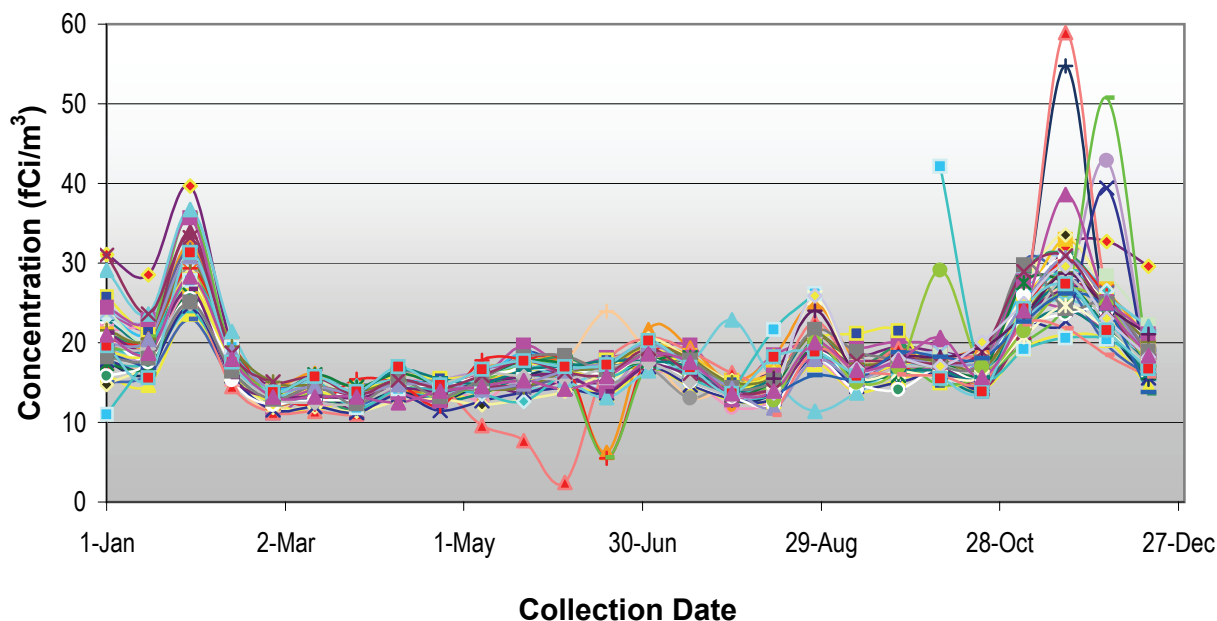


Figure 4-6. Gross beta measurements (fCi/m³) for all sampling sites by date collected in 2007.

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). We measure the tritium in water (HTO or tritiated water) because the dose impact is about 14,000 times higher than if it were hydrogen gas (HT or tritium) (DOE 1988b).

Water-vapor concentrations in the air and tritium concentrations in the water vapor were used to calculate ambient levels of tritium. Corrections for blanks, bound water in the silica gel, and isotopic distillation effects are included in this calculation.

The annual concentrations of tritium for 2007 at the regional stations were not significantly greater than zero (Table 4-4). The average concentration of tritium for the perimeter, on-site, and D&D samplers was significantly greater than zero. The highest concentrations were measured at the TA-54 waste site in Area G. All annual mean concentrations at all sampling stations were well below the applicable EPA and DOE guidelines.

The highest off-site annual tritium concentration in 2007, 3.5 picocuries (pCi)/m³ at station 75, is equivalent to about 0.25% of the EPA public dose limit of 1,500 pCi/m³. We measured elevated tritium concentrations at a number of on-site stations, with the highest annual concentration (1,100 pCi/m³) at TA-54, Area G. This annual mean concentration is less than 0.001% of the DOE DAC for worker exposure of 20,000,000 pCi/m³ and is measured at a location near a pit containing tritium-contaminated waste.

d. Plutonium

While plutonium occurs naturally at extremely low concentrations from cosmic radiation and spontaneous fission (Eisenbud and Gesell 1997), this element is not naturally present in measurable quantities in the ambient air. All measurable sources in air 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.

Table 4-5 summarizes the plutonium-238 data for 2007. One occurrence of plutonium-238 greater than 3s was measured. This was during road construction in preparation for clean-up at MDA-B. The highest quarterly concentration was at this site and was 2.6 aCi/m³.

Seven quarterly concentrations at station 66 and temporary station 64 (both near the Ashley Hotel and Suites [formerly the Los Alamos Inn]) were above their 3s uncertainties (Table 4-6). The annual mean concentration at station 66 was 19 aCi/m³, or about 1% of the EPA public dose limit. These higher ambient concentrations are from historical activities at LANL's old main Technical Area (TA-1) that deposited plutonium on the hillside to the south of the Los Alamos Inn. Twelve quarterly concentrations above 3s were measured off-site near the MDA-B cleanup. This fact should be viewed in light of our conservative choice of baseline levels for new stations which have yet to accumulate historical data. There were four other off-site measurements above 3s but they all had average annual concentrations below 4 aCi/m³.

Finally, 12 quarterly concentrations at or near Area G exceeded 3s. All on-site and waste site concentrations were below 0.005% of the DOE DAC for workplace exposure.

e. Americium-241

As with plutonium isotopes, americium is present in very low concentrations in the environment. Eight off-site quarterly samples with a concentration greater than 3s were measured. Table 4-7 summarizes the americium-241 data. Six on-site quarterly samples, all near Area G, with a concentration of greater than 3s were measured. The highest quarterly off-site and on-site concentrations were less than 0.5% and 0.001% of public and worker limits, respectively.

f. Uranium

Three isotopes of uranium are normally found in nature: uranium-234, uranium-235, and uranium-238. In natural uranium, 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 (Walker et al., 1989). Comparisons of isotopic concentrations are used to estimate LANL contributions because known LANL emissions in the past 50 years are not of natural uranium, but are of enriched uranium (EU—enriched in uranium-234 and -235) or depleted uranium (DU—depleted of uranium-234 and -235). No EU was detected during 2007.

All annual mean concentrations of the three uranium isotopes were below 1% of the applicable EPA and DOE guidelines (Tables 4-8 to 4-10). The highest annual uranium concentrations are typically at locations with high dust levels from local soil disturbances.

During 2007, there were seven detections of DU as shown in Figure 4-7. Their locations were at stations 20, 23, 40, 46, 49, 68, and 71 all on Laboratory property or close to the perimeter and within Los Alamos County. Legacy DU dust at the Laboratory can be resuspended by strong winds.

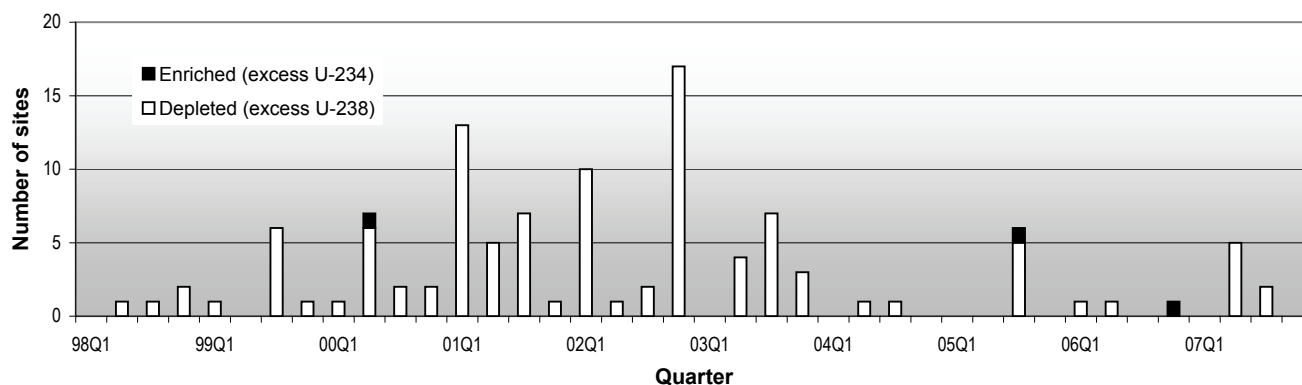


Figure 4-7. Number of sites where enriched or depleted uranium has been detected from 1998 through 2007.

Elevated uranium-238 concentrations were identified by statistically comparing the uranium-234 and uranium-238 concentrations. If the concentrations in a sample were more than 3s apart, the sample was considered to have significant concentrations of EU or DU (see Section A.6). Off-site concentrations of DU are comparable to, or less than, historical natural uranium concentrations. No EU was detected during 2007.

g. Gamma Spectroscopy Measurements

The filters are grouped across sites for each sampling period and are identified as “clumps”. The following analytes are routinely requested: arsenic-73, arsenic-74, cadmium-109, cobalt-57, cobalt-60, cesium-134, cesium-137, manganese-54, sodium-22, rubidium-83, rubidium-103, selenium-75, and zinc-65. None of these analytes were detected in 2007 or in the preceding three years. Our practice is to investigate the measurement of any of these analytes above its minimum detectable activity.

Beryllium-7 and lead-210 were also analyzed but we do not investigate detected quantities of beryllium-7, potassium-40, and lead-210, which are natural radionuclides normally present in measurable concentrations, unless they are seen in levels elevated over previous years. During 2007, beryllium-7 was routinely detected at concentrations similar to previous years.

5. Investigation of Elevated Air Concentrations

Two action levels have been established to determine the potential occurrence of an unplanned release: “investigation” and “alert.” Investigation action levels are based on historical measurements and are designed to indicate that an air concentration is higher than expected. These levels are set at values equal to a five-year rolling average plus 3s. Alert action levels are based on allowable EPA and DOE annual doses and require a more thorough and immediate follow-up.

When a measured air concentration exceeds an action level, the air quality team verifies that the calculations were done correctly and that the sampled air concentrations are representative, i.e., there is no cross contamination. Next, we work with personnel from the appropriate operations to assess potential sources and possible mitigation for the elevated concentrations.

In 2007, air sampling values for plutonium, americium and uranium did not exceed alert action levels.

Tritium alert levels were not exceeded at any off-site station. Elevated levels were observed at Area G near a pit containing tritium-contaminated items.

6. Long-Term Trends

a. Uranium

Each year peak concentrations for all three uranium isotopes typically occur during the windier second quarter (Figure 4-8). Typically, the uranium-238 concentrations are consistently higher than those of uranium-234. Uranium levels have been in general decline since the Cerro Grande fire in 2000.

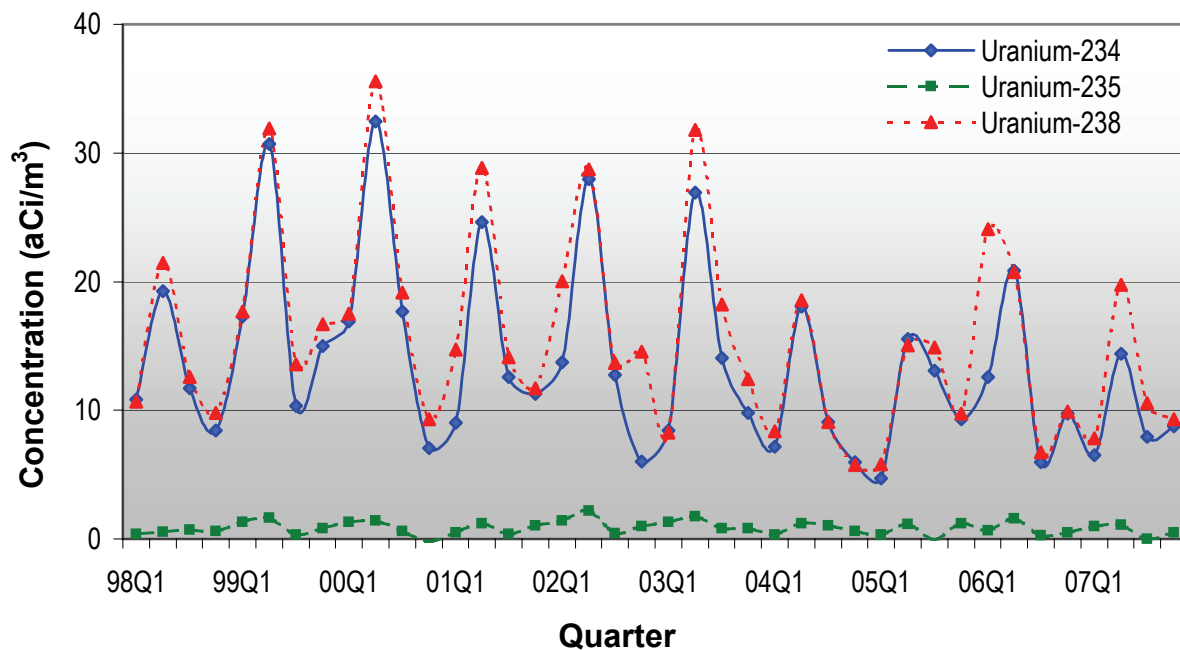


Figure 4-8. AIRNET quarterly uranium isotopic concentrations

b. Plutonium and Americium

No quarterly measurements during the last 10 years for the regional and pueblo samples were above their 3s analytical uncertainties. However, on-site measurements of plutonium-238, plutonium-239, and americium-241 are clearly higher for the waste site sampling stations at TA-54 Area G, where about one-fifth of the measurements exceed 3s. Perimeter samplers are somewhere in between, with occasional samples having detected concentrations. Figures 4-9, 4-10, and 4-11 are graphs of the annual concentrations by isotope and station location grouping. The increased concentration at the TA-54 waste site in 2006 was due to operations involving the transfer of cleanup waste from TA-21 to Area G. Remediation activities at TA-21 raised the on-site americium-241 and plutonium-239 annual averages. Annual average concentrations of plutonium-239 and americium-241 are close to but above zero at Area G, except for plutonium-239 last year (Figure 4-12).

c. Tritium

Tritium concentrations are strongly influenced by current operations so emissions show no distinctive trends (Figure 4-13). In 2006, tritiated waste near a few samplers raised the annual average. This waste, from a decommissioned tank, was subsequently buried at Area G, leading to the lower releases seen in 2007.

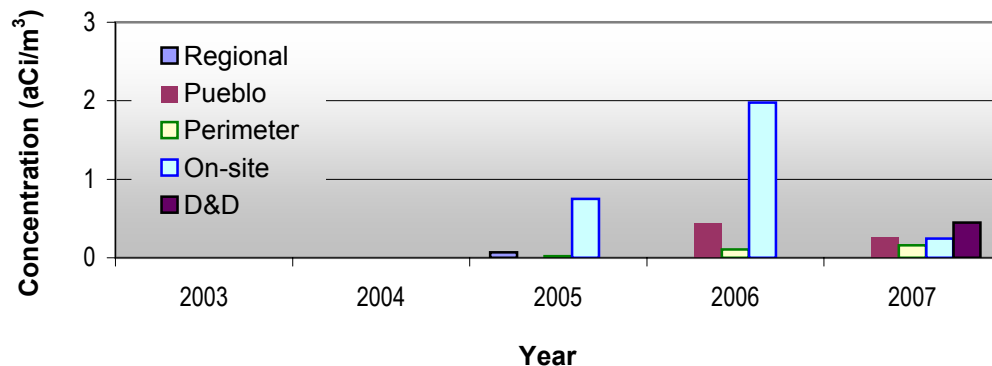


Figure 4-9. Americium-241 concentration trends.

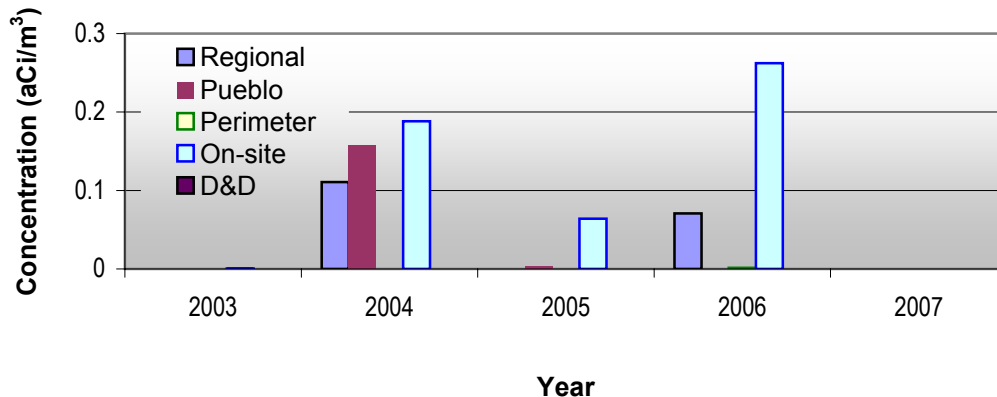


Figure 4-10. Plutonium-238 concentration trends.

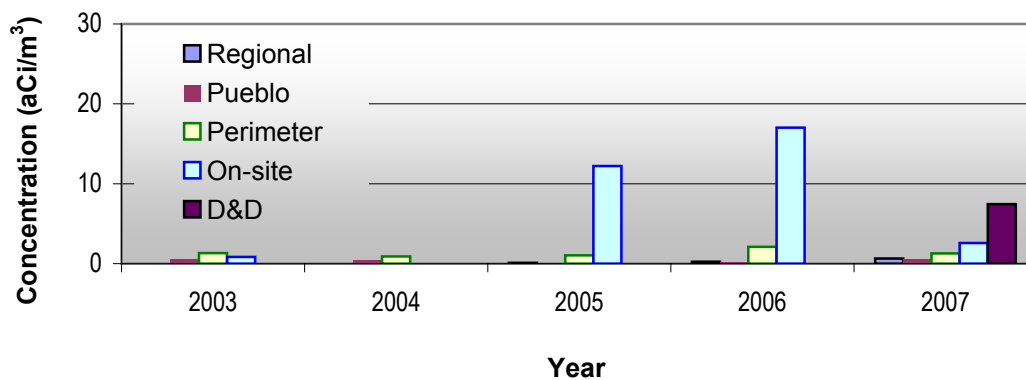


Figure 4-11. Plutonium-239/240 concentration trends.

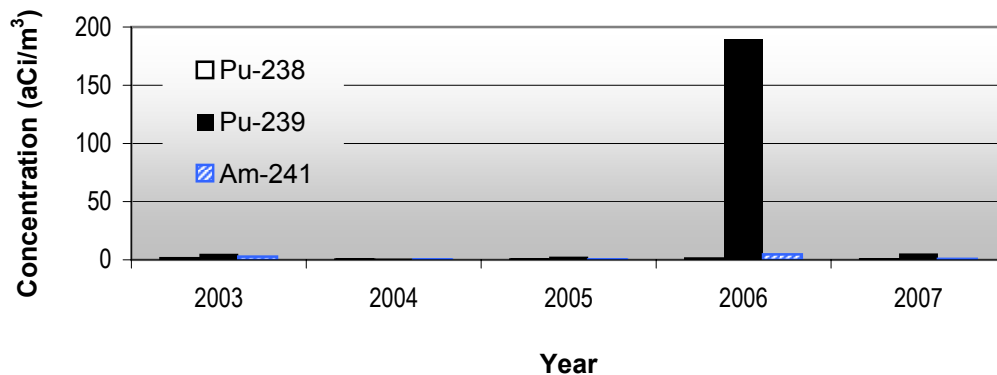


Figure 4-12. Americium and plutonium concentration trends for TA-54, Area G.

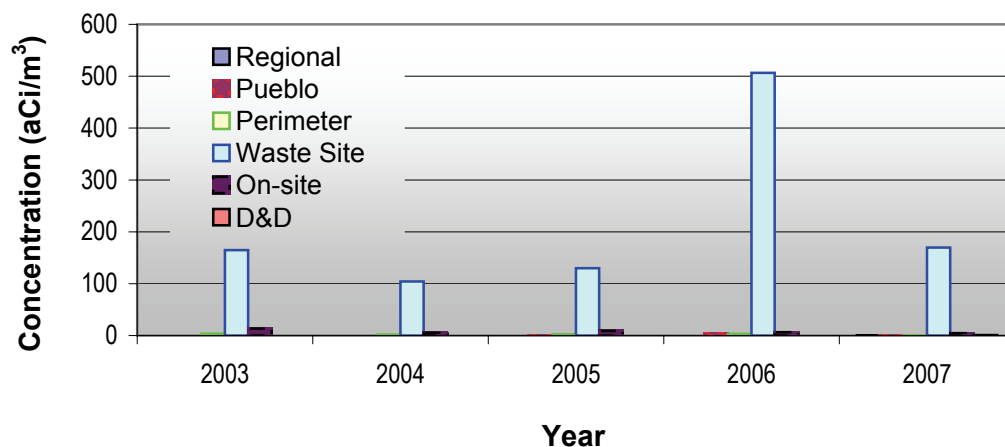


Figure 4-13. Tritium concentration trends.

B. STACK SAMPLING FOR RADIONUCLIDES

1. Introduction

Radioactive materials are an integral part of many activities at LANL. Some operations involving these materials may be vented to the environment through a stack or other forced air release point. Members of the Rad-NESHAP team at LANL evaluate these operations to determine potential impacts to the public and the environment. Emissions are estimated using engineering calculations and radionuclide materials usage information with the assumption there are no emission controls in place, such as the high-efficiency particulate air filters which are present on most stacks. If this evaluation shows that emissions from a stack may potentially result in a member of the public receiving as much as 0.1 mrem in a year, LANL must sample the stack in accordance with 40 CFR Part 61, Subpart H, “National Emission Standards for Emissions of Radionuclides Other than Radon from Department of Energy Facilities” (Rad-NESHAP) (EPA 1989). During 2007, we identified 27 stacks meeting this criterion.

2. Sampling Methodology

In 2007, we continuously sampled 27 stacks for the emission of radioactive material to the ambient air. LANL categorizes its radioactive stack emissions into one of four types: (1) particulate matter, (2) vaporous activation products, (3) tritium, and (4) gaseous mixed activation products (GMAP). For each of these emission types, LANL employs an appropriate sampling method, as described below.

Emissions of radioactive particulate matter generated by operations at facilities such as the Chemistry and Metallurgy Research Building and the TA-55 Plutonium Facility are sampled using a glass-fiber filter. A continuous sample of stack air is pulled through a filter that captures small particles of radioactive material. These samples are collected weekly and shipped to an off-site analytical laboratory. The analytical laboratory uses gross alpha/beta counting and gamma spectroscopy to identify any increase in emissions and to identify short-lived radioactive materials. Every six months, the laboratory composites these samples and analyzes them to determine the cumulative activity on all the filters of radionuclides such as uranium-234, -235, and -238, plutonium-238 and -239/240, and americium-241. The isotopic data are used to calculate emissions from the stack for the six-month period.

A charcoal cartridge samples emissions of vapors, such as bromine-82, and highly volatile compounds, such as selenium-75, generated by operations at the Los Alamos Neutron Science Center (LANSCE) and hot cell activities at the Chemistry and Metallurgy Research Building and TA-48. A continuous sample of stack air is pulled through a charcoal filter that adsorbs vaporous emissions of radionuclides. This charcoal filter is mounted downstream of a glass-fiber filter (discussed above) that removes any particulates from this sample media. Gamma spectroscopy determines the amount and identity of the radionuclide(s) present on the filter.

We measure tritium emissions from LANL's tritium facilities with a collection device known as a bubbler. This device enables us 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 is then "bubbled" 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 HT. The air is then passed through a palladium catalyst that converts the HT to HTO. The sample is pulled through three additional vials containing ethylene glycol, which collect the newly formed HTO. The vials of ethylene glycol are sent to an analytical laboratory for liquid scintillation counting to determine the amount of HTO and HT.

In previous years, stacks at LANSCE were monitored for tritium. After an historical evaluation of HTO emissions from LANSCE in 2001, we discontinued sampling tritium following the July 2001 report period based on the low historical emissions of HTO from TA-53 and the low relative contribution of tritium to the off-site dose from TA-53 emissions. Emissions of tritium reported in 2007 from LANSCE are based on 2001 tritium generation rates.

We measure GMAP emissions from LANSCE activities using real-time monitoring data. A sample of stack air is pulled through an ionization chamber that measures the total amount of radioactivity in the sample. Gamma spectroscopy and decay curves are used to identify specific radioisotopes and the quantity of each. From these data, the total emissions of each radionuclide are calculated.

3. Sampling Procedures and Data Analysis

a. Sampling and Analysis

Analytical methods used comply with EPA requirements (40 CFR 61, Appendix B, Method 114). Section F of this chapter presents the results of analytical quality assurance measurements. General discussions on the sampling and analysis methods for each of LANL's emissions are described here.

b. Particulate Matter Emissions

We remove and replace the glass-fiber filters that each week sample facilities with significant potential for radioactive particulate emissions and ship them to an off-site analytical laboratory. Prior to shipping, each sample filter is screened with a hand-held instrument to determine if there are any unusually high levels of alpha or beta radioactivity. The laboratory performs analyses for the presence of alpha and beta radioactivity after the sample has been allowed to decay for approximately one week (to allow short-lived radon progeny to decay). In addition to alpha and beta analyses, the laboratory performs gamma spectroscopy analysis to identify specific isotopes in the sample. The glass-fiber filters are composited every six months for radiochemical analysis because gross alpha/beta counting cannot identify specific radionuclides. We use the data from these composite analyses to quantify emissions of radionuclides, such as the isotopes of uranium and plutonium. The Rad-NESHAP team compares the results of the isotopic analysis with gross activity measurements to ensure that the requested analyses (e.g., uranium-234, -235, and -238; and plutonium-238 and -239/240, etc.) identify all significant activity in the composites.

For particulate filters from the LANSCE accelerator facility, the analytical laboratory only performs gamma spectroscopy analyses based on the anticipated suite of emissions from this facility. Again, hand-screening of each filter is performed the day of change-out prior to shipment to the off-site analytical laboratory.

c. Vaporous Activation Products Emissions

We remove and replace the charcoal canisters weekly at facilities with the potential for significant vaporous activation products emissions and then ship the samples to the off-site analytical laboratory where gamma spectroscopy identifies and quantifies the presence of vaporous radioactive isotopes.

d. Tritium Emissions

Tritium bubbler samples, used to sample facilities with the potential for significant elemental and oxide tritium emissions, are collected weekly and transported to LANL's Health Physics Analytical Laboratory. The Health Physics Analytical Laboratory adds an aliquot of each sample to a liquid scintillation cocktail and determines the amount of tritium in each vial by liquid scintillation counting.

e. Gaseous Mixed Activation Products (GMAP) Emissions

To record and report GMAP emissions, we used continuous monitoring, rather than off-line analysis, 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 GMAP monitoring system includes a flow-through ionization chamber in series with a gamma spectroscopy system. Total GMAP emissions are measured with the ionization chamber. The real-time current this ionization chamber measured is recorded on a strip chart and the total amount of charge collected in the chamber over the entire beam operating cycle is integrated on a daily basis. The gamma spectroscopy system analyzes the composition of these GMAP emissions. Using decay curves and energy spectra to identify the various radionuclides, we determine the relative composition of the emissions. Decay curves are typically taken one to three times per week based on accelerator operational parameters. When major ventilation configuration changes are made at LANSCE, new decay curves and energy spectra are recorded.

4. Analytical Results

Measurements of LANL stack emissions during 2007 totaled approximately 477 Ci. Of this total, tritium emissions composed approximately 260 Ci, and air activation products from LANSCE stacks contributed nearly 218 Ci. Combined airborne emissions of materials such as plutonium, uranium, americium, and thorium were less than 0.000012 Ci. Emissions of particulate matter plus vaporous activation products (P/VAP) were about 0.016 Ci, which is about a 100-fold decrease from 2006 but consistent with years prior to 2006.

Table 4-11 provides detailed emissions data for LANL buildings with sampled stacks.

Table 4-12 provides a detailed listing of the constituent radionuclides in the groupings of GMAP and P/VAP.

Table 4-13 presents the half-lives of the radionuclides typically emitted by LANL. During 2007, the LANSCE facility non-point source emissions of activated air comprised approximately 79.7 Ci of carbon-11 and 3.32 Ci of argon-41.

5. Long-Term Trends

Figures 4-14 to 4-17 present radioactive emissions from sampled LANL stacks and illustrate trends in measured emissions for plutonium, uranium, tritium, and GMAP emissions, respectively. As the figures demonstrate, emissions from plutonium and uranium isotopes stayed relatively steady over recent years, varying slightly each year but staying in the low-microcurie range. Tritium emissions showed a major decrease from 2006 due to a maintenance upgrade at the main tritium facility that limited operations for much of 2007. In 2007, emissions of GMAP dropped further from the very low levels in 2006, following a one-year elevation in 2005, as described below.

Site-wide tritium emissions are staying low due to the consolidation of most tritium operations at TA-16. In 2006, source removal activities were completed at buildings TA-21-155 and TA-21-209. Continued emissions from these facilities result from off-gassing of contaminated equipment remaining in the building. Following removal of the majority of the tritium source term, monitoring continued until we had a clear grasp of the emissions potential from these two stacks. At the end of September 2006, monitoring activities at these two stacks ceased. Until these stacks are fully decommissioned and torn down, the future emissions will be calculated based on emissions rates measured in the summer and early fall of 2006.

Table 4-11
Airborne Radioactive Emissions from LANL Buildings with Sampled Stacks in 2007 (Ci)

| TA-Bldg | H-3 ^a | Am-241 | Pu ^b | U ^c | Th ^d | P/VAP ^e | GMAP ^f | Sr-90 ^g |
|--------------------------|------------------------|-------------------------|-------------------------|-------------------------|--------------------------|-------------------------|--------------------------|--------------------|
| TA-03-029 | | 1.71 x 10 ⁻⁸ | 1.12 x 10 ⁻⁶ | 9.63 x 10 ⁻⁶ | 6.66 x 10 ⁻⁷ | 1.85 x 10 ⁻⁵ | | |
| TA-03-102 | | | | 3.66 x 10 ⁻⁹ | | | | |
| TA-16-205/450 | 2.42 x 10 ² | | | | | | | |
| TA-48-001 | | | | | 1.64 x 10 ⁻⁹ | 9.95 x 10 ⁻³ | | |
| TA-50-001 | | | | | 3.60 x 10 ⁻⁸ | | | |
| TA-50-037 | | | 1.15 x 10 ⁻⁹ | | 5.33 x 10 ⁻⁹ | | | |
| TA-50-069 | | 1.10 x 10 ⁻⁹ | 2.76 x 10 ⁻⁹ | | 7.47 x 10 ⁻¹⁰ | | | |
| TA-53-003 | 6.43 | | | | | 1.82 x 10 ⁻⁵ | 1.88 x 10 ¹ | |
| TA-53-007 | 4.68 | | | | | 6.05 x 10 ⁻³ | 1.99 x 10 ² | |
| TA-55-004 | 6.29 | | 1.02 x 10 ⁻⁹ | 1.92 x 10 ⁻⁸ | 4.78 x 10 ⁻⁸ | | | |
| Total^h | 2.60 x 10 ² | 1.82 x 10 ⁻⁸ | 1.13 x 10 ⁻⁶ | 9.66 x 10 ⁻⁶ | 7.57 x 10 ⁻⁷ | 1.60 x 10 ⁻² | 3.01 x 10 ^{2 i} | 0.00 |

NOTE: Some buildings have more than one sampled stack.

^a Includes both gaseous and oxide forms of tritium.

^b Includes Pu-238, Pu-239, and Pu-240.

^c Includes U-234, U-235, and U-238. Does not include radioactive progeny of U-238.

^d Includes Th-228, Th-230, and Th-232.

^e P/VAP—Particulate/vapor activation products (with measured radionuclides and short-lived radioactive progeny).

^f GMAP—Gaseous mixed activation products.

^g Strontium-90 values include yttrium-90 short-lived radioactive progeny.

^h Some differences may occur because of rounding.

ⁱ Total for GMAP includes 83.0 curies released from diffuse sources at TA-53.

LANSCE operated in the same configuration as recent years, with continuous beam operations to the 1L Target and the Lujan Neutron Scattering Center causing the majority of radioactive air emissions. Operations to the 1L Target took place from late spring of 2007 through the end of the calendar year.

The emissions control system at the LANSCE 1L Target is a “delay line,” which retains the short-lived activation products for a short time before release out the stack. This time interval allows decay of the short-lived radionuclides to non-radioactive components. A cracked valve in the inlet of this delay system caused substantially elevated emissions in 2005, compared to previous years. Additional delay line sections were installed in May and November of 2005 and the defective valve was fixed in late 2005. The additional delay line contributed to the relatively low emissions since 2005. In all years, emissions were below all regulatory limits.

Figure 4-18 shows the individual contribution of each emission type to total LANL emissions. It clearly shows that GMAP emissions and tritium emissions make up the vast majority of radioactive stack emissions. This plot does not directly relate to off-site dose because some radionuclides have a higher dose impact per curie released than others. GMAP and tritium remain the highest contributors to the total curies released. These gas-phase nuclides are not easily removed from an exhaust stack air stream by standard control techniques, such as filtration. GMAP and tritium emissions continue to fluctuate as the major emissions type; tritium cleanup operations and LANSCE operations vary from year to year. GMAP emissions are normally the greatest source of off-site dose from the airborne pathway because of the close proximity of the LANSCE facility to the LANL boundary.



Table 4-12
Detailed Listing of Activation Products Released from
Sampled LANL Stacks in 2007 (curies)

| TA-Building | Nuclide | Emission (Ci) |
|-------------|---------|---------------|
| TA-03-0029 | Br-82 | 0.0000185 |
| TA-48-0001 | As-72 | 0.00000432 |
| TA-48-0001 | As-73 | 0.000910 |
| TA-48-0001 | As-74 | 0.00000114 |
| TA-48-0001 | Br-76 | 0.000425 |
| TA-48-0001 | Br-77 | 0.000453 |
| TA-48-0001 | Br-82 | 0.00000493 |
| TA-48-0001 | Ga-68 | 0.00390 |
| TA-48-0001 | Ge-68 | 0.00390 |
| TA-48-0001 | Hg-197 | 0.0000404 |
| TA-48-0001 | Hg-197m | 0.0000404 |
| TA-48-0001 | Se-75 | 0.000276 |
| TA-53-0003 | Ar-41 | 0.752 |
| TA-53-0003 | Br-82 | 0.0000182 |
| TA-53-0003 | C-11 | 18.0 |
| TA-53-0007 | Ar-41 | 10.1 |
| TA-53-0007 | Be-7 | 0.00000162 |
| TA-53-0007 | Br-76 | 0.000760 |
| TA-53-0007 | Br-77 | 0.0000950 |
| TA-53-0007 | Br-82 | 0.00215 |
| TA-53-0007 | C-10 | 0.233 |
| TA-53-0007 | C-11 | 127.0 |
| TA-53-0007 | Hg-197 | 0.00150 |
| TA-53-0007 | Hg-197m | 0.00150 |
| TA-53-0007 | N-13 | 21.8 |
| TA-53-0007 | Na-24 | 0.00000211 |
| TA-53-0007 | O-14 | 0.390 |
| TA-53-0007 | O-15 | 39.5 |
| TA-53-0007 | Os-191 | 0.0000160 |
| TA-53-0007 | Se-75 | 0.0000229 |

Table 4-13
Radionuclide Half-Lives

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

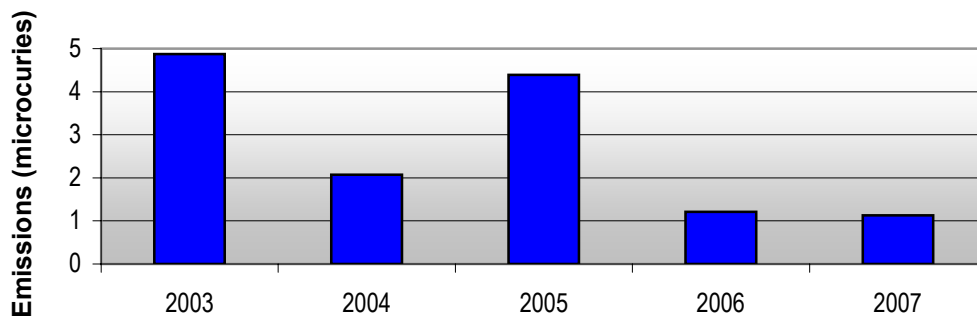


Figure 4-14. Plutonium emissions from sampled LANL stacks.

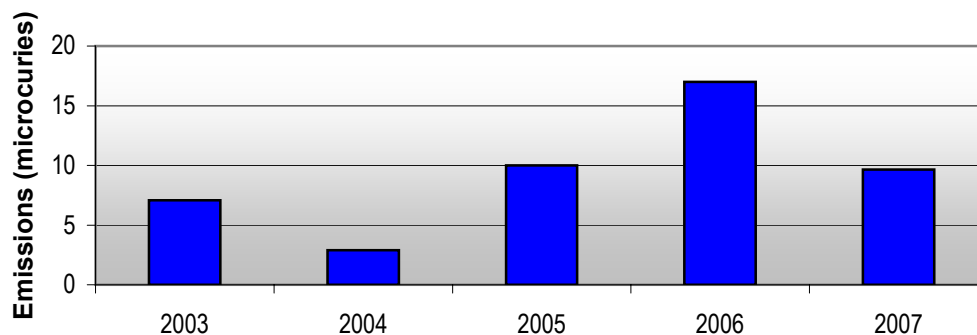


Figure 4-15. Uranium emissions from sampled LANL stacks.

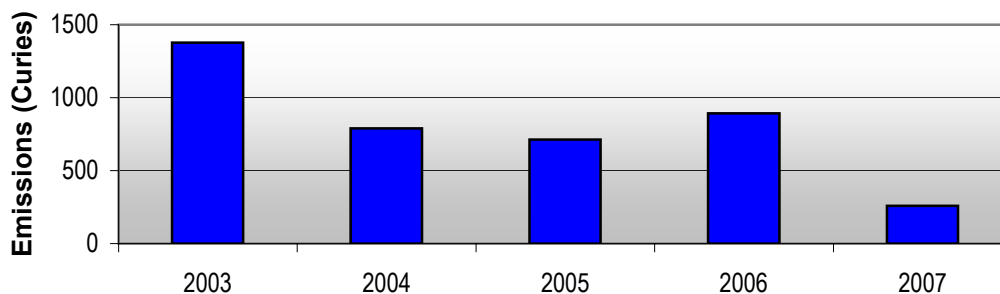


Figure 4-16. Tritium emissions from sampled LANL stacks.

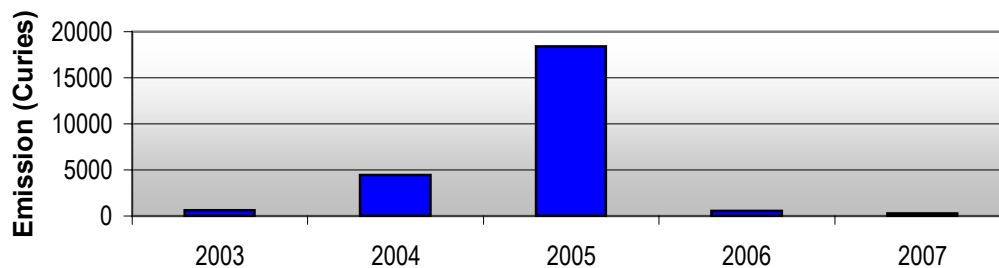


Figure 4-17. GMAP emissions from sampled LANL stacks.

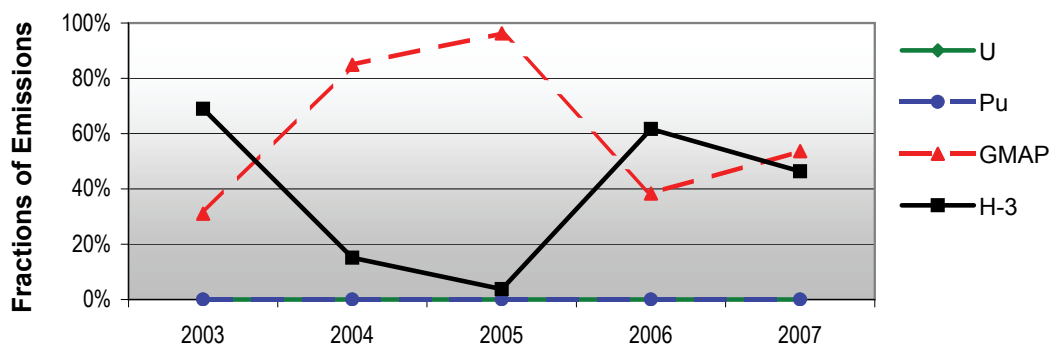


Figure 4-18. Fraction of total annual stack emissions resulting from plutonium, uranium, tritium, and GMAP.

C. GAMMA AND NEUTRON RADIATION MONITORING PROGRAM

1. Introduction

We monitor gamma and neutron radiation in the environment—that is, outside of the workplace—according to the criteria specified in McNaughton et al. (2000) as part of our Direct Penetrating Radiation Monitoring Network (DPRNET). Naturally occurring radiation originates from terrestrial and cosmic sources. It is extremely difficult to distinguish man-made sources from the natural background because the natural radiation doses are generally much larger than those from man-made sources. The dose rate from natural terrestrial and cosmic sources measured by the dosimeters (does not include radon and internal sources) varies from approximately 100 to 200 mrem/yr.

2. Monitoring Network

a. Dosimeter Locations

In an attempt to distinguish any impact from LANL operations on the public, we located 85 thermoluminescent dosimeter (TLD) stations around LANL and in the surrounding communities. There is a TLD at every AIRNET station shown in Figures 4-1 and 4-3; the corresponding TLD station numbers are listed in Supplementary Data Table S4-10. Additional stations are around TA-54, Area G (shown in Figure 4-19); at LANSCE (eight stations); at Santa Clara Pueblo (two stations); and inside the San Ildefonso Sacred Area (two stations).

b. Neutron Dosimeters

We monitor potential neutron doses with 47 albedo TLD stations near known or suspected sources of neutrons: TA-53 (Area G) and TA-54 (LANSCE). Albedo dosimeters are sensitive to neutrons and use a hydrogenous material that causes neutron backscatter to simulate the human body.

c. Neutron Background

Natural cosmic rays result in a neutron background dose of approximately 10 mrem/yr (NCRP 1987b). However the neutron dosimeters record a dose of approximately 2 mrem/yr because the environmental dosimeters are calibrated with a D₂O-moderated neutron source with a different energy spectrum from cosmic-ray neutrons. Therefore, a neutron reading of 2 mrem/yr indicates a normal background reading.

3. Quality Assurance

The calibration laboratory at LANL's Health Physics Measurements Group (RP-2) calibrates the dosimeters every quarter of the calendar year. The DOE Laboratory Accreditation Program has accredited the dosimeters that RP-2 provides, and RP-2 provides quality assurance (QA) for the dosimeters. The uncertainty in the TLD data is estimated from the standard deviation of data from dosimeters exposed to the same dose. The overall 1s uncertainty is similar to previous data and is 9%.

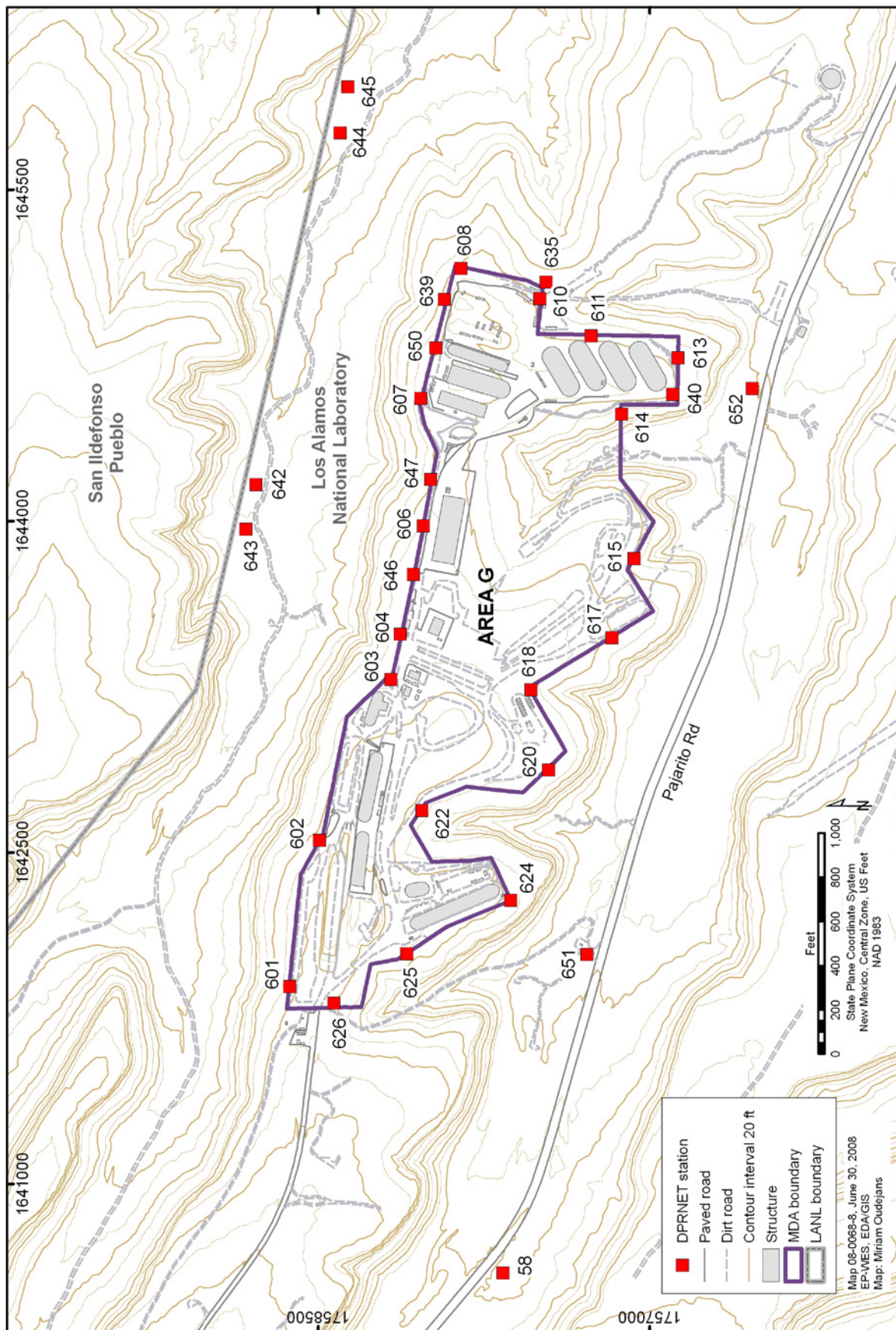


Figure 4-19. Thermoluminescent dosimeter locations at TA-54, Area G.

4. Results

The annual dose equivalents at all stations except those within or near Area G are consistent with natural background radiation and with previous measurements. Detailed results are listed in the Supplemental Data [Table S4-10](#). The only location with a measurable contribution from LANL operations is near TA-54, Area G. Figure 4-19 shows the locations of the stations at TA-54, Area G.

South of the line of TLDs from #601 to #608, Area G is a controlled-access area, so these data are not representative of a potential public dose. However, TLDs #642 and #643 are close to the boundary of the Pueblo de San Ildefonso sacred area, which is accessible to members of the Pueblo. Furthermore, TLDs #133 and #134 are deployed by Pueblo staff within the boundaries of the sacred area. After subtracting background, the annual doses measured by TLDs #134, #642, and #643 were 12 mrem, 9 mrem, and 9 mrem, respectively. The dose measured by TLD #134 is higher than the others because TLDs #642 and #643 are in Cañada del Buey and are partially shielded by the rim of the canyon. These are the doses that would be received by a person who is at the location of the TLDs 24 hours per day and 365 days per year. As discussed in Chapter 3, we apply an occupancy factor of 1/16 (NCRP 1976) so the public dose near TLD #134 is calculated to be 0.75 mrem/yr.

TLDs #133, #644, and #645 are located several hundred meters further from Area G and measure nothing above the terrestrial and cosmic-ray natural background. This is expected because of the distance and the shielding provided by the air. Annual doses of 9 mrem were measured by TLDs #651 and #652, which are located along Pajarito Road, south of Area G. This section of Pajarito Road is controlled to limit public access.

D. NON-RADIOLOGICAL AMBIENT AIR MONITORING

1. Introduction

The nonradioactive ambient air monitoring network (NonRadNet) continued to develop a database of typical background levels of selected nonradiological species in the communities nearest LANL and measured LANL's potential contribution to nonradiological air pollution in the surrounding communities. The program consists of six ambient particulate matter monitoring units at three locations plus selected AIRNET samples, which are analyzed for the nonradiological constituents aluminum, calcium, and beryllium.

2. Air Monitoring Network

During 2007, ambient particulate matter monitoring continued at three locations—one in White Rock and two in Los Alamos. The White Rock sampling location is at the White Rock Fire Station (at AIRNET station 15). One Los Alamos sampling station is at the Los Alamos Medical Center (at AIRNET station 61) and the other is near 48th Street (at AIRNET station 6). Both of the Los Alamos locations lie between TA-3 and the population center of the Los Alamos town site. Two monitors are operated at each location: one for particles with diameters of 10 micrometers (μm) or less (PM-10), and another for particles with diameters of 2.5 μm or less (PM-2.5).

3. Sampling Procedures, Data Management, and Quality Assurance

A tapered-element oscillating microbalance ambient particulate monitor, fitted with either a PM-10 or a PM-2.5 sample inlet, continuously measures PM-10 and PM-2.5 concentrations. The microbalance has an oscillating ceramic “finger” with a filter that collects particles. The added mass of the particles changes the resonant frequency of the oscillator. As the change in frequency is measured, an associated mass of accumulated particulate matter is recorded and saved. The data are later downloaded to a database. Personnel use these data as an indicator of natural dust loading in the atmosphere. The sampled air volumes are calculated and the ambient air concentrations derived.

4. Ambient Air Concentrations

For particulate matter, we achieved an overall data collection efficiency of approximately 75% during 2007.

Annual averages and 24-hour maxima for both particle sizes at the three locations are shown in Table 4-14. The annual average for PM-10 is about 14 $\mu\text{g}/\text{m}^3$ at all locations; the annual average for PM-2.5 is about 8 $\mu\text{g}/\text{m}^3$. The annual averages and the 24-hour maxima for both PM-2.5 and PM-10 are well below EPA standards for all three locations.

Table 4-14
PM-2.5 and PM-10 Concentration Data Summary for 2007 ($\mu\text{g}/\text{m}^3$)

| Station Location | Constituent | Maximum 24-Hour ($\mu\text{g}/\text{m}^3$) | Annual Average ($\mu\text{g}/\text{m}^3$) |
|---------------------------|-------------|---|--|
| 48th Street, Los Alamos | PM-10 | 53 | 12 |
| | PM-2.5 | 19 | 8 |
| Los Alamos Medical Center | PM-10 | 66 | 15 |
| | PM-2.5 | 18 | 8 |
| White Rock Fire Station | PM-10 | 46 | 15 |
| | PM-2.5 | 18 | 7 |
| EPA Standard | PM-10 | 150 | 50 ^a |
| | PM-2.5 | 65 | 15 ^a |

^a EPA 40 CFR Part 50

5. Detonation and Burning of Explosives

LANL tests explosives by detonating them at firing sites operated by the Dynamic and Energetic Materials Division and the Hydrodynamic Experiments Division. LANL maintains records that include the type of explosives used and other material expended at each site. The Data Supplement Table S4-11 (on the included compact disc) summarizes the amounts of expended materials for the last five years. LANL also burns scrap and waste explosives because of treatment requirements and safety concerns. In 2007, LANL burned roughly 12,000 kilograms of high explosives. An assessment of the ambient impacts of high-explosives testing (DOE 1999) indicates no adverse air-quality impacts.

6. Beryllium Sampling

During 2007, we analyzed quarterly composite samples from 35 sites for beryllium, aluminum, and calcium (Table S4-12 in the Data Supplement). These sites are located near potential beryllium sources at LANL or in nearby communities.

The State of New Mexico has no ambient air quality standard for beryllium. For comparison purposes, we use the NESHAP standard of 10 ng/m^3 (40 CFR Part 61). All measured values were less than 1% of this standard. Beryllium air concentrations for 2007 were similar to those measured in recent years.

E. METEOROLOGICAL MONITORING

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, the meteorology team measures a wide variety of meteorological variables across the network, including wind, temperature, pressure, relative humidity and dew point, precipitation, and solar and terrestrial radiation. The Meteorological Monitoring Plan (Rishel et al. 2003) provides details of the meteorological monitoring program. An electronic copy of the “Meteorological Monitoring Plan” is available online at <http://www.weather.lanl.gov/documentation.asp>.

2. Monitoring Network

A network of seven towers gathers meteorological data at the Laboratory (Figure 4-20). Four of the towers are located on mesa tops (TA-6, TA-49, TA-53, and TA-54), two are in canyons (TA-41 in Los Alamos Canyon and MDCN in Mortandad Canyon), 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 located adjacent to the TA-6 meteorological tower. Precipitation is also measured in North Community (NCOM) of the Los Alamos town site.

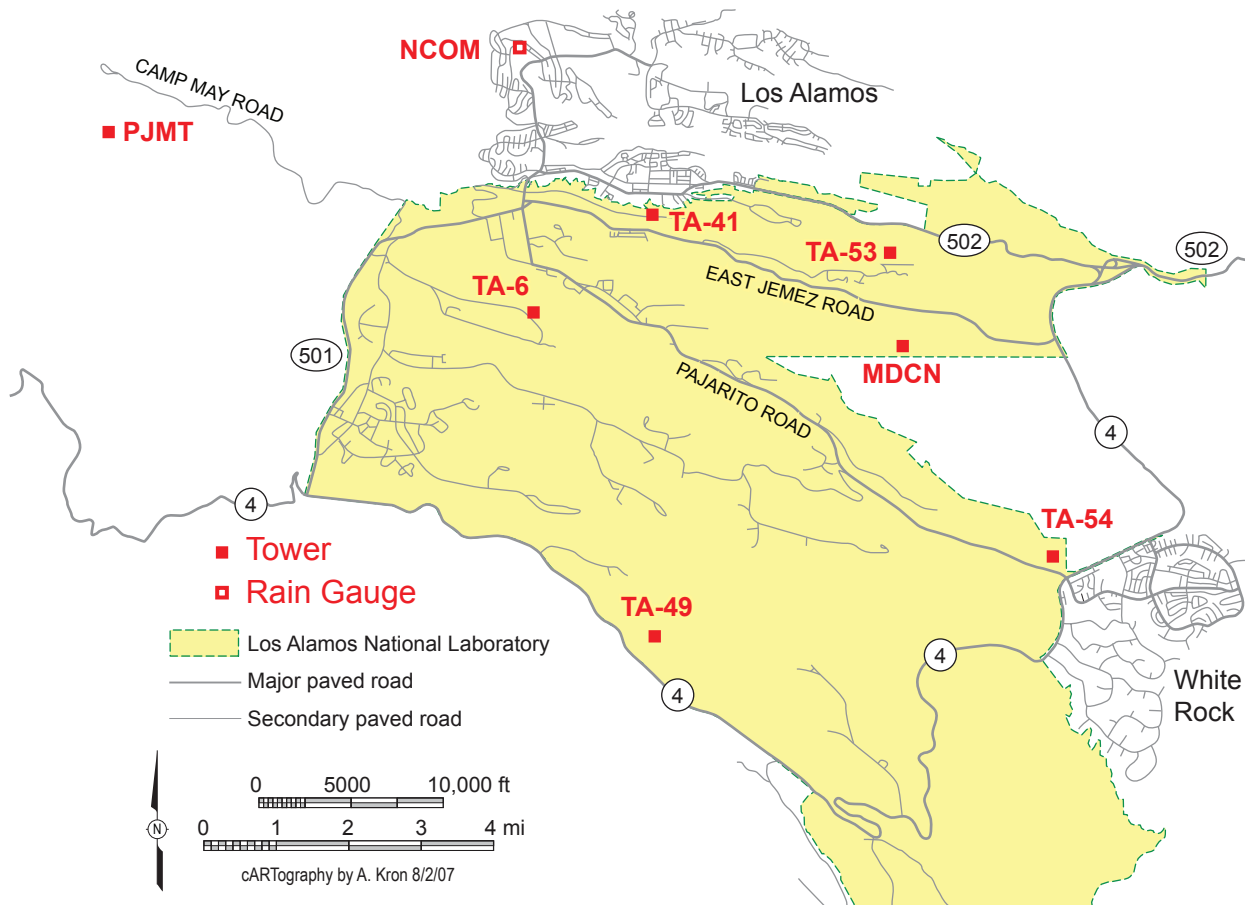


Figure 4-20. Location of meteorological monitoring towers and rain gauges.

3. Sampling Procedures, Data Management, and Quality Assurance

We place instruments in the meteorological network 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. Temperature and wind are measured at multiple levels on open lattice towers. 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 that 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 hertz (Hz), store the data, average the samples over a 15-min period, and transmit the data to a Hewlett-Packard workstation located at the Meteorology Lab (TA-59) by telephone or cell phone. The workstation automatically edits measurements that fall outside of realistic ranges. Time-series plots of the data are also generated for a meteorologist's data-quality

review. Daily statistics of certain meteorological variables (e.g., daily minimum and maximum temperatures, daily total precipitation, maximum wind gust, etc.) are also generated and checked for quality. During the past 50 years, a similar once-daily set of statistics has been telephoned to the National Weather Service. Observers log cloud type and percentage cloud cover three times daily.

All meteorological instruments are biennially refurbished and calibrated during an internal audit/inspection. Field instruments are replaced with backup instruments, and the replaced instruments are checked to verify they remained in calibration while in service. An external audit is typically performed once every two to three years. The most recent audit was an “assist visit” by the DOE Meteorological Coordinating Council in August 2006. The report can be requested at <http://www.weather.lanl.gov/>.

4. Climatology

Los Alamos has a temperate, semiarid mountain climate. Atmospheric moisture levels are low, and clear skies are present about 75% of the time. These conditions lead to high solar heating during the day and strong long-wave radiative cooling at night. Winters are generally mild, with occasional winter storms. Spring is the windiest season. Summer is the rainy season, with frequent afternoon thunderstorms. Fall is typically dry, cool, and calm. The climate statistics summarized here are from analyses of historical meteorological databases maintained by the meteorology team and following Bowen (1990 and 1992).

The years from 1971 to 2000 represents the time period over which the climatological standard normal is defined. The standard should be 1961-1990, according to the World Meteorological Organization, until 2021 when 1991-2020 will become the standard, and so on every 30 years (WMO 1984). In practice, however, normals are computed every decade, and so 1971-2000 is generally used. Our averages are calculated according to this widely followed practice.

December and January are the coldest months. The majority (90%) of minimum temperatures during December and January range from 4°F to 31°F. Minimum temperatures are usually reached shortly before sunrise. Ninety percent (90%) of maximum temperatures, which are usually reached in mid-afternoon, range from 25°F to 55°F. The record low temperature of -18°F was recorded on January 13th 1963. Wintertime arctic air masses that descend into the central United States tend to have sufficient time to heat before they reach our southern latitude so the occurrence of local subzero temperatures is rare. Winds during the winter are relatively light, so extreme wind chills are uncommon.

Temperatures are highest from June through August. Ninety percent (90%) of minimum temperatures during these months range from 45°F to 61°F and 90% of maximum temperatures range from 67°F to 89°F. The record high temperature of 95°F was recorded on June 29, 1998.

The average annual precipitation, which includes both rain and the water equivalent from frozen precipitation, is 18.95 in. The average annual snowfall is 58.7 in. Winter precipitation in Los Alamos is often caused by storms approaching from the Pacific Ocean. Large snowfalls may occur locally as a result of orographic lifting of the storms by the high terrain. The record single-day snowfall is about 39 in., which occurred between 11 a.m. January 15, 1987, and 11 a.m. the next day. The record single-season snowfall is 153 in. set in 1986–87.

Precipitation in July and August account for 36% of the annual precipitation and encompass the bulk of the rainy season, which typically begins in early July and ends in mid September. Afternoon thunderstorms form as moist air from the Gulf of California and the Gulf of Mexico is convected and/or orographically lifted by the Jemez Mountains. The thunderstorms yield short, heavy downpours and an abundance of lightning.

The complex topography of the Pajarito Plateau influences local wind patterns, notable in the absence of large-scale disturbances. Often a distinct diurnal cycle of winds occurs. As air close to the ground is heated during the day, it tends to flow upslope along the ground. This is called anabatic flow. During the night, cool air

that forms close to the ground tends to flow downslope and is known as katabatic flow. As the daytime anabatic breeze flows up the Rio Grande valley, it adds a southerly component to the prevailing westerlies of the Pajarito Plateau. Nighttime katabatic flow enhances the local westerly winds. Flow in the east-west-oriented canyons of the Pajarito Plateau is generally aligned with the canyons, so canyon winds are usually from the west at night as katabatic flow and from the east during the day.

5. 2007 in Perspective

Figure 4-21 presents a graphical summary of Los Alamos weather for 2007. The figure depicts the year's monthly average temperature ranges, monthly precipitation, and monthly snowfall totals compared to monthly normals (averages during the 1971–2000 time period).

The year 2007 was warmer and wetter than normal. The average annual temperature in 2007 of 49.2°F exceeded the normal annual average of 47.9°F by 1.3°F. The total precipitation in 2007 of 20.31 in. was 107% of normal (18.95 in.). Summer and autumn were particularly warm, while January, February, and December were cooler than normal. The pace of precipitation held close to normal until about July, when it was clear that the monsoon would miss the average starting date of approximately July 7. Late monsoons are often weak monsoons and the end of August seemed to confirm this rule of thumb. An unusually wet September, however, brought the annual rainfall total back to normal. October and November were unseasonably warm and also very dry. A massive system from the tropical Pacific Ocean arrived from the south and delivered a 25-year rainfall event from November 30 through December 1, bringing rainfall totals for both months to well above normal. Winter arrived approximately one week into December, with snow and cold temperatures to close out the year.

Temperature and precipitation data have been collected in the Los Alamos area since 1910. Figure 4-22 shows the historical record of temperatures in Los Alamos from 1927 through 2007. The annual average temperature is not the average temperature per se, but rather the mid-point between daily high and low temperatures, averaged over the year. One-year averages are shown in green in Figure 4-22. Every year since 1998 has been warmer than the 1971-2000 normal, just under 48°F. To aid in showing longer-term trends, the five-year running mean is also shown. With five-year averaging, for example, it can be seen that the warm spell during the past decade is not as extreme as the warm spell during the early-to-mid 1950s. On the other hand, the current warming trend is longer-lived.

Figure 4-23 shows the historical record of the annually summed total precipitation. The drought appears to have ended in 2003, and 2004 and 2005 brought surplus precipitation to help restore normal conditions. The moist trend did not continue in 2006, but returned again in 2007 with just over 20 inches, where the norm is 19 inches. As with the historical temperature profile, the five-year running mean is also shown. The five-year average indicates not only that the recent drought is behind us, but that it was the most severe drought on the 80-year record in Los Alamos.

Daytime winds (sunrise to sunset) and nighttime winds (sunset to sunrise) are shown in the form of wind roses in Figure 4-24. Wind roses depict the percentage of time that wind blows from each of 16 direction bins. For example, winds are directly from the south at TA-6 over 12% of the time during days in 2007. Winds are directly from the north about 3% of the time during the day. Wind roses also show the distribution of wind speed. About 8% of the time, for example, winds at TA-6 are from the south and range from 2.5 to 5 meters per second. Winds from the south at TA-6 exceed 7.5 meters per second only a fraction of 1% of the time.



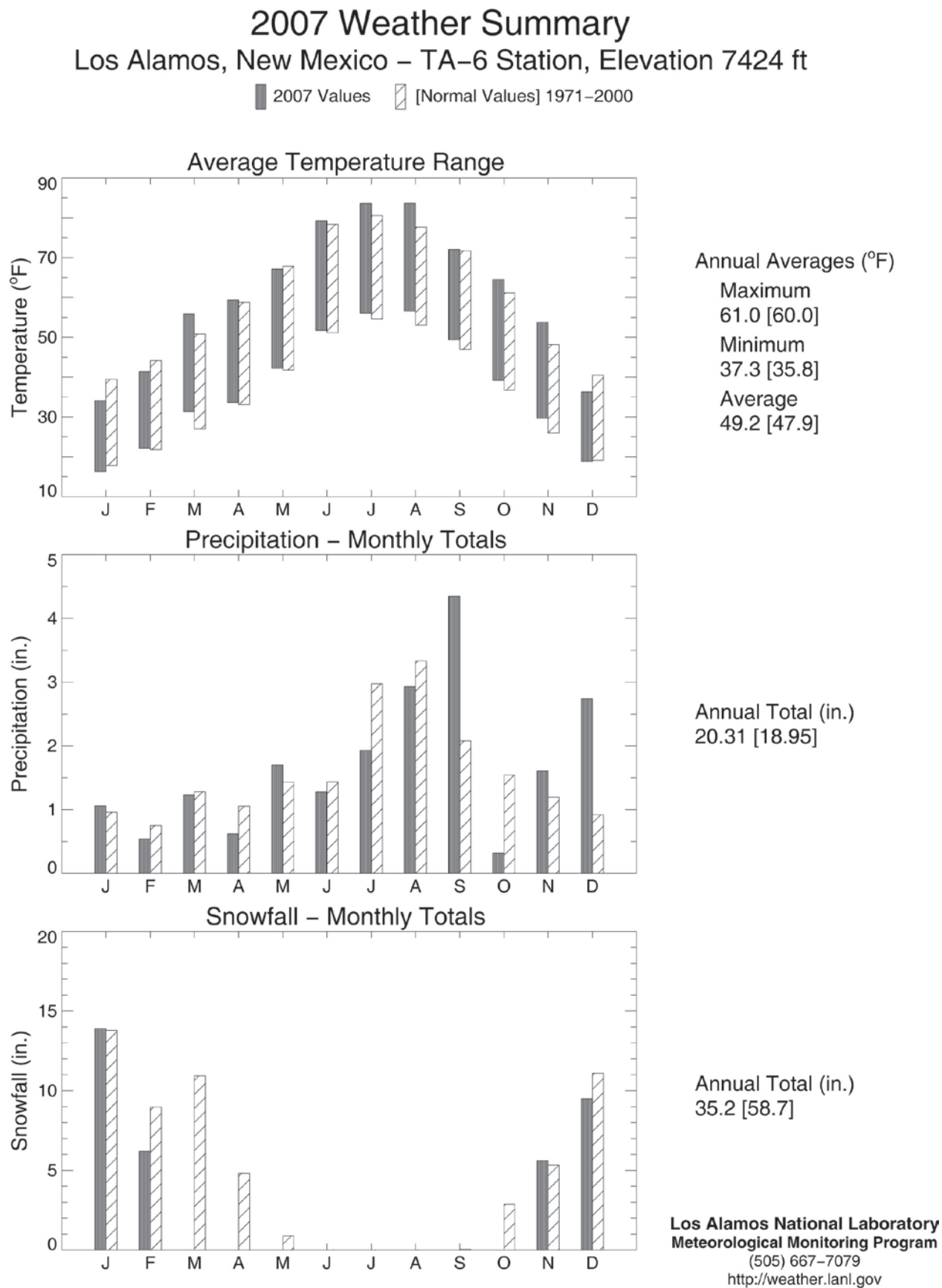


Figure 4-21. Weather summary for Los Alamos for 2007 at the TA-6 meteorology station.

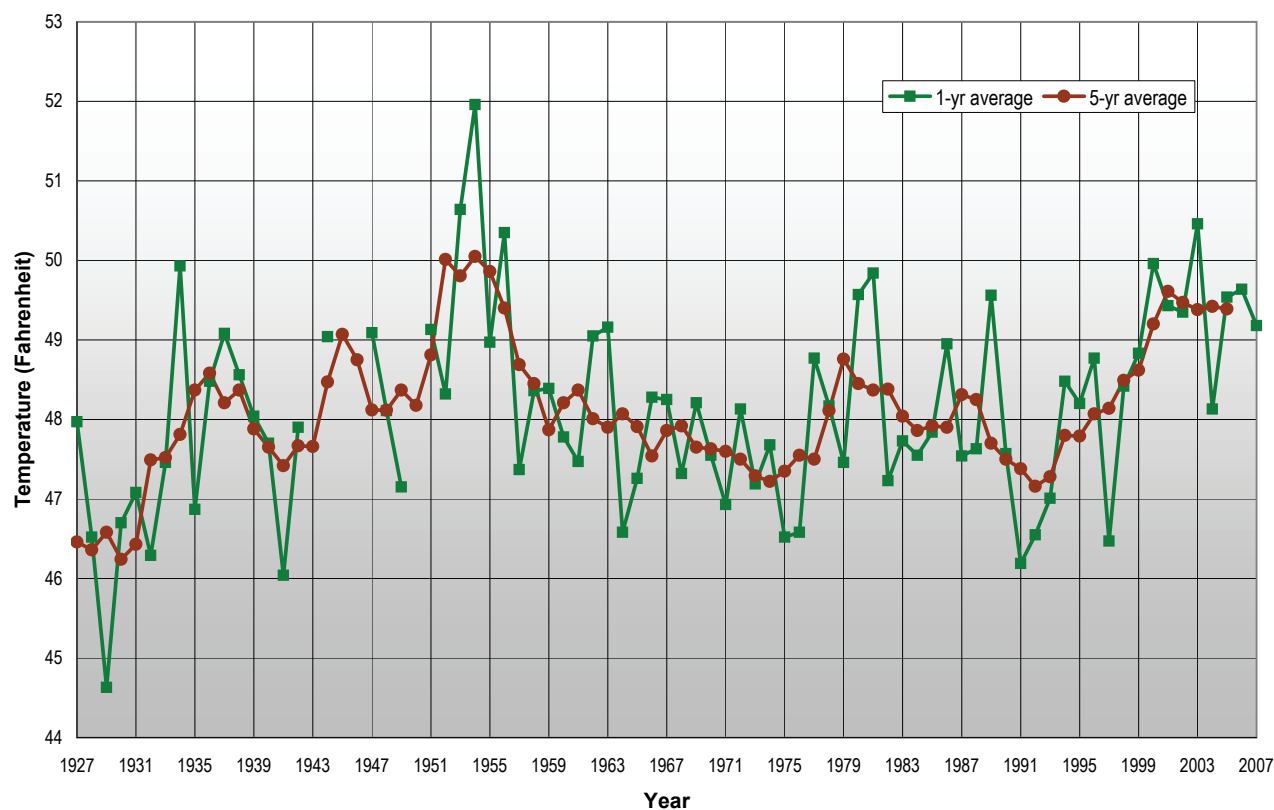


Figure 4-22. Temperature history for Los Alamos.

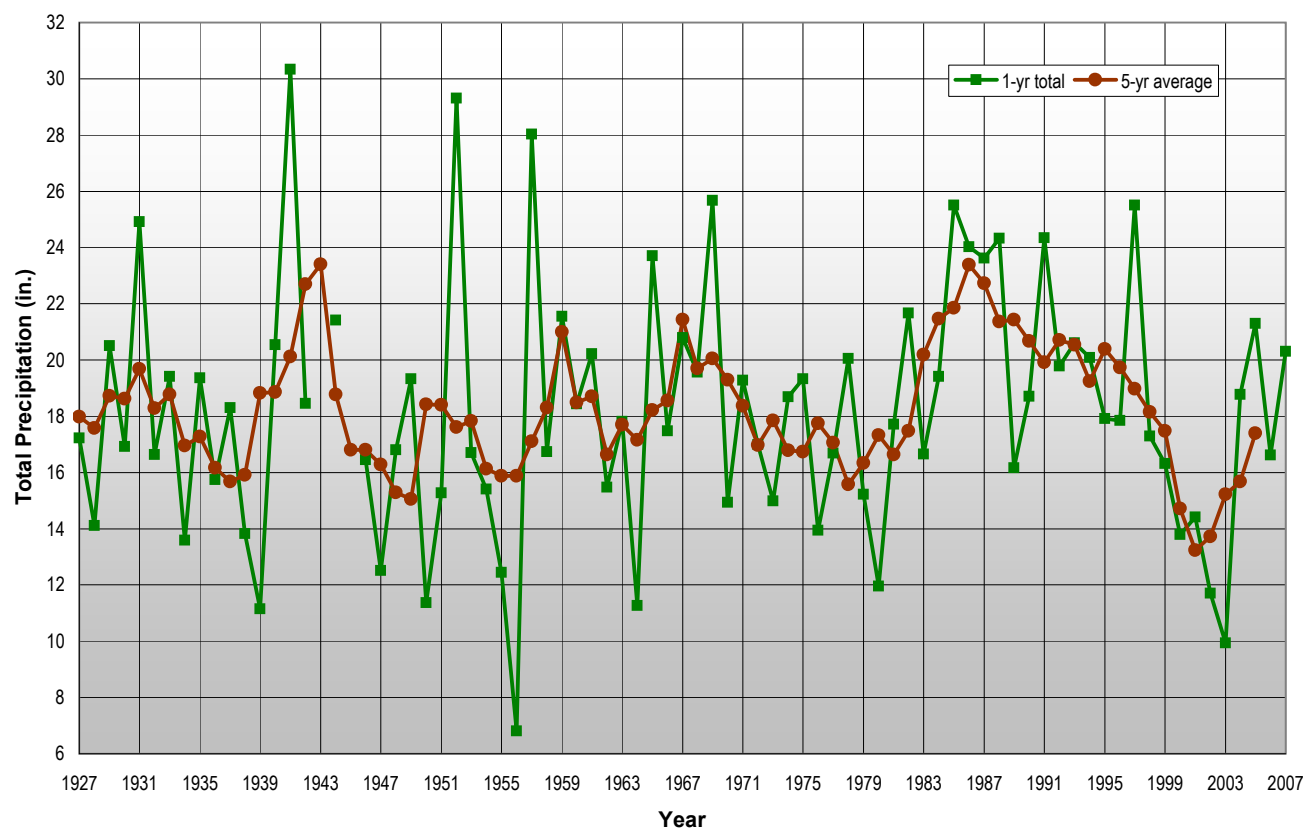


Figure 4-23. Total precipitation history for Los Alamos.

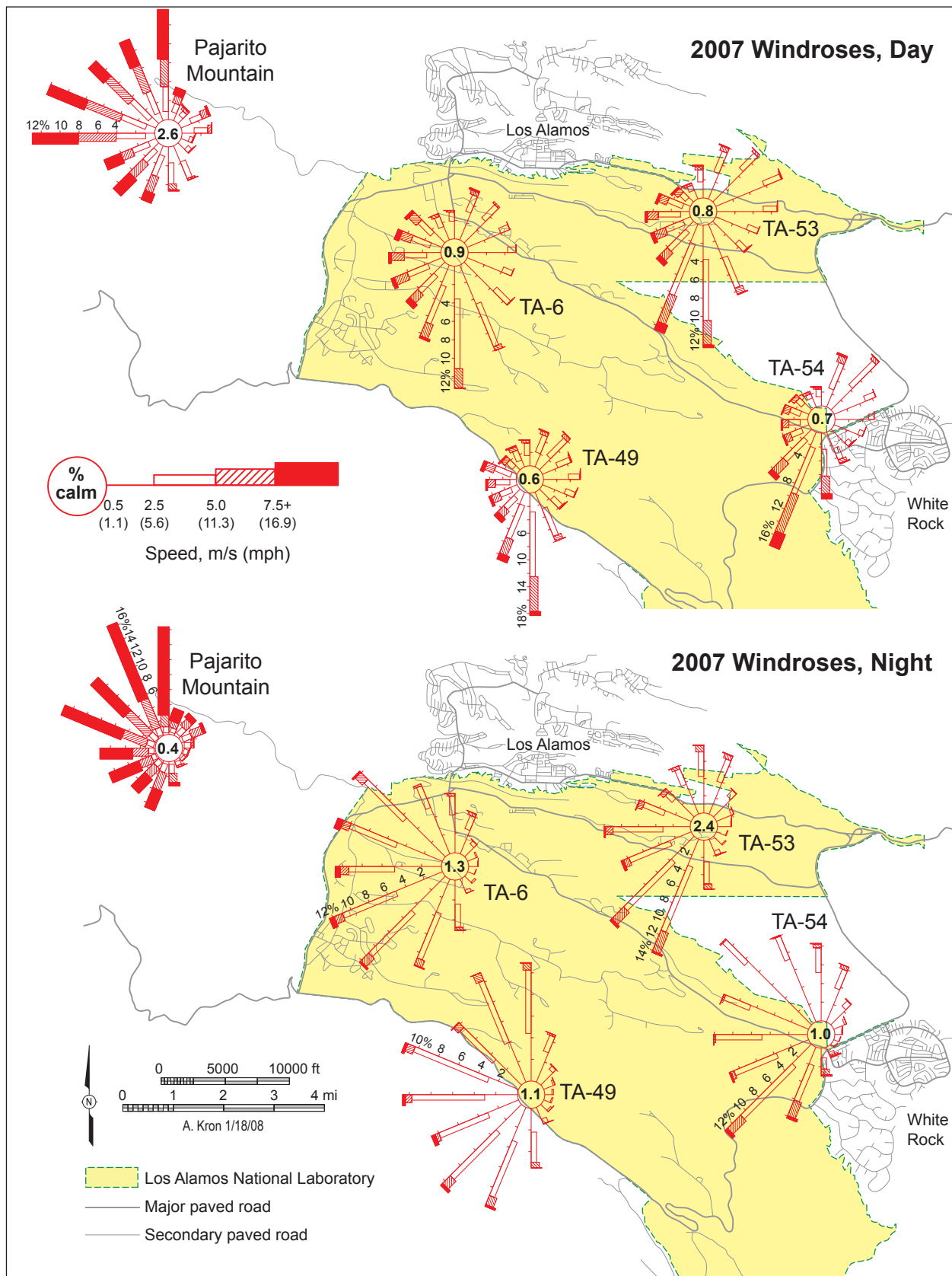


Figure 4-24. Daytime and nighttime wind roses for 2007.

The wind roses are based on 15-minute-averaged wind observations for 2007 at the four Pajarito Plateau towers and the Pajarito Mountain tower. Interestingly, wind roses from different years are almost identical, indicating that wind patterns are constant when averaged over a year.

Daytime winds measured by the four Pajarito Plateau towers are predominately from the south, consistent with the typical upslope flow of heated daytime air moving up the Rio Grande valley. Nighttime winds on the Pajarito Plateau are lighter and more variable than daytime winds and typically have a westerly component, resulting from a combination of prevailing westerly winds and downslope katabatic flow of cooled mountain air.

Winds atop Pajarito Mountain are more representative of upper-level flows and primarily range from the northwest to the southwest, reflecting the prevailing westerlies. The thick, red barbs of the Pajarito Mountain roses reveal that winds there are much faster than on the Pajarito Plateau and are faster at night than during the day.

Winds on the Pajarito Plateau are faster during the day than at night due to vertical mixing which is driven by sunshine. During the day, the mixing is strong and brings momentum down to the surface. This results in slower wind aloft, at the level of Pajarito Mountain, and faster wind at the surface. At night, there is little mixing so wind aloft remains fast - hence faster nighttime wind at Pajarito Mountain. Wind at the surface receives little boosting from aloft and so is slower on the Pajarito Plateau at night than during the day.

F. QUALITY ASSURANCE PROGRAM

1. Quality Assurance Program Development

During 2007, the air quality monitoring and compliance organizations revised approximately 35 procedures and one quality assurance project plan to reflect constant improvements in the processes. Together, these plans and procedures describe or prescribe all the planned and systematic activities necessary to provide confidence that processes perform satisfactorily. All current quality-related documents are available online at <http://www.lanl.gov/environment/air/qa.shtml>.

2. Field Sampling Quality Assurance

a. Methods

Overall quality of this portion of the program is maintained through the rigorous use of documented procedures that govern all aspects of the sample-collection program.

Particulate and water-vapor samples are (1) collected from commercially available media of known performance, (2) collected under common chain-of-custody procedures using field-portable electronic data systems to minimize the chances of data transcription errors, and (3) prepared in a secure and radiologically clean laboratory for shipment. The samples are delivered to internal and external analytical laboratories under full chain-of-custody, including secure FedEx shipment, to all external vendors and tracked at all stages of their collection and analysis through the AIRNET and RADAIR relational databases.

Field-sampling completeness is assessed every time the analytical laboratory returns the AIRNET biweekly gross alpha/beta data. RADAIR field-sampling completeness is evaluated each week upon receipt of the gross alpha/beta and tritium bubbler data. All these calculations are performed for each ambient air and stack sampling site and are included in the quality assessment memo prepared by stack monitoring staff to evaluate every data group received from a supplier.

b. Results

Field sample completeness for AIRNET was 99.5% for filters and 99.2% for silica gel (tritium samples). Sample run time was greater than 98.5% for AIRNET and 99.46% for stacks.

3. Analytical Laboratory Quality Assessment

a. Methods

Specific statements of work are written to govern the acquisition and delivery of analytical-chemistry services after the Data Quality Objective process has identified and quantified our program objectives. These statements of work are sent to potentially qualified suppliers who undergo a pre-award, on-site assessment by experienced and trained quality systems and chemistry-laboratory assessors. Statement of work specifications, professional judgment, and quality system performance at each laboratory, including recent past performance on nationally conducted performance evaluation programs, are primarily used to award contracts for specific types of radiochemical and inorganic chemical analyses.

Each analytical laboratory conducts its chain-of-custody and analytical processes under its own quality plans and analytical procedures. We submit independently prepared blind spiked samples with each sample set to be analyzed for tritium. Preliminary data are returned by email in an electronic data deliverable of specified format and content. The analytical laboratory also submits a full paper set of records that serves as the legally binding copy of the data. Each set of samples contains all the internal QA/QC data the analytical laboratory generates during each phase of analysis, including laboratory control standards, process blanks, matrix spikes, duplicates, and replicates, when applicable. The electronic data are uploaded into either the AIRNET or RADAIR databases and immediately subjected to a variety of quality and consistency checks. Analytical completeness is calculated, tracking and trending of all blank and control-sample data is performed, and all tracking information documented in the quality assessment memo mentioned in the field sampling section. All parts of the data management process are tracked electronically in each database, and periodic reports to management are prepared.

b. Results

Analytical data completeness was 99.4% for AIRNET filters, 99.5% for AIRNET silica gel, and 99.91% for stacks. The overall results of the quality monitoring in 2007 indicate that all analytical laboratories maintained the same high level of control observed in the past several years.

4. Analytical Laboratory Assessments

During 2007, one internal and one external laboratory performed all analyses reported for AIRNET and stack samples. Paragon Analytics, Inc., Fort Collins, Colorado, provided the following analyses:

- Biweekly gross alpha, gross beta, and gamma analyses of filters for AIRNET.
- Biweekly analyses for tritium in AIRNET silica gel.
- Weekly gross alpha, gross beta, gamma, and stable beryllium analyses on stack samples.
- Quarterly analyses for alpha-emitting isotopes (americium, plutonium, and uranium) and stable beryllium, calcium, and aluminum on AIRNET quarterly composite samples.
- Semester analyses of composites of stack filters for gross alpha, gross beta, americium-241, gamma-emitting isotopes, lead-210, polonium-210, plutonium isotopes, strontium-90, thorium isotopes, and uranium isotopes.

The Laboratory's on-site Health Physics Analytical Laboratory (HSR-4) performed instrumental analyses of tritium in stack emissions.

Paragon Analytics was assessed during 2006 and the laboratory was found to provide very high quality work in compliance with all LANL requirements. This laboratory has consistently performed well. The laboratory annually participates in two national performance evaluation studies and the study sponsors have consistently judged the analytical laboratory to have acceptable performance for all analytes attempted in all air sample matrices.

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5. Groundwater Monitoring



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A. INTRODUCTION

Los Alamos National Laboratory (LANL or the Laboratory) routinely analyzes groundwater samples to monitor water quality beneath the Pajarito Plateau and the surrounding area. The Laboratory conducts groundwater monitoring and characterization programs to comply with the requirements of the Department of Energy (DOE) Orders and New Mexico (NM) and federal regulations. The objectives of the Laboratory’s Water Stewardship Program are to determine compliance with waste discharge requirements and to evaluate any impact of Laboratory activities on groundwater resources. This program addresses regulatory compliance, environmental monitoring, resource management, aquifer protection, and hydrogeologic investigations (LANL 1996, 1998).

Because of the Laboratory’s semiarid, mountainside setting, significant groundwater is found only at depths of more than several hundred feet. The Los Alamos County public water supply comes from supply wells that draw water from the regional aquifer, found at depths of 600 to 1,200 ft. Groundwater protection efforts at the Laboratory focus on the regional aquifer underlying the area and also include the shallow perched groundwater found within canyon alluvium and the perched groundwater at intermediate depths above the regional aquifer.

Groundwater monitoring conducted during 2007 was carried out according to the Interim Sitewide Monitoring Plan approved by the New Mexico Environment Department (NMED) under the Compliance Order on Consent (Consent Order) (LANL 2006). The Water Stewardship Program collected groundwater samples from wells and springs within or adjacent to the Laboratory and from the nearby Pueblo de San Ildefonso.

B. HYDROGEOLOGIC SETTING

The following sections describe the hydrogeologic setting of the Laboratory and include a summary of groundwater contaminant sources and distribution. Additional detail can be found in LANL (2005a), which summarizes results of investigations conducted under the Hydrogeologic Workplan from 1998 through 2004.

1. Geologic Setting

The Laboratory is located in northern NM on the Pajarito Plateau, which extends eastward from the Sierra de los Valles, the eastern range of the Jemez Mountains (Figure 5-1). The Rio Grande borders the Laboratory on the east. Rocks of the Bandelier Tuff cap the Pajarito Plateau. The tuff was formed from volcanic ashfall deposits and pyroclastic flows that erupted from the Jemez Mountains volcanic center approximately 1.2 to 1.6 million years ago. The tuff is more than 1,000 ft thick in the western part of the plateau and thins eastward to about 260 ft adjacent to the Rio Grande.

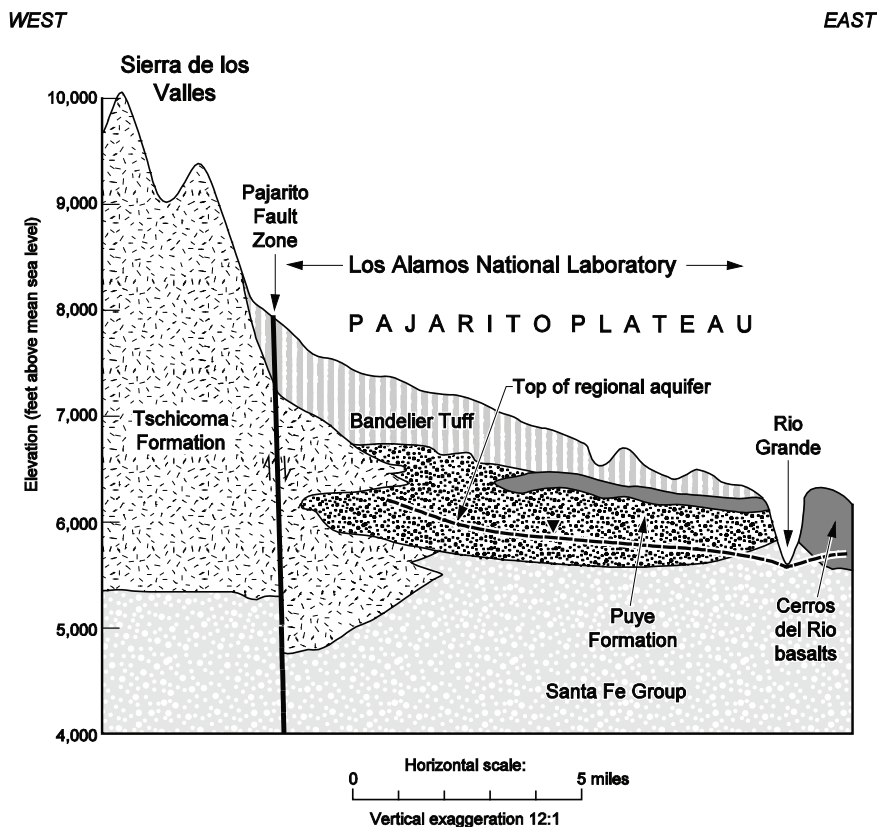


Figure 5-1. Generalized geologic cross-section of the Pajarito Plateau.

On the western part of the Pajarito Plateau, the Bandelier Tuff overlaps the Tschicoma Formation, which consists of older volcanics that form the Jemez Mountains (Figure 5-1). The Puye Formation conglomerate underlies the tuff beneath the central and eastern portion of the plateau. The Cerros del Rio basalt flows interfinger with the Puye Formation conglomerate beneath the Laboratory. These formations overlie the sediments of the Santa Fe Group, which extend across the Rio Grande Valley and are more than 3,300 ft thick.

2. Groundwater Occurrence

Due to its location on a semiarid mountainside, the Laboratory land sits atop a thick zone of mainly unsaturated rock, with the regional aquifer found 600 to 1,200 ft below the ground surface. Groundwater beneath the Pajarito Plateau occurs in three modes, two of which are perched (Figure 5-2). Perched groundwater is retained above less permeable layers and is separated from underlying groundwater by unsaturated rock.

The three modes of groundwater occurrence are (1) perched alluvial groundwater in canyon bottoms, (2) discontinuous zones of intermediate-depth perched groundwater whose location is controlled by availability of recharge and by subsurface changes in rock type and permeability, and (3) the regional aquifer beneath the Pajarito Plateau. The regional aquifer extends throughout the neighboring Española Basin.

Stream runoff may be supplemented or maintained by Laboratory discharges. Many relatively dry canyons have little surface water flow and little or no alluvial groundwater. Streams have filled some parts of canyon bottoms with alluvium up to 100-ft thick. In wet canyons, runoff percolates through the alluvium until downward flow is impeded by less permeable layers of tuff or other rocks, maintaining shallow bodies of perched groundwater within the alluvium. These saturated zones have limited extent, as evapotranspiration and percolation into underlying rocks deplete the alluvial groundwater as it moves down the canyon.

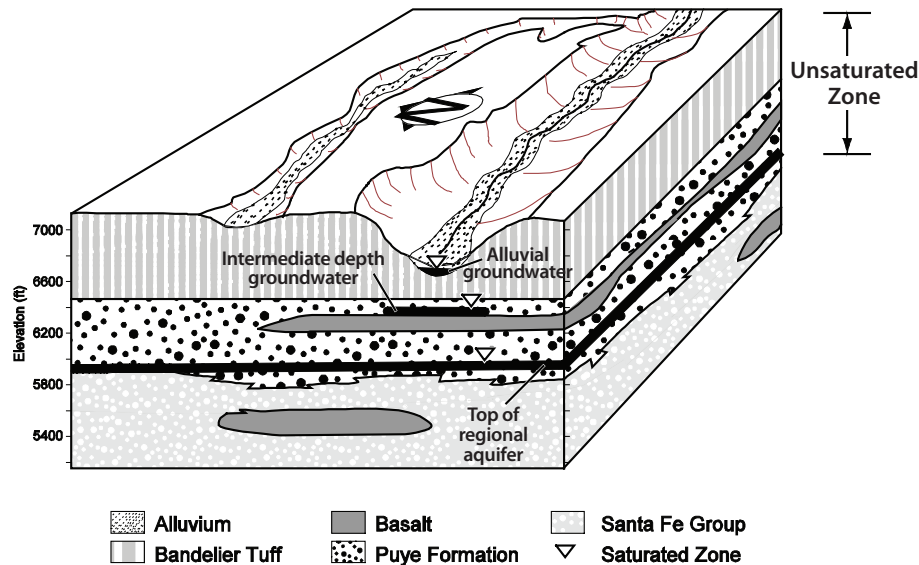


Figure 5-2. Illustration of geologic and hydrologic relationships in the Pajarito Plateau, showing the three modes of groundwater occurrence.

Underneath portions of Pueblo, Los Alamos, Mortandad, Sandia, and other canyons, intermediate perched groundwater occurs within the lower part of the Bandelier Tuff and within the underlying Puye Formation and Cerros del Rio basalt (Figure 5-2). These intermediate-depth groundwater bodies are formed in part by recharge from the overlying perched alluvial groundwater. The intermediate groundwater is discontinuous; occurrence is controlled by availability of recharge and variations in permeability of the rocks underlying the plateau. Depths of the intermediate perched groundwater vary: approximately 120 ft in Pueblo Canyon, 450 ft in Sandia Canyon, and 500–750 ft in Mortandad Canyon.

Some intermediate perched groundwater occurs in volcanic rocks on the flanks of the Sierra de los Valles to the west of the Laboratory. This water discharges at several springs and yields a significant flow from a gallery in Water Canyon. Intermediate groundwater also occurs in the southwest portion of the Laboratory just east of the Sierra de los Valles. A number of intermediate springs, fed by local recharge, discharge from mesa edges along canyons. Other intermediate groundwater is found in the Bandelier Tuff at a depth of approximately 700 ft. The source of this deeper perched groundwater may be percolation from streams that discharge from canyons along the mountain front, or underflow of recharge from the Sierra de los Valles.

The regional aquifer occurs at a depth of 1,200 ft along the western edge of the plateau and 600 ft along the eastern edge (Figures 5-1 and 5-3). The regional aquifer lies about 1,000 ft beneath the mesa tops in the central part of the plateau. This is the only aquifer in the area capable of serving as a municipal water supply. Water in the regional aquifer generally flows east or southeast toward the Rio Grande. Groundwater model studies indicate that underflow of groundwater from the Sierra de los Valles is the main source of regional aquifer recharge (LANL 2005a). Groundwater velocities vary spatially but are typically 30 ft/yr.

The surface of the aquifer rises westward from the Rio Grande within the Tesuque Formation, part of the Santa Fe Group (Figure 5-1). Underneath the central and western part of the plateau the aquifer rises farther into the Cerros del Rio basalt and the lower part of the Puye Formation.

The regional aquifer is separated from alluvial and intermediate perched groundwater by approximately 350 to 620 ft of unsaturated tuff, basalt, and sediments with generally low (<10%) moisture content. Water lost by downward seepage from alluvial and intermediate groundwater zones travels through the underlying rock by unsaturated flow. This percolation is a source of certain contaminants, mobile in water, which may reach the regional aquifer within a few decades. The limited extent of the alluvial and intermediate groundwater bodies, along with the dry rock that underlies them, restricts their volumetric contribution to recharge reaching the regional aquifer.

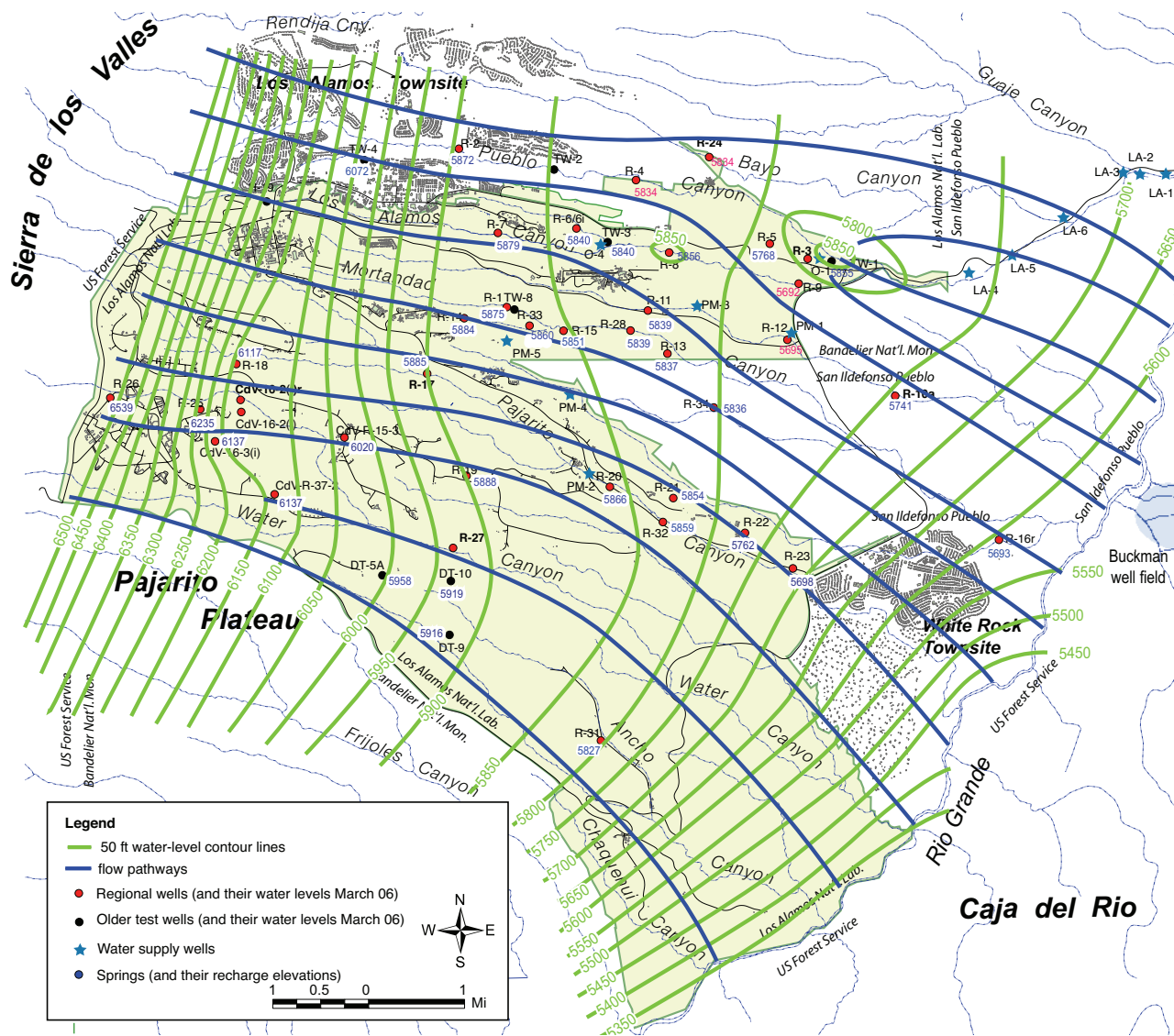


Figure 5-3. Contour map of average water table elevations in March 2006 for the regional aquifer (LANL 2007a).

3. Overview of Groundwater Quality

Since the 1940s, liquid effluent discharge by the Laboratory has affected water quality in the shallow perched groundwater that lies beneath the floor of a few canyons. Liquid effluent discharge is also the primary means by which Laboratory contaminants have affected the quality of intermediate perched zones and the regional aquifer. Where contaminants are found at depth, the setting is either a canyon where alluvial groundwater is usually present (perhaps because of natural runoff or Laboratory effluents) or a location beneath a mesa-top site where large amounts of liquid effluent have been discharged.

The discharge of effluents to canyons or mesa-top locations in the Laboratory's semiarid setting initiates or increases downward percolation of water. Even under unsaturated flow conditions, this percolation may move water and contaminants to the regional aquifer within a few decades.

The contaminated alluvial and intermediate perched groundwater bodies are separated from the regional aquifer by hundreds of feet of dry rock, so recharge from the shallow groundwater occurs slowly. As a result, less contamination reaches the regional aquifer than is found in the shallow perched groundwater bodies, and impacts on the regional aquifer are reduced or not significant.

Liquid effluent discharge at the Laboratory has impacted the quality of alluvial groundwater in several canyons. Drainages that received liquid radioactive effluents include Mortandad Canyon, Pueblo Canyon from its tributary Acid Canyon, and Los Alamos Canyon from its tributary DP Canyon (Figure 5-4). Rogers (2001) and Emelity (1996) summarize radioactive effluent discharge history at the Laboratory.

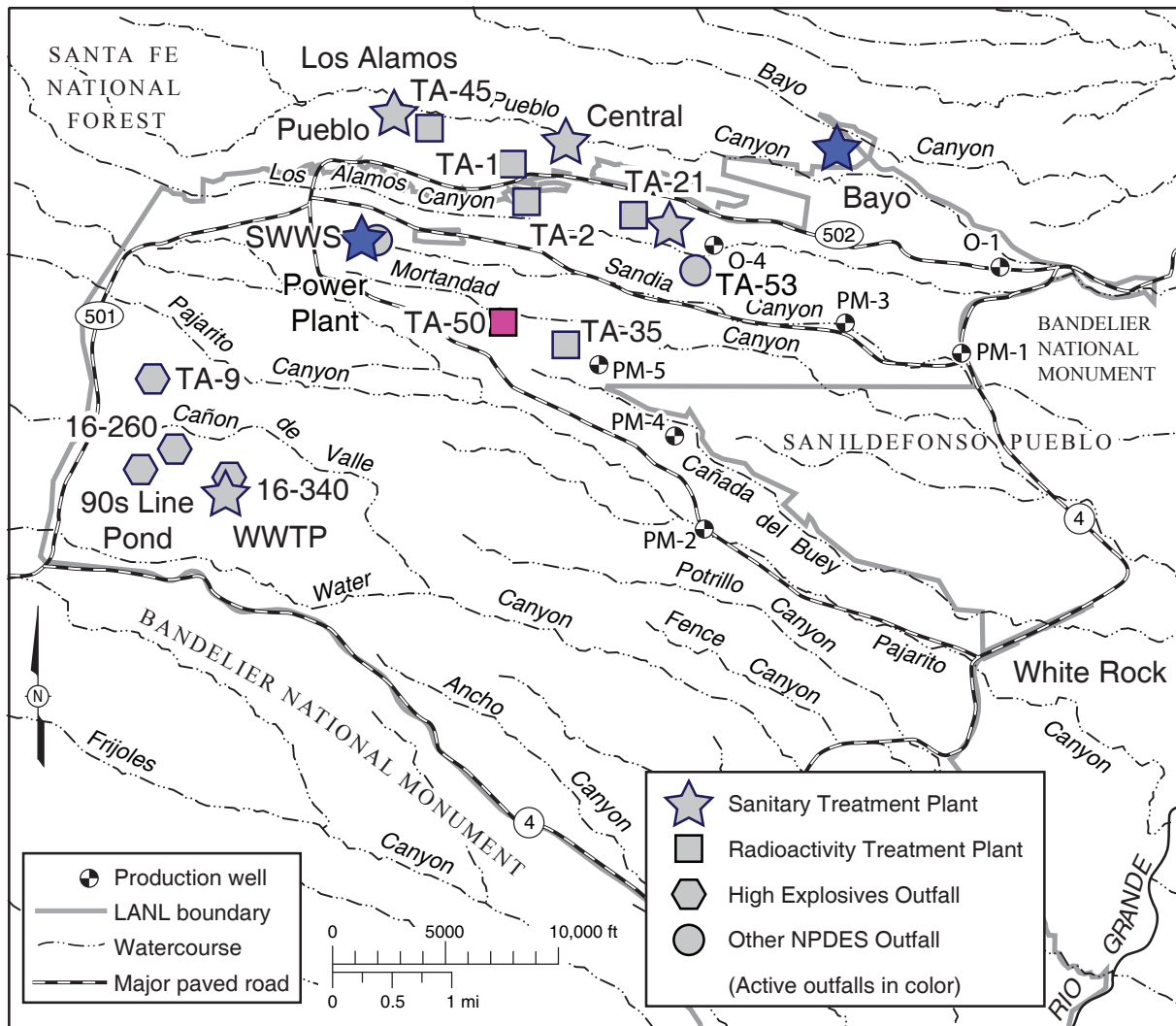


Figure 5-4. Major liquid release sources (effluent discharge) potentially affecting groundwater. Most outfalls shown are inactive.

Because of releases of power plant cooling water and water from the Laboratory's Sanitary Wastewater Systems (SWWS) Plant, Sandia Canyon has received the largest liquid discharge volumes of any canyon in recent decades. Water Canyon and its tributary Cañon de Valle have received effluents produced by high explosives (HE) processing and experimentation (Glatzmaier 1993; Martin 1993).

Over the years, Los Alamos County has operated several sanitary wastewater treatment plants in Pueblo Canyon (ESP 1981). Only the new Los Alamos County Wastewater Treatment Plant (LACWTP) is currently operating. The Laboratory has also operated numerous sanitary treatment plants, three of which are shown in Figure 5-4.

Since the early 1990s, the Laboratory has significantly reduced both the number of industrial outfalls (from 141 to 17) and the volume of water released (by more than 80%). For 1993 to 1997, total estimated average flow was 1,300 M gal/yr; flow decreased to 230 M gal/yr for 1998 to 2005 (Rogers 2006). The quality of the remaining discharges has been improved through treatment process improvements so that the discharges meet applicable standards.

Certain chemicals are good indicators of the possible presence of Laboratory effluents in groundwater. These chemicals are described as being chemically conservative, that is, their concentrations are usually not affected by chemical reactions. Examples of these conservative chemicals include perchlorate, tritium, hexavalent chromium, and, to a lesser extent, nitrate. Nitrate is often conservative but its concentration may be affected by bacterial activity. Because these chemicals travel readily in groundwater and are indicators of effluents, groundwater that has background concentrations of perchlorate, tritium, hexavalent chromium, and nitrate is likely to be unaffected by LANL discharges.

Liquid effluent discharges have affected intermediate perched groundwater and the regional aquifer to a lesser degree than the alluvial groundwater. The intermediate groundwater in various locations shows localized radioactive (tritium), organic (Royal Demolition Explosive [RDX], chlorinated organic chemicals, dioxane[1,4-]), and inorganic (hexavalent chromium, barium, boron, perchlorate, fluoride, and nitrate) contamination from Laboratory operations.

In 2007, the high explosives compound RDX continued to be detected in the regional aquifer at Pajarito Canyon regional aquifer well R-18. RDX is listed as a toxic pollutant in the New Mexico groundwater regulations (NMWQCC 2002). The RDX concentration was near the detection limit and at 2% of the Environmental Protection Agency's (EPA's) 10^{-5} excess cancer risk tap water screening level of 6.1 $\mu\text{g/L}$. Earlier detection of RDX in the regional aquifer at regional aquifer well R-25 (to the south of R-18) was probably due to cross-contamination from shallower well screens caused by well construction delays. The Laboratory is investigating these issues in cooperation with NMED.

Hexavalent chromium and nitrate have been found in several regional monitoring wells. Hexavalent chromium is at concentrations above the NM groundwater standard in one regional aquifer well and at 70% of that standard in another. Nitrate (as nitrogen) concentrations reach 50% of the NM groundwater standard in two regional aquifer monitoring wells and fluoride is at 50% of the standard in one well. Traces of tritium and perchlorate are also found in the regional aquifer.

With one exception, Los Alamos County drinking water supply wells in the Los Alamos area have not been impacted by Laboratory discharges. The exception is well O-1 in Pueblo Canyon, where perchlorate is found at concentrations that average 1/10th of the Environmental Protection Agency's (EPA's) Drinking Water Equivalent Level (DWEL) of 24.5 $\mu\text{g/L}$. Consequently, this well is not used by Los Alamos County for water supply. All drinking water produced by the Los Alamos County water supply system meets federal and state drinking water standards.

C. GROUNDWATER STANDARDS

In evaluating groundwater samples, we applied regulatory standards and risk levels as described in Table 5-1. For drinking water supply wells, which draw water from the regional aquifer, we compared concentrations of radionuclides in samples to (1) the derived concentration guides (DCGs) for ingested water calculated from DOE's 4-mrem drinking water dose limit and (2) the EPA maximum concentration levels (MCLs). For radioactivity in groundwater other than water supply wells, there are NM groundwater standards for uranium and radium. For risk-based screening of other radioactivity, groundwater samples from sources other than water supply wells may be compared with DOE's 4-mrem drinking water DCGs and with EPA MCLs. The DCGs for the 100-mrem public dose limit apply as effluent release guidelines. Where used in this chapter for such comparison purposes, in assessing water samples from sources other than water supply wells, these DCGs and EPA MCLs are referred to as screening levels.

The NM drinking water regulations and EPA MCLs apply as regulatory standards to nonradioactive constituents in water supply samples. They may be used as risk-based screening levels for other groundwater samples. The New Mexico Water Quality Control Commission (NMWQCC) groundwater standards (NMWQCC 2002) apply to concentrations of nonradioactive chemical quality parameters in all groundwater samples. NMWQCC (2002) specifies how to determine standards for the toxic pollutants listed in the NMWQCC groundwater standards, if they have no other state or federal standard. Accordingly, we screened results for these compounds at a risk level of 10^{-5} for cancer-causing substances or a hazard quotient of one ($HQ = 1$) for non-cancer-causing substances.

Table 5-1
Application of Standards to LANL Groundwater Monitoring Data

| Constituent | Sample Location | Standard or DCG | Risk-Based Screening Level | Reference | Location | Notes |
|-------------------|---------------------------|---|----------------------------|--|----------------------|--|
| Radionuclides | Water supply wells | DOE 4-mrem DCGs, EPA MCLs | None | DOE Order 5400.5, 40 CFR 141-143 | On-site and off-site | A 4-mrem/year dose rate limit and EPA MCLs apply to drinking water systems |
| Radionuclides | Effluent samples | DOE 100-mrem DCGs | None | DOE Order 5400.5 | On-site | DOE public dose limit is 100 mrem/yr, applies to effluent discharges |
| Radionuclides | Other groundwater samples | None | 4-mrem DCGs EPA MCLs | DOE Order 5400.5, 40 CFR 141-143 | On-site and off-site | A 4-mrem/year dose rate limit and EPA MCLs are for comparison purposes because they apply only to drinking water systems |
| Non-radionuclides | Water supply wells | EPA MCLs, NM groundwater standards, EPA 10^{-5} , and HQ = 1 risk levels for NM toxic pollutants with no standard | None | 40 CFR 141-143, 20.6.2 NM Administrative Code, http://www.epa.gov/earth1r6/6pd/rcra_c/pd-n/screen.htm | On-site and off-site | EPA MCLs apply to drinking water systems. Use EPA Region 6 table for 10^{-5} and HQ = 1 risk levels |
| Non-radionuclides | Other groundwater samples | NM groundwater standards, EPA 10^{-5} and HQ = 1 risk levels for NM toxic pollutants with no standard | EPA MCLs | 40 CFR 141-143, 20.6.2 NM Administrative Code, http://www.epa.gov/earth1r6/6pd/rcra_c/pd-n/screen.htm | On-site and off-site | NMED regulations apply to all groundwater. EPA MCLs are for comparison purposes because they apply only to drinking water systems. Use EPA Region 6 table for 10^{-5} and HQ = 1 risk levels |

A HQ of one or less indicates that no (noncancer) adverse human health effects are expected to occur from that chemical. We used the EPA Region 6 tap water screening levels to screen these toxic pollutant compounds (http://www.epa.gov/earth1r6/6pd/rcra_c/pd-n/screen.htm). For cancer-causing substances, the EPA Region 6 tap water screening levels are at a risk level of 10^{-6} , so we use 10 times the values to screen at a risk level of 10^{-5} .

Groundwater is a source of flow to springs and other surface water that neighboring tribal members and wildlife use. NMWQCC's surface water standards (NMWQCC 2000), including the wildlife habitat standards, also apply to this surface water (for a discussion of surface water, see Chapter 6).

D. MONITORING NETWORK

In 2005, DOE and its Operations and Management Contractor and NMED signed a Compliance Order on Consent (Consent Order), which specifies the process for conducting groundwater monitoring at the Laboratory. The Consent Order requires that the Laboratory submit annually an Interim Facility-Wide Groundwater Monitoring Plan (Interim Plan) to NMED for its approval. The first Interim Plan was approved in June 2006 (LANL 2006). Groundwater monitoring conducted during calendar year 2007 was carried out according to two Interim Plans approved by NMED under the Consent Order (LANL 2006, LANL 2007b).

Groundwater sampling locations are divided into three principal groups related to the three modes of groundwater occurrence: perched alluvial groundwater in the bottom of some canyons, localized intermediate-depth perched groundwater systems, and the regional aquifer (Figures 5-5 through 5-9).

To document the potential impact of Laboratory operations on Pueblo de San Ildefonso land, the DOE signed a memorandum of understanding in 1987 with the Pueblo and the Bureau of Indian Affairs to conduct environmental sampling on Pueblo land. Groundwater monitoring stations at Pueblo de San Ildefonso are shown in Figure 5-9 and mainly sample the regional aquifer. Basalt Spring, Los Alamos Spring, GU-0.01 Spring, and Pine Rock Spring are intermediate groundwater sampling points, and wells LLAO-1B and LLAO-4 sample alluvial groundwater. Figure 5-9 also shows the location of three City of Santa Fe water supply wells monitored by the Laboratory.

Water quality monitoring results are given in accompanying supplemental data tables (on included compact disc), which include results for several boreholes. The water quality results from borehole samples are for screening purposes and used to guide further investigation. Borehole samples cannot be used to accurately evaluate aquifer conditions because they are a mixture of high-turbidity water affected by drilling fluids and sample over a large portion of the borehole. Following well installation, well development is used to remove aquifer and drilling materials from the well before sampling.

LANL conducts a regular program of water level measurements for monitoring wells. A summary of groundwater level measurements for 2007 is given in Allen et al. (2008).

1. Regional Aquifer and Intermediate Perched Groundwater Monitoring

Sampling locations for the regional aquifer and intermediate perched groundwater include monitoring wells, water supply wells, and springs. Wells recently constructed under the Hydrogeologic Workplan (LANL 1998), and planned for the future under the Consent Order, are intended for additional groundwater characterization efforts and to extend the Laboratory's groundwater monitoring system. Several of these wells were added to the monitoring well network beginning in 2002. New wells completed in 2007 are described in Chapter 2, Section B.9.b. A column on the supplemental data tables for Chapter 5 (on the included compact disc) identifies the groundwater zones sampled by different ports of these wells and gives the depth of the port or top of the well screen.

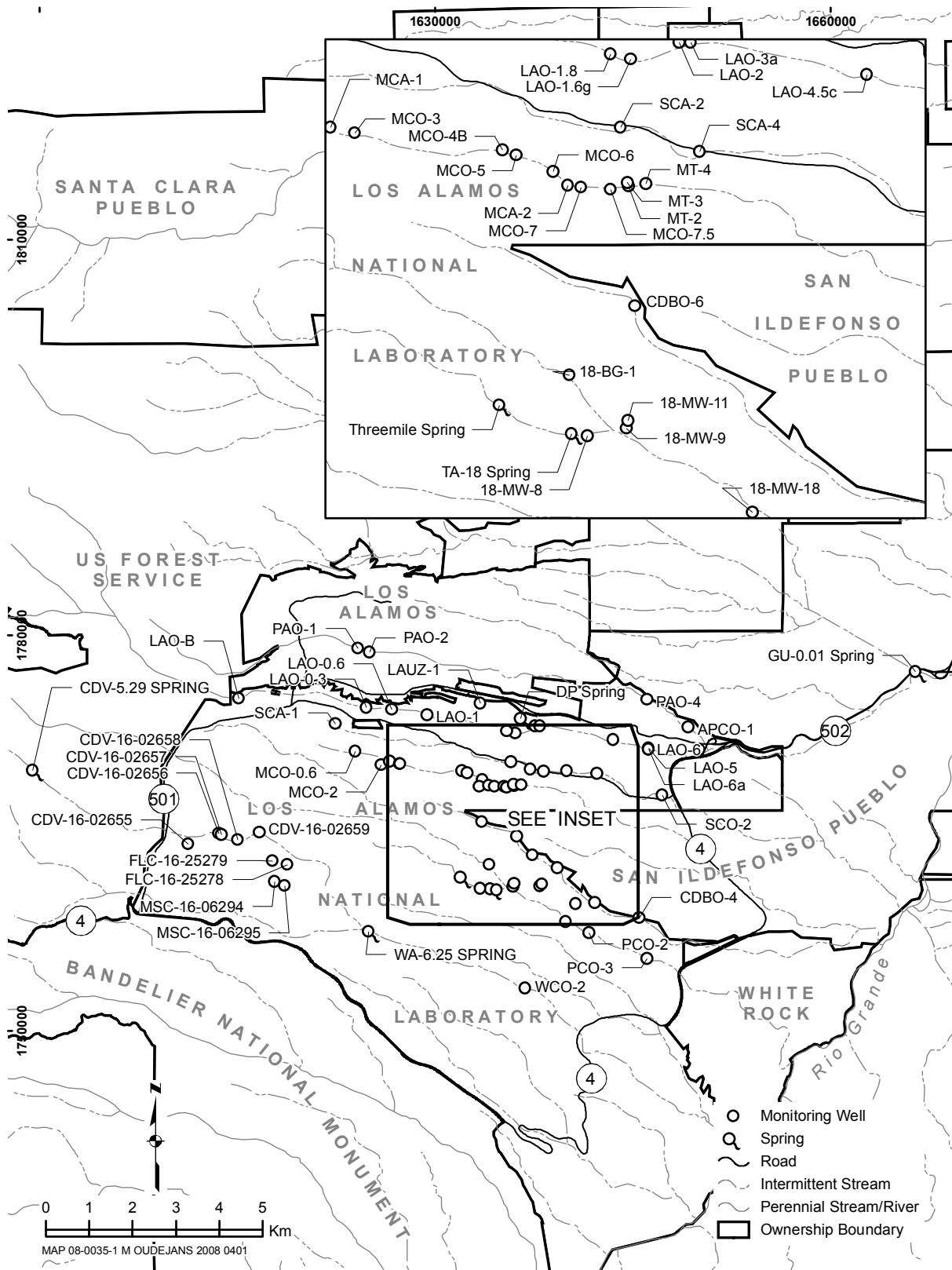


Figure 5-5. Springs and wells used for alluvial groundwater monitoring.

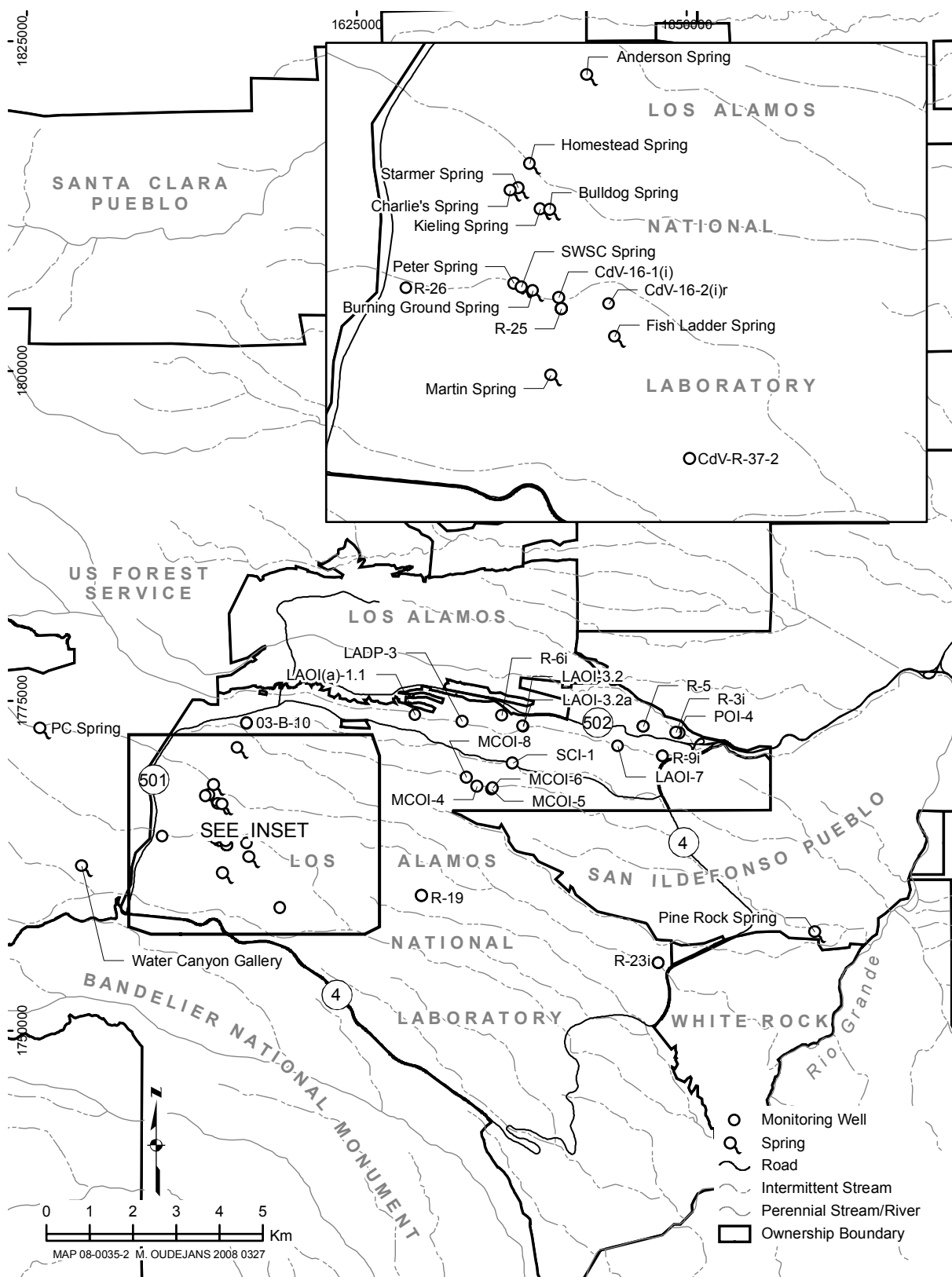


Figure 5-6. Springs and wells used for intermediate-depth perched zone monitoring.

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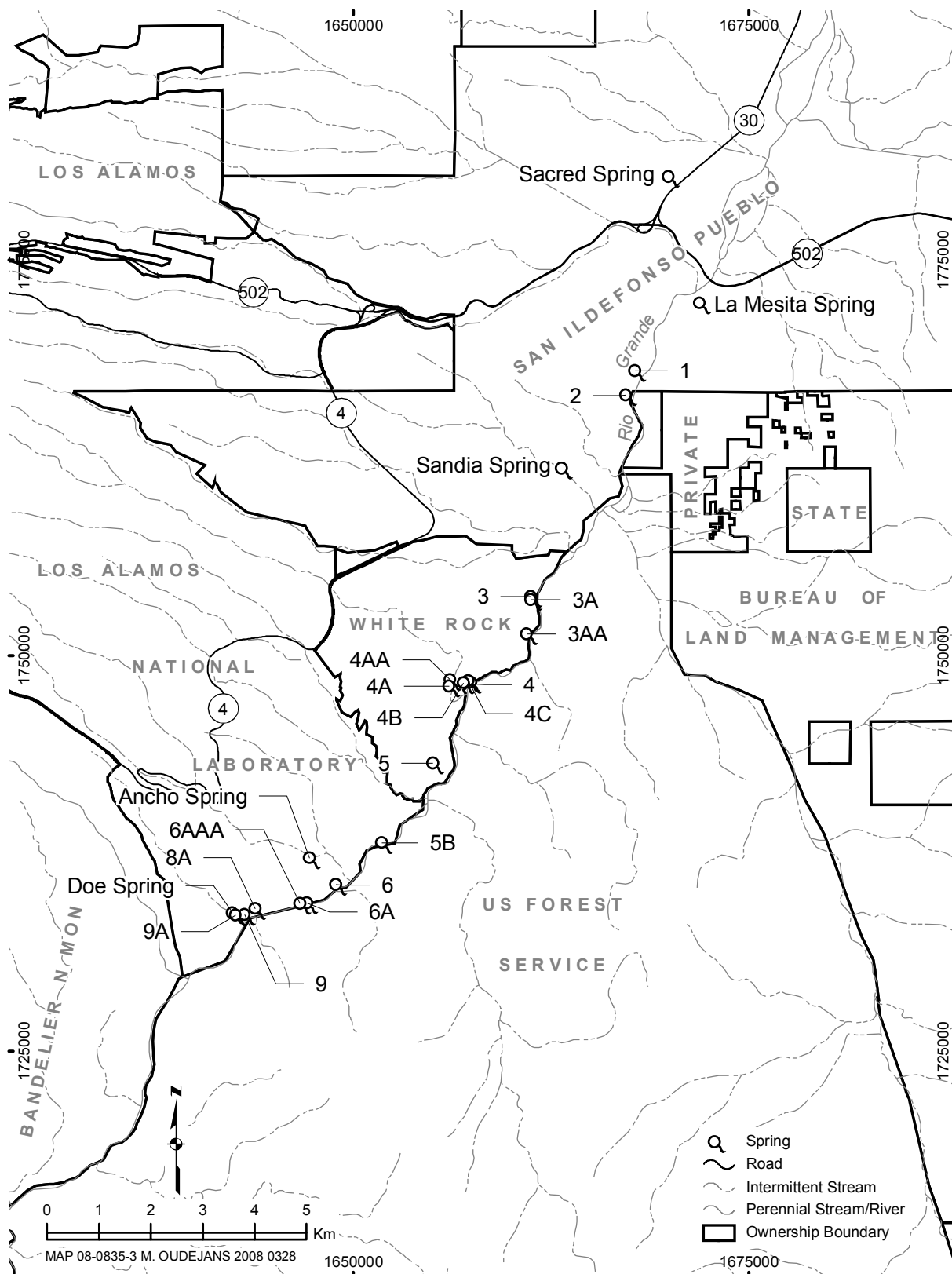


Figure 5-8. Springs used for regional aquifer monitoring.

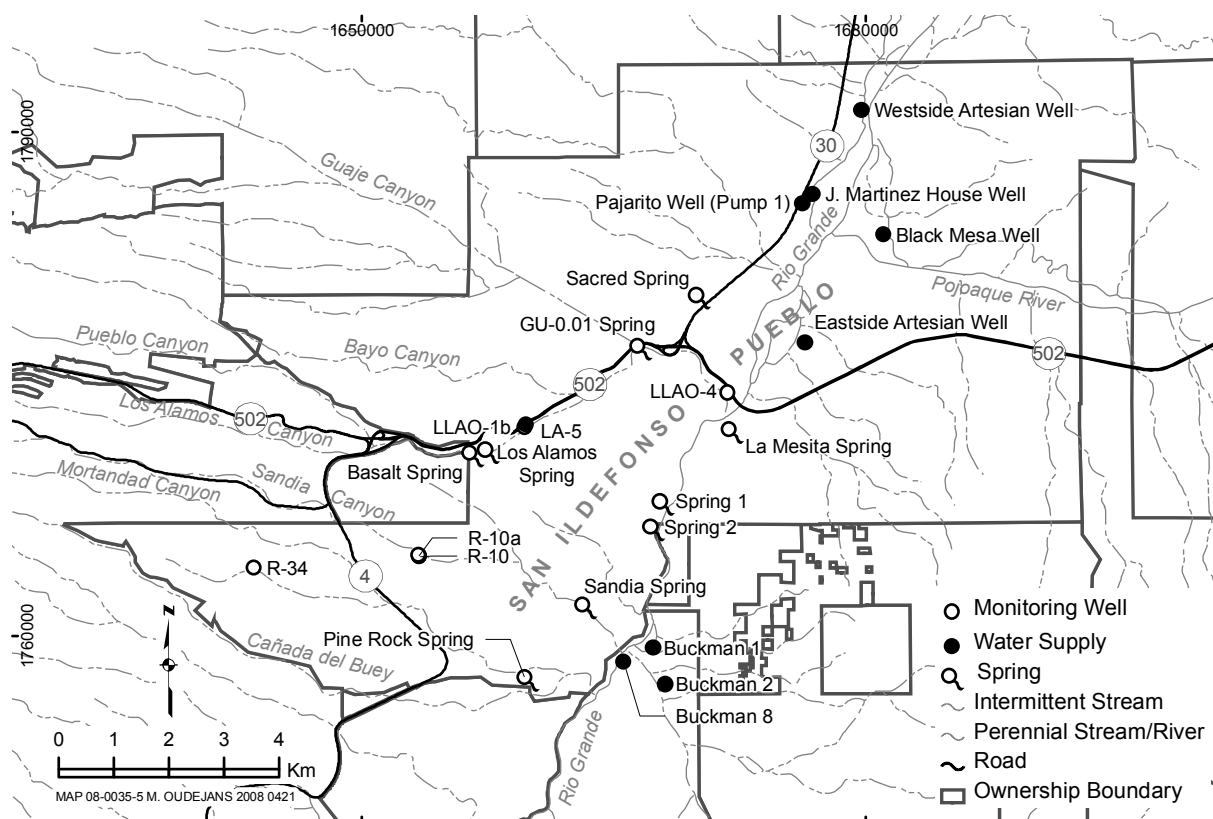


Figure 5-9. Springs and wells used for groundwater monitoring at the City of Santa Fe Buckman well field and on Pueblo de San Ildefonso lands.

The Laboratory collected samples from 12 Los Alamos County water supply wells in three well fields that produce drinking water for the Laboratory and the community. The water supply wells are screened up to lengths of 1,600 ft within the regional aquifer, and the wells draw samples that integrate water over a large depth range. Los Alamos County owns and operates these wells. The County is responsible for demonstrating that the supply system meets Safe Drinking Water Act requirements. This chapter reports on supplemental sampling of those wells by the Laboratory.

Additional regional aquifer samples came from wells located on Pueblo de San Ildefonso lands and from the Buckman well field operated by the City of Santa Fe.

We sample numerous springs near the Rio Grande because they represent natural discharge from the regional aquifer (Purtymun et al., 1980). Sampling the springs allows us to detect possible discharge of contaminated groundwater from underneath the Laboratory into the Rio Grande.

2. Alluvial Groundwater Monitoring

To determine the effect of present and past industrial discharges on water quality, we used shallow wells and some springs to sample perched alluvial groundwater in several canyons. In any given year, some of these alluvial observation wells may be dry, and water samples cannot be obtained. Some observation wells in Water, Fence, and Sandia Canyons have been dry most often since their installation in 1989. All but one of the wells in Cañada del Buey are generally dry.

3. Well Sampling Issues

In some LANL characterization wells, the use of fluids to assist well drilling has affected the chemistry of groundwater samples. From 1998 through 2006, more than 40 new wells were drilled for hydrogeologic characterization beneath the Pajarito Plateau as part of the Laboratory's Hydrogeologic Workplan (LANL 1998) or as part of corrective measures. Of these wells, some have screens in perched intermediate zones, most have screens in the regional aquifer, and a few have screens in both perched intermediate zones and the regional aquifer. Concerns about the reliability or representativeness of the groundwater quality data obtained from these wells stem from the potential for residual drilling fluids and additives to mask the present and future detection of contaminants.

New wells (e.g., regional aquifer wells R-35 and R-36 drilled in 2007 and 2008, respectively) are drilled without the use of drilling fluids and also undergo extensive well development to reduce the turbidity of water samples.

NMED approved a well screen analysis methodology set forth in the Well Screen Analysis Report (LANL 2007c). The methodology relies on comparing well water quality data for certain chemical species that can be affected by drilling fluids at their natural background ranges. The well screen analysis methodology now provides a means of (1) marking historical data for drilling fluid effects, (2) determining trends in improvement of degradation of well screen water quality for monitoring purposes, and (3) determining the condition of screens undergoing redevelopment and rehabilitation.

In 2007, three wells underwent redevelopment: R-32, R-12, and R-20. These wells were selected for redevelopment because of their important locations for groundwater monitoring. Physical redevelopment methods included jetting, swabbing, and extensive pumping. All of the wells were converted to dual- or single-screen wells. The preferred sampling system installed in dual-screen wells is the Baski system, which allows active purging while sampling, as do submersible pumps in single-screen wells. A summary of redevelopment results for each of the wells is as follows:

- R-32 was converted from a three-screen well to a single-screen well with a dedicated submersible pump. Its water quality is very good (that is, unaffected by drilling impacts), as determined by analysis of geochemical parameters (LANL 2007d).
- R-12 was converted from a three-screen to a dual-screen well with a Baski sampling system. The top two screens that were retained improved in water quality and the top screen also improved in hydraulic properties. Their water quality is now good (LANL 2008a).
- R-20 was converted from a three-screen to a dual-screen well with a Baski sampling system. The top two screens that were retained improved in water quality and in hydraulic properties. Their water quality is now very good (LANL 2008b).

E. GROUNDWATER SAMPLING RESULTS BY CONSTITUENTS

The supplemental data tables for this chapter present groundwater monitoring data for 2007. Columns on the data tables identify the groundwater zones sampled—whether alluvial, intermediate, or regional; the latter includes water supply wells—or indicate if the location is a spring. For wells with several sampling ports, the depth and groundwater zone sampled for each port appear in the table. For single-screen wells, the depth of screen top is given. Springs have a depth of 0 ft, and wells with unknown depth list a value of -1. Supplemental Data Table S5-1 provides definitions for sample description codes used in the data tables.

Table S5-2 lists the results of radiochemical analyses of groundwater samples for 2007. The table also gives the total propagated one-sigma (one standard deviation) analytical uncertainty and the analysis-specific minimum detectable activity (MDA), where available. A "<" symbol indicates that based on the analytical laboratory or secondary validation qualifiers the result was a nondetect. Uranium was analyzed by chemical methods and by isotopic methods. Table S5-3 shows low-detection-limit tritium results from analyses done by the University of Miami.

Table S5-4 lists radionuclides detected in groundwater samples, as reported by the analytical laboratory. For most radionuclide measurements, we reported a detection as an analytical result that does not include an analytical laboratory (or in some cases, secondary validation) qualifier code of X or U (which indicates that the result is a nondetect). The analytical laboratory reports a result as detected that is greater than the measurement-specific MDA. University of Miami contract laboratory tritium data do not have laboratory qualifiers; in that case, a result is reported as detected when analytical results are greater than three times the reported (one-sigma) uncertainty.

Data with qualifier codes other than X or U are shown in Table S5-4 to provide additional information on analytical results; in some cases, for example, the analyte was found in the laboratory blank, or there were other analytical quality issues. The table shows two categories of qualifier codes: those from the analytical laboratory and those from secondary validation (Table S5-5, Table S5-6, and Table S5-7). After we received the analytical laboratory data packages, an independent contractor performed a secondary validation on the packages, Analytical Quality Associates, Inc. (AQA). The reviews by AQA include verifying that holding times were met, that all documentation is present, and that analytical laboratory quality control measures were applied, documented, and kept within contract requirements.

Because uranium, gross alpha, and gross beta are usually detected in water samples and to focus on the higher measurements, Table S5-4 only includes occurrences of these measurements above threshold values (all of the results are included in Table S5-2). We selected threshold levels of 5 µg/L for uranium, 5 pCi/L for gross alpha, and 20 pCi/L for gross beta, which are lower than the respective EPA MCLs or screening levels (30 µg/L for uranium, 15 pCi/L for gross alpha, and 50 pCi/L for gross beta). The right-hand columns of Table S5-4 compare results with the regulatory standards or screening levels listed on the table.

Table S5-8 lists the results of general chemical analyses of groundwater samples for 2007. Table S5-9 lists groundwater perchlorate results. We analyzed samples for perchlorate using two methods. This table includes all perchlorate results determined by the liquid chromatography/mass spectrometry/mass spectrometry (LC/MS/MS) method (now EPA 6850 Modified, formerly SW-846:8321A[M]) and all detections by the ion chromatography (IC) method (EPA:314.0). The method detection limit (MDL) for the IC method is 4 µg/L; the LC/MS/MS method MDL is 0.05 µg/L or larger if the sample had higher concentrations and was analyzed using sample dilution. During part of 2007, we used both methods until LC/MS/MS by SW-846 6850 (or EPA 6850 Modified) for perchlorate was officially promulgated by the EPA. The results of trace metal analyses appear in Table S5-10.

As part of the well rehabilitation project discussed earlier, three wells (R-32, R-20, R-12) underwent redevelopment, testing, or sampling during 2007 to improve and evaluate water sample quality. Results for those tests and accompanying sampling are covered in separate reports (LANL 2007d, 2008a, 2008b, 2008c) but are not included here.

In the following sections, we discuss groundwater quality results for each of the three groundwater modes in the major watersheds that cross the Laboratory. The accompanying maps depict the location of detected groundwater contaminants. The maps provide a spatial context for distribution of groundwater contamination. Rather than showing data for 2007 alone, the maps represent a synthesis of the last several years of groundwater data collected by Laboratory groundwater monitoring and characterization programs.

The contaminant distribution maps show contaminant locations extrapolated beyond the area covered by monitoring wells. This extrapolation takes into account the location of contaminant sources and direction of groundwater flow. Question marks on the maps indicate where contaminant extent is inferred but not confirmed by monitoring coverage. For alluvial groundwater in canyons, the extent of contamination lateral to the canyon is not to scale; contaminated groundwater is confined to the canyon bottom alluvium and is quite narrow at the map scale.

1. Organic Chemicals in Groundwater

In 2007, we analyzed samples from selected springs and monitoring wells for organic chemicals. Table S5-11 summarizes the stations sampled and organic chemical suites for which samples were analyzed. These samples were analyzed for some or all of the following organic chemical suites: volatile organic compounds, semivolatile organic compounds, polychlorinated biphenyls (PCBs), pesticides, diesel-range organics (DRO), and HE. The Quality Assurance (QA) section of this chapter (Section G) covers analytes and analytical methods. Many of the possible organic chemical detections that the analytical laboratory reported were rejected because the compounds were either detected in method blanks (that is, they were introduced during laboratory analysis) or were detected in field quality control (QC) samples, including equipment, field, and trip blanks. Equipment blanks use distilled water with which sampling equipment is rinsed before sampling to check for organic chemical contamination acquired during sampling. Trip blanks accompany samples during sample storage, and shipment to determine if organic contamination occurs. Table S5-12 shows organic chemicals detected in 2007 and results from field QC samples.

A large number of groundwater samples were analyzed for dioxins and furans in 2007. Only two of these compounds (hexachlorodibenzodioxin[1,2,3,7,8,9-] and tetrachlorodibenzodioxin[2,3,7,8]) have screening levels or regulatory standards. These screening values are about the same magnitude as the detection limits. The analytical method is quite sensitive and these compounds were found near the detection limit in a large number of samples. See Section G, Quality Assurance, below, for more discussion on this topic.

a. Organic Chemical Sample Quality Control Program

Because of the sensitive nature of organic chemical sampling and analysis, a carefully designed field and analytical laboratory quality control program is essential for evaluating the presence of organic chemicals in environmental samples. Organic analytes may be detected in field quality control samples such as field blanks or equipment blanks, indicating that they are not truly present in associated groundwater samples. These analytes may be present in the quality control samples because of inadvertent contamination of sampling or analytical laboratory equipment by organic chemicals that come from other sources.

Most analytical methods require the analysis of laboratory-prepared method blanks or instrument blanks with each batch of samples. Target organic chemicals that are detected in these blanks indicate contamination from the sampling or analytical environments. Certain organic compounds used in analytical laboratories are frequently detected in laboratory blanks, that is, contamination introduced by the analytical process is common for these compounds. These compounds include acetone, methylene chloride, toluene, 2-butanone, di-n-butyl phthalate, di-n-octyl phthalate, and bis(2-ethylhexyl)phthalate (Fetter 1993). Numerous field, trip, and equipment blanks collected during this reporting period contained toluene, acetone, butanone[2-], and hexanone[2-], which indicates inadvertent sample contamination in either the field or analytical laboratory.

2. Radioactivity in Groundwater

The principal radioactive element detected in the regional aquifer is naturally occurring uranium, found at higher concentrations in springs and wells throughout the Rio Grande Valley. The large gross alpha values found in samples from these springs and wells result from the decay of naturally occurring uranium in the water. Other naturally occurring radioactivity in groundwater samples comes from members of the uranium-235, uranium-238, and thorium-232 decay chains. Potassium-40 is also a source of natural radioactivity.

In 2007, other than for naturally occurring radionuclides (for example, radium-226, and uranium-234), no water supply radioactivity analyte activity or concentration value exceeded any regulatory standard including the 4-mrem DOE DCGs applicable to drinking water. While there are no applicable standards for radioactivity from a DOE (LANL) source in the regional aquifer, other radioactivity results greater than standards are shown in Table 5-2.

Table 5-2
Radioactivity Results Near Screening Levels in Regional Aquifer Groundwater for 2007

| Chemical | Location | Result | Trends |
|-------------------------|-------------------------------------|--|---|
| Americium-241 | R-18 in Pajarito Canyon | 1.31 pCi/L, above 4-mrem DCG screening level of 1.2 pCi/L | False positive; not found in reanalysis or nine other samples analyzed in 2007 |
| Gross beta | R-22 at 1273 ft in Pajarito Canyon | 71 pCi/L, above EPA drinking water screening level of 50 pCi/L | False positive; average of four other results for 2007 is 6.7 pCi/L |
| Radium-228 | R-25 at 1796 ft in Water Canyon | 14.5 pCi/L, above EPA MCL screening level of 5 pCi/L | Naturally occurring; first measurement in well; shallower screens all nondetect |
| Gross alpha and uranium | City of Santa Fe Buckman well field | Results above EPA MCLs | Uranium is naturally occurring; drinking water system compliance achieved by mixing with water from other wells |

Pine Rock Spring, which flows from intermediate groundwater on Pueblo de San Ildefonso lands, had a uranium concentration near the NM groundwater standard. The high uranium value may be due to dissolution of uranium from the bedrock by sanitary effluent, which is used to water athletic fields at nearby Overlook Park (Teerlink 2007). While there are no applicable standards for radioactivity from a DOE (LANL) source in intermediate groundwater, other radioactivity results near standards are shown in Table 5-3. For well and spring samples from intermediate perched groundwater, only a gross beta result at Charlie's Spring in Pajarito Canyon exceeded the 4-mrem DOE DCG screening levels.

Table 5-3
Radioactivity Results Near Screening Levels in Intermediate Groundwater for 2007

| Chemical | Location | Result | Trends |
|------------|--|--|---|
| Gross beta | Charlie's Spring in Pajarito Canyon | 55 pCi/L, above EPA drinking water screening level of 50 pCi/L | High value; four other results for 2007 are mainly nondetect |
| Tritium | MCOI-4, MCOI-5, MCOI-6 in Mortandad Canyon | 4,000 to 13,000 pCi/L, below EPA MCL screening level of 20,000 pCi/L | Values steady over three years of sampling; wells sample separate isolated perched zones |
| Uranium | Pine Rock Spring (Pueblo de San Ildefonso) | 29.6 µg/L, below NM groundwater standard of 30 µg/L | Steady over two years, may be leached from bedrock by percolation of sanitary effluent used to irrigate Overlook Park athletic fields |

There are no applicable groundwater standards for radioactivity from a DOE (LANL) source in perched alluvial groundwater. However, for comparison purposes, results for strontium-90 in Los Alamos and Mortandad Canyons were near or exceeded the 4-mrem DOE DCGs and EPA MCL screening levels (Table 5-4, Figures 5-10 and 5-11). The gross beta activity in these wells and spring is likely due to presence of strontium-90. Strontium-90 has a half-life of approximately 28.8 years, slightly more than twice as long as the half-life of tritium (12.3 years).

3. Tritium in Groundwater

Tritium is an important contaminant to monitor at LANL because it was discharged in some effluents and travels readily through groundwater. However, tritium activity decreases rapidly due to radioactive decay, with a half-life of 12.3 years. Groundwater with tritium activity below approximately 1.6 pCi/L is probably old and isolated from surface recharge. The age of such groundwater is more than 3,000 years, but large dating uncertainties may be associated with small tritium activities (Blake et al., 1995).

Table 5-4
Radioactivity Results Near Screening Levels in Alluvial Groundwater for 2007

| Chemical | Location | Result | Trends |
|--------------|--|--|---|
| Strontium-90 | One spring and four wells in DP and Los Alamos Canyons | 8 pCi/L to 62 pCi/L, above EPA drinking water screening level of 50 pCi/L and 40 pCi/L 4-mrem DOE DCG screening level | Decreased since cessation of discharges in 1986, now stable due to retention on sediments |
| Gross beta | One spring and two wells in DP and Los Alamos Canyons | 53 pCi/L to 143 pCi/L, above EPA drinking water screening level of 50 pCi/L | Gross beta mainly due to presence of strontium-90 |
| Strontium-90 | Three wells in Mortandad Canyon | 41 pCi/L to 65 pCi/L, above EPA drinking water screening level of 50 pCi/L and 40 pCi/L 4-mrem DOE DCG screening level | Fairly stable for 10 years due to retention on sediments |
| Gross beta | Three wells in Mortandad Canyon | 105 pCi/L to 150 pCi/L, above EPA drinking water screening level of 50 pCi/L | Gross beta mainly due to presence of strontium-90 |

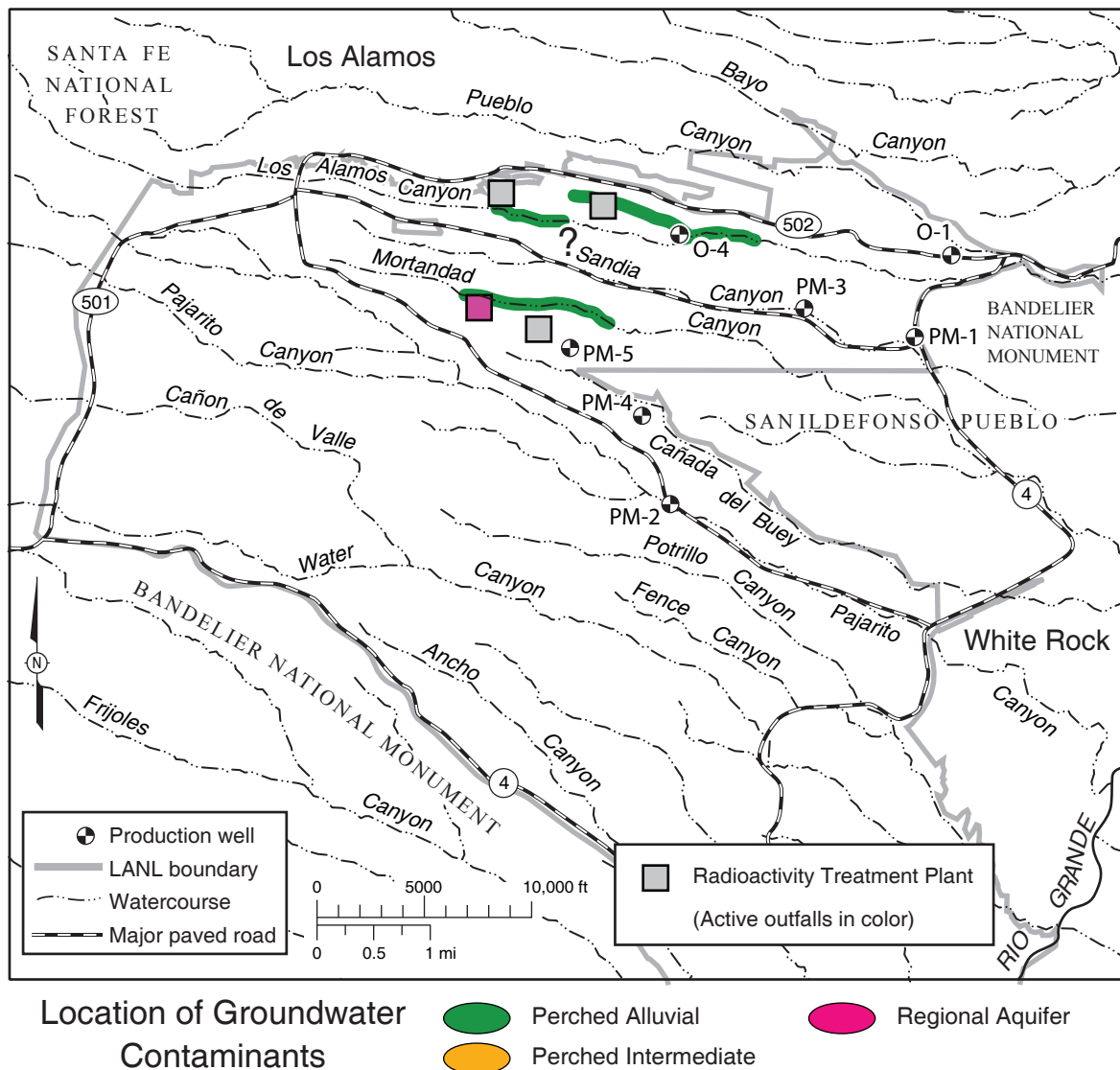


Figure 5-10. Location of groundwater contaminated by strontium-90: while there is no applicable groundwater standard, for comparison purposes, the area indicated has Sr-90 activity above the 8 pCi/L EPA MCL screening level. Different colors indicate the affected groundwater zones. Along canyons, the extent of alluvial groundwater contamination lateral to the canyon is not to scale; contamination is confined to the alluvium within the canyon bottom and is narrow at the map scale.

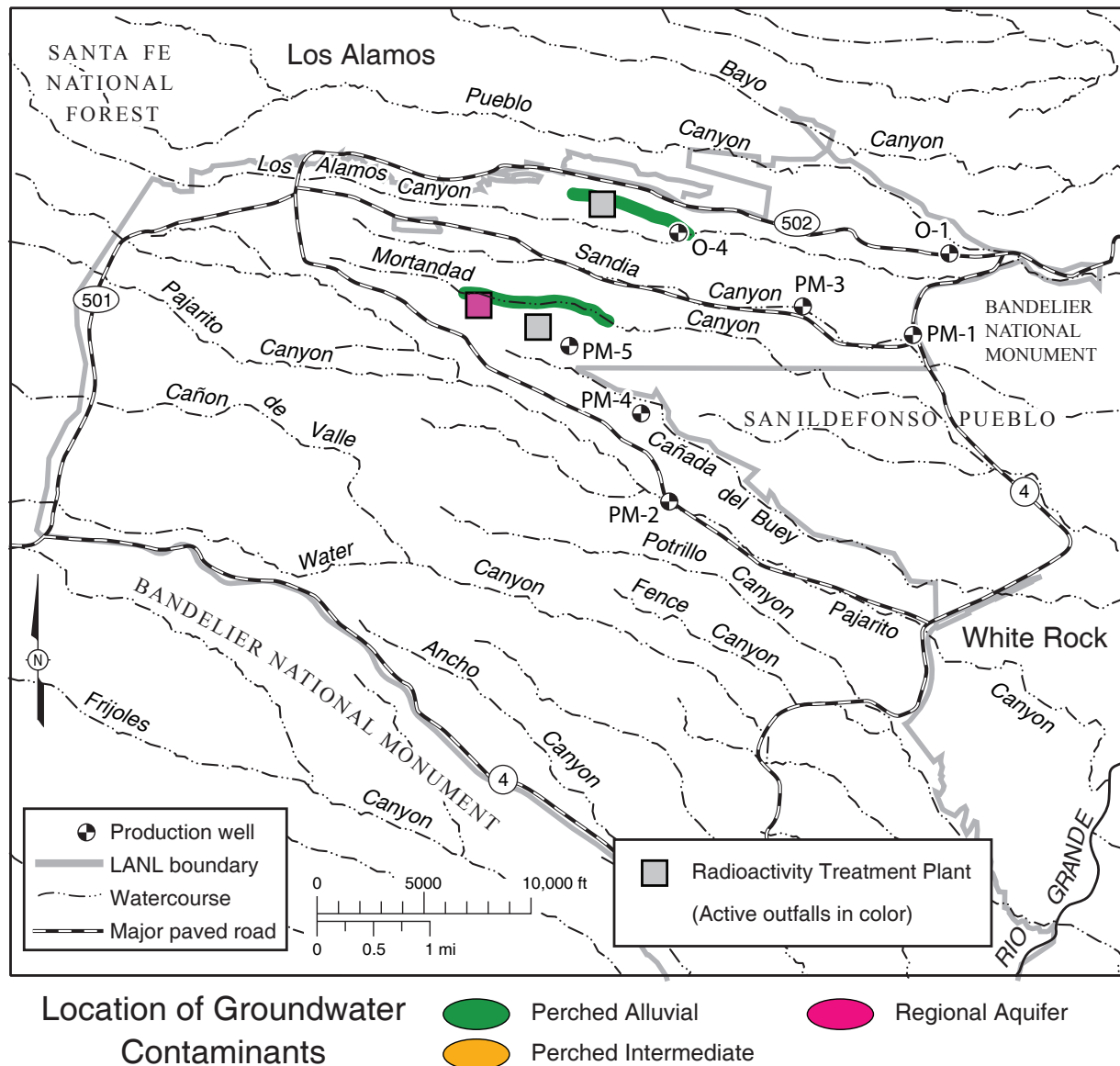


Figure 5-11. Location of groundwater contaminated by radioactivity. While there is no applicable groundwater standard, for comparison purposes, samples from the area indicated have the sum of Sr-90, Pu-238, Pu-239/240, and Am-241 above the 4-mrem DOE DCG screening level. Different colors indicate the affected groundwater zones.

4. Perchlorate in Groundwater

Perchlorate is an important contaminant to monitor at LANL because it was discharged in some effluents and travels readily through groundwater. During the last decade, the EPA recognized the potential for perchlorate toxicity at concentrations in the range of $1\mu\text{g/L}$ to $100\mu\text{g/L}$. Based on a recent toxicity assessment by the National Academy of Sciences, the EPA set a DWEL of $24.5\mu\text{g/L}$ for perchlorate in 2006. The Consent Order mandates a $4\mu\text{g/L}$ screening level for perchlorate. Several studies indicate that perchlorate occurs naturally in groundwater of arid regions due to atmospheric deposition and other sources. Plummer et al. (2006) found perchlorate concentrations ranging from $0.12\mu\text{g/L}$ to $1.8\mu\text{g/L}$ in samples of north-central NM groundwater that have ages predating anthropogenic influence and that are not affected by industrial perchlorate sources. Perchlorate concentrations in Mortandad Canyon groundwater are considerably above background as a result of past effluent discharges. Otherwise perchlorate concentrations are near the values found by Plummer et al. (2006).

5. Metals in Groundwater

In 2005, LANL found hexavalent chromium in Mortandad Canyon regional aquifer monitoring well samples at levels above the NM groundwater standard and in intermediate-depth groundwater at levels just below the NM groundwater standard. Hexavalent chromium has also been found in Sandia Canyon regional aquifer well R-11 as discussed below. In alluvial groundwater beneath Cañon de Valle, barium occurs at concentrations above the NM groundwater standard. Molybdenum concentrations have been near the NM groundwater standard (for irrigation use) in Los Alamos Canyon alluvial groundwater for more than a decade. Other metals occur in groundwater at concentrations near or above regulatory standards. This may be because of issues related to well sampling and well construction, rather than being from LANL releases.

In addition to the effect of drilling fluids, well samples may have relatively high turbidity. The presence of residual aquifer or soil material in groundwater samples leads to detection of metals such as aluminum, iron, and manganese, which are primary constituents of the silicate and other minerals that make up the aquifer framework. The effects of turbidity on water quality are also seen in many samples from alluvial wells and springs (in the case of springs, because they incorporate surrounding soil material).

The older LANL test wells (Test Well 8, DT-5A, DT-9, and DT-10) have steel casings and galvanized metal well fittings that are subject to rust and metal flaking. Over time and with wear, corrosion, and work on the wells, water samples have shown increasing content of metals like iron, lead, manganese, and zinc.

F. GROUNDWATER SAMPLING RESULTS BY WATERSHED

1. Guaje Canyon (includes Rendija and Barrancas Canyons)

Guaje Canyon is a major tributary in the Los Alamos Canyon watershed that heads in the Sierra de los Valles and lies north of Laboratory land. The canyon has not received any effluents from LANL activities (Table 5-5). The Guaje well field, located northeast of the Laboratory, contains five water supply wells. Naturally occurring arsenic has been found in this well field at similar levels since the field was developed in the early 1950s (Table 5-6). Rendija and Barrancas Canyons have seen little past Laboratory activity, have only ephemeral surface water, and have no known alluvial or intermediate groundwater.

Table 5-5
Summary of Groundwater Contamination in Guaje Canyon (includes Rendija and Barrancas Canyons)

| Canyon | Contaminant Sources | Groundwater Contaminants | | |
|---------------------------------------|---------------------|---|-----------------------------|-------------------------------|
| | | Alluvial | Intermediate | Regional |
| Guaje, Rendija, and Barrancas Canyons | Minor dry sources | None, alluvial groundwater only in upper Guaje Canyon | No intermediate groundwater | Natural arsenic above EPA MCL |

Table 5-6
Groundwater Quality in Guaje Canyon (includes Rendija and Barrancas Canyons)

| Chemical | Location | Result | Trends |
|----------|---|--|---|
| Arsenic | Regional aquifer water supply well G-2A | 10.4 µg/L, above EPA MCL of 10 µg/L; NM groundwater standard is 100 µg/L | Sporadic values above EPA MCL for many years in this well field |

2. Los Alamos Canyon (includes Bayo, Acid, Pueblo, and DP Canyons)

Bayo Canyon contained a now-decommissioned firing site. The canyon has only ephemeral surface water, and no known alluvial or intermediate groundwater (Table 5-7).

Table 5-7
Summary of Groundwater Contamination in Los Alamos Canyon
(includes Bayo, Acid, Pueblo, and DP Canyons)

| Canyon | Contaminant Sources | Groundwater Contaminants | | |
|---------------------------|--|---|---|--|
| | | Alluvial | Intermediate | Regional |
| Bayo Canyon | Minor past dry and liquid sources | No alluvial groundwater | No intermediate groundwater | None |
| Pueblo and Acid Canyons | Multiple past effluent discharges, current sanitary effluent | Chloride at 50% and total dissolved solids (TDS) at 80% of NM groundwater standard | Nitrate at 75% of NM GW Std., fluoride at 70% of NM GW Std. | Trace fluoride, perchlorate, and nitrate |
| Los Alamos and DP Canyons | Multiple past effluent discharges | Strontium-90 above 4 mrem DCG screening level, chloride and TDS above NM groundwater standard, fluoride at 50% of NM groundwater standard, trace perchlorate and molybdenum | Tritium at 20% of EPA MCL screening level, trace nitrate, fluoride, perchlorate | None |
| Lower Los Alamos Canyon | Multiple past effluent discharges | Nitrate above NM groundwater standard | Nitrate at 70% of NM groundwater standard, natural fluoride at 55% of NM groundwater standard | None |

Pueblo Canyon receives effluent from the LACWTP. Acid Canyon, a tributary, received radioactive industrial effluent from 1943 to 1964. Little radioactivity is found in current groundwater samples. Tritium, nitrate, fluoride, and perchlorate results from regional aquifer groundwater in this canyon, though below standards, indicate the lingering influence of past discharges from radioactive wastewater outfalls in Acid Canyon. In the case of nitrate in regional aquifer wells, the source may also be from past sanitary effluent discharges in the upper part of the canyon. High nitrate concentrations found in alluvial and intermediate groundwater in lower Pueblo Canyon and downstream in lower Los Alamos Canyon may be due to sanitary effluent from the former Los Alamos County Bayo Sewage Treatment Plant.

Los Alamos Canyon received releases of radioactive effluents during the earliest Manhattan Project operations at Technical Area (TA)-1 (1942–1945) and until 1993 from nuclear reactors at TA-2. From 1952 to 1986, a liquid-waste treatment plant discharged effluent containing radionuclides from the former plutonium-processing facility at TA-21 into DP Canyon, a tributary to Los Alamos Canyon. Los Alamos Canyon also received radionuclides and metals in discharges from the sanitary sewage lagoons and cooling towers at the Los Alamos Neutron Science Center (LANSCE) at TA-53. Except for strontium-90, contaminant concentrations in shallow groundwater have decreased dramatically over the years.

a. Pueblo Canyon

The levels of tritium, perchlorate, and nitrate for water supply well O-1, though below standards or screening levels, indicate the presence of past effluent and surface water recharge in the regional aquifer (Table 5-8). Because of the perchlorate concentrations, the well is not used by Los Alamos County for water supply, although the concentrations are below the EPA DWEL of 24.5 µg/L.

Only one Pueblo Canyon regional aquifer monitoring well, R-4, located downstream from the former Acid Canyon outfall, shows low-detection-limit tritium values indicative of past discharges. The values range up to 53 pCi/L. Two regional aquifer wells (R-4 and R-5) show fluoride values higher than those in unaffected wells, but the results are below the NM groundwater standard (Figure 5-12).

Table 5-8
Groundwater Quality in Pueblo Canyon (includes Acid Canyon)

| Chemical | Location | Result | Trends |
|------------------------------|--|---|---|
| Tritium | Water supply well O-1 | 14 pCi/L, below EPA MCL of 20,000 pCi/L | Reduced from about 40 pCi/L since 2004 |
| Tritium | Regional aquifer monitoring well R-4 | 53 pCi/L, below EPA MCL screening level of 20,000 pCi/L | Results higher than unaffected wells, fairly steady for three years of sampling |
| Perchlorate | Water supply well O-1 | 1.3 µg/L to 2.3 µg/L, below EPA DWEL of 24.5 µg/L | Small decrease since 2004 |
| Perchlorate | Regional aquifer monitoring well R-4 | 2.5 µg/L to 4.3 µg/L, below EPA DWEL of 24.5 µg/L | Results higher than unaffected wells, vary by factor of two during five years of sampling |
| Fluoride | Regional aquifer monitoring wells R-4 and R-5 | 0.66 mg/L to 0.71 mg/L, below NM groundwater standard of 1.6 mg/L | Results higher than unaffected wells, fairly steady for three to four years of sampling |
| Nitrate (as Nitrogen [N]) | Regional aquifer monitoring wells R-4 and R-5 | 1.0 mg/L to 2.4 mg/L, below NM groundwater standard of 10 mg/L | Results higher than unaffected wells, fairly steady for three to four years of sampling |
| Uranium | Intermediate monitoring well R-3i | 8.5 µg/L to 10 µg/L, below NM groundwater standard of 30 µg/L | May be leached from bedrock by percolation of sanitary effluent; steady over two years of sampling |
| Fluoride | Intermediate monitoring well R-5 at 384 ft | 1.05 mg/L, below NM groundwater standard of 1.6 mg/L | Results fairly steady for four years of sampling |
| Nitrate (as N) | Intermediate monitoring well POI-4 | 7.5 mg/L, below NM groundwater standard of 10 mg/L | Concentrations nearly doubled over 11 years of sampling |
| Perchlorate | Alluvial monitoring wells PAO-4, APCO-1 | 4.4 µg/L to 15.7 µg/L, below EPA DWEL of 24.5 µg/L | False positives by IC method due to analytical interference; results by more sensitive LC/MS/MS method were nondetections; results with latter method below 0.1 µg/L for three to four years at each location |
| Chloride | Alluvial monitoring well PAO-2 | 135 mg/L, below NM groundwater standard of 250 mg/L | Highest result in two years of sampling; four measurements; no trend |
| Total Dissolved Solids (TDS) | Alluvial monitoring well PAO-1 | 773 mg/L, below NM groundwater standard of 1,000 mg/L | Highest result in four years of sampling, otherwise steady at about 240 mg/L |
| Turbidity | Alluvial monitoring wells PAO-1, PAO-2, APCO-1 | 1.1 Nephelometric Turbidity Units (NTU) to 8.8 NTU | Lower than flood-affected 2006 results of 10.7 NTU to 84.5 NTU |
| Plutonium-239/240 | Alluvial monitoring wells PAO-2, APCO-1 | Unfiltered results of 0.14 to 0.24 pCi/L | Lower than flood-affected 2006 results of 1.2 to 1.5 pCi/L, above earlier values, which are mainly nondetections over seven and 10 years of samples |

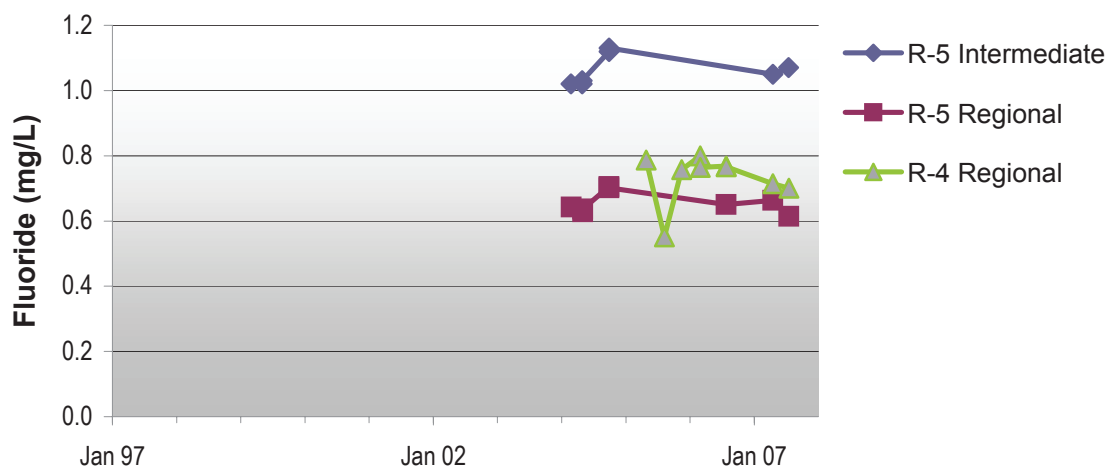


Figure 5-12. Fluoride in Pueblo Canyon intermediate and regional aquifer groundwater. The NM groundwater standard is 1.6 mg/L.

Intermediate groundwater also shows the effects of past effluent releases, with concentrations near standards of nitrate and fluoride (Figures 5-13 and 5-14). The nitrate concentration in intermediate well POI-4 has nearly doubled over 11 years of sampling (Figure 5-15). An intermediate port in regional aquifer well R-5 shows fluoride values higher than that in unaffected wells, but the results are below the NM groundwater standard (Figure 5-12). The uranium concentrations in samples from Pueblo Canyon intermediate well R-3i ranged from 8.5 $\mu\text{g/L}$ to 10 $\mu\text{g/L}$, above levels in unaffected wells but below standards. The higher uranium may result from dissolution of uranium from surrounding bedrock by sanitary or other effluent (Teerlink 2007).

On several days in August 2006 (including August 7, 8, and 25) large rainstorms caused significant runoff in Pueblo Canyon. All of the alluvial wells were flooded and PAO-3 was washed away. Several of these wells were sampled immediately after flooding (on August 8 and 10, 2006). The samples showed unusually high turbidity and unfiltered plutonium-239/240 results. Turbidity measured in 2007 had returned to usual ranges. The 2006 unfiltered plutonium-239/240 activities in PAO-2 and APCO-1 were, for comparison purposes in absence of an applicable groundwater standard, near or above the 4-mrem DOE DCG screening level of 1.2 pCi/L. The 2007 plutonium-239/240 results were much lower, but were still above prior results. Prior samples had plutonium-239/240 results that were mainly nondetections.



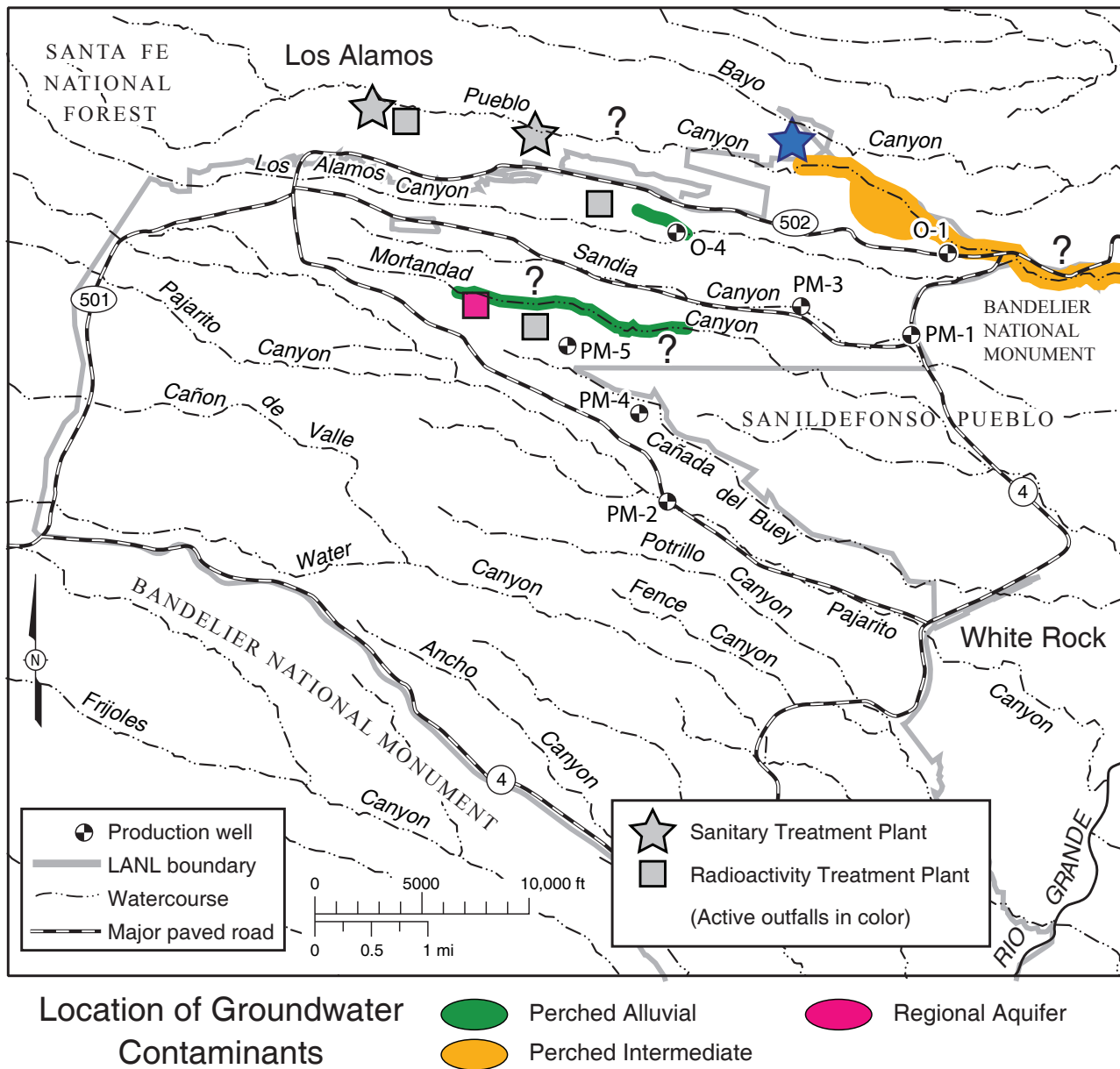


Figure 5-13. Location of groundwater containing fluoride above one half of the 1.6 mg/L NM groundwater standard. Different colors indicate the affected groundwater zones. Question marks indicate where contaminant extent is inferred but not confirmed by monitoring coverage.

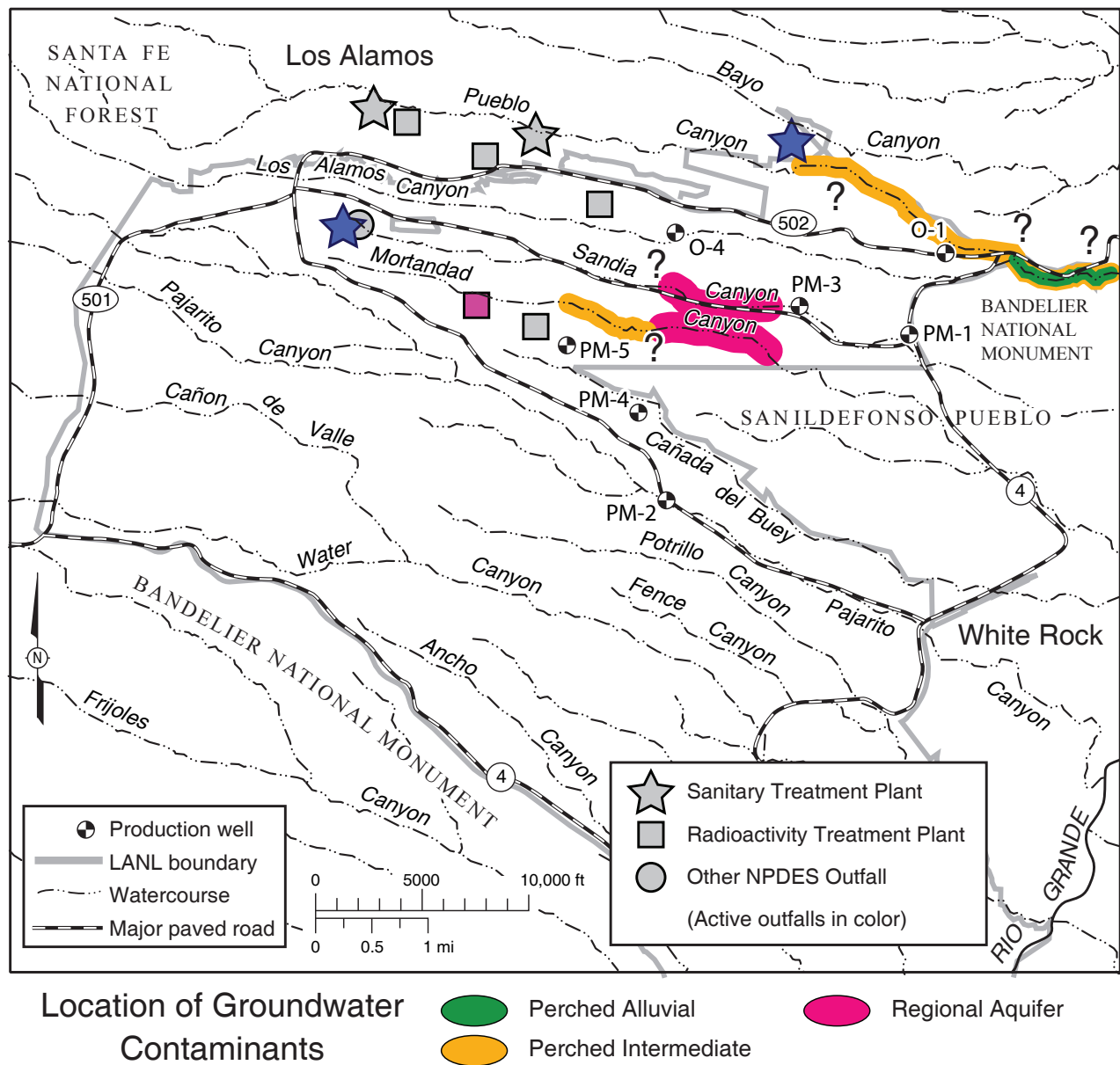


Figure 5-14. Location of groundwater containing nitrate (as nitrogen) above one half of the 10 mg/L NM groundwater standard. Different colors indicate the affected groundwater zones.

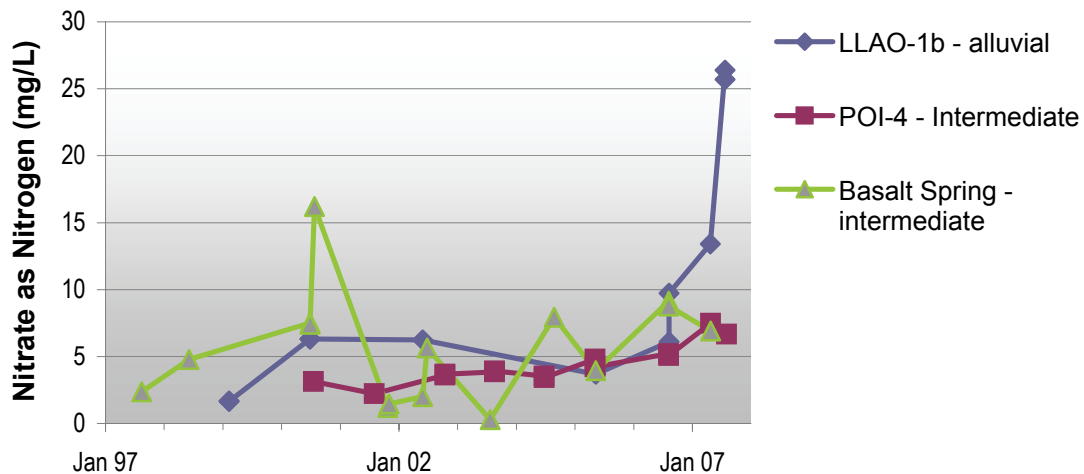


Figure 5-15. Nitrate (as nitrogen) in Pueblo and lower Los Alamos Canyon alluvial and intermediate groundwater. The NM groundwater standard is 10 mg/L.

b. Los Alamos Canyon

Alluvial and intermediate groundwater in Los Alamos Canyon show effects of past effluent releases (Table 5-9).

Table 5-9
Groundwater Quality in Los Alamos Canyon (includes DP Canyon)

| Chemical | Location | Result | Trends |
|----------------|--|---|---|
| Tritium | Five intermediate wells | 150 pCi/L to 4250 pCi/L, below EPA MCL screening level of 20,000 pCi/L | Highest activities in R-6i, LAOI-3.2, LAOI-3.2a; increasing in LAOI-3.2 |
| Nitrate (as N) | Intermediate wells R-6i, LAOI-3.2, LAOI-3.2a | 2.3 mg/L to 4.8 mg/L, below NM groundwater standard of 10 mg/L | Increasing in LAOI-3.2 |
| Perchlorate | Intermediate wells R-6i, LAOI-3.2, LAOI-3.2a | 3.4 µg/L to 9.0 µg/L, below EPA DWEL of 24.5 µg/L | Increasing in LAOI-3.2 |
| Strontium-90 | One alluvial spring and four alluvial wells | 8 pCi/L to 62 pCi/L, above EPA drinking water screening level of 50 pCi/L and 40 pCi/L 4-mrem DOE DCG screening level | Decreased since cessation of discharges in 1986, now stable due to retention on sediments |
| Gross beta | One alluvial spring and two alluvial wells | 53 pCi/L to 143 pCi/L, above EPA drinking water screening level of 50 pCi/L | Gross beta mainly due to presence of strontium-90 |
| Fluoride | Alluvial wells LAUZ-1, LAO-2, LAO-3a | 0.6 to 0.81 mg/L, below NM groundwater standard of 1.6 mg/L | Some fluctuation but present in each well for 10 years |
| Chloride | Alluvial well LAUZ-1 | 506 mg/L, above NM groundwater standard of 250 mg/L | Highest result in 12 years of monitoring, second result above standard |
| TDS | Alluvial well LAUZ-1 | 1,160 mg/L, above NM groundwater standard of 1000 mg/L | Highest result in three years of measurement, twice prior values |
| Perchlorate | Alluvial well LAO-0.6 | 0.15 µg/L to 8.5 µg/L, below EPA DWEL of 24.5 µg/L | Highest results over three total sample events |
| Molybdenum | Alluvial wells LAO-2, LAO-3a | 338 µg/L to 350 µg/L, below NM groundwater standard of 1,000 µg/L | Last above standard in 2004; concentrations decreasing due to outfall improvement |
| Nitrate (as N) | Intermediate Basalt Spring | 6.9 mg/L, below NM groundwater standard of 10 mg/L | Apparent result of discharge from Bayo Sanitary Treatment Plant (STP) |
| Nitrate (as N) | Alluvial well LLAO-1b | 13 mg/L to 26 mg/L, above NM groundwater standard of 10 mg/L | Large increase in last two years; apparent result of discharge from Bayo STP |

Samples from intermediate wells R-6i, LAOI-3.2, LAOI-3.2a, and LAOI-7 contained up to 4,250 pCi/L of tritium. These moderate values indicate a residual impact of past effluent discharges; the wells lie downstream from the former radioactive liquid waste discharge from TA-21 in DP Canyon (Figure 5-16). Nitrate (as nitrogen) concentrations in these wells have increased over the period of sampling (Figure 5-17) but are below the 10 mg/L NM groundwater standard.

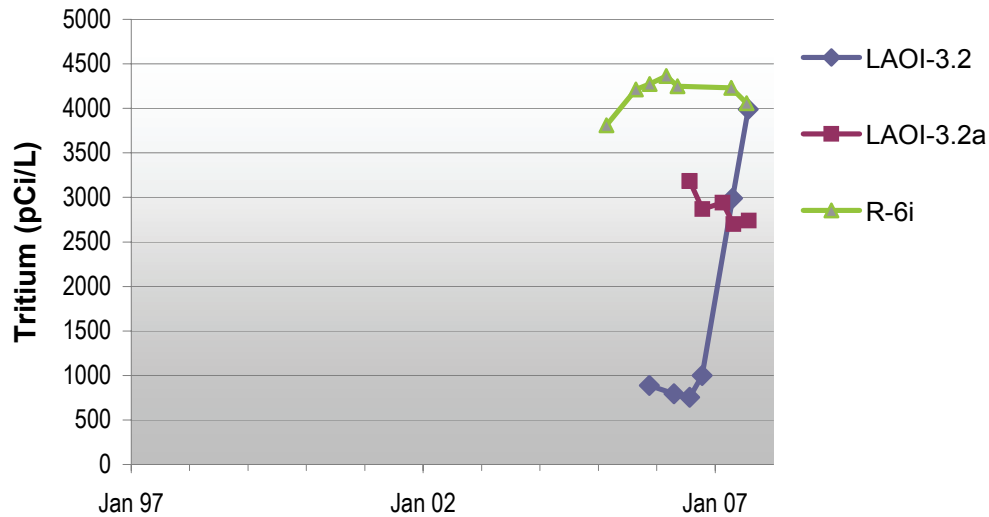


Figure 5-16. Tritium in Los Alamos Canyon intermediate groundwater. For comparison purposes, the EPA MCL screening level (which does not apply to these samples) is 20,000 pCi/L.

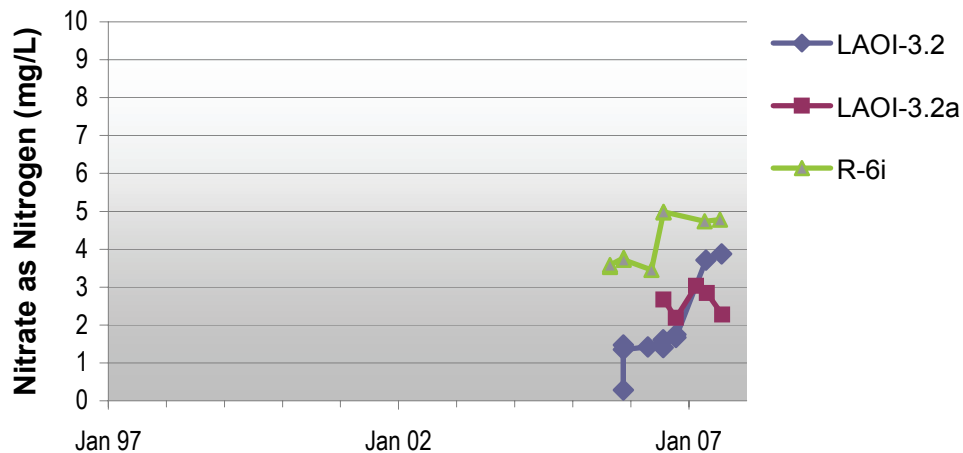


Figure 5-17. Nitrate (as nitrogen) in Los Alamos Canyon intermediate groundwater. The NM groundwater standard is 10 mg/L.

Alluvial groundwater in DP and Los Alamos Canyons continues to show strontium-90; although there is no applicable groundwater standard, for comparison purposes, the values range up to and above the 8-pCi/L EPA MCL screening level (Figure 5-10, Figure 5-18). Fluoride is also present in samples as a result of past effluent release but at concentrations below the NM groundwater standard of 1.6 mg/L (Figure 5-19).

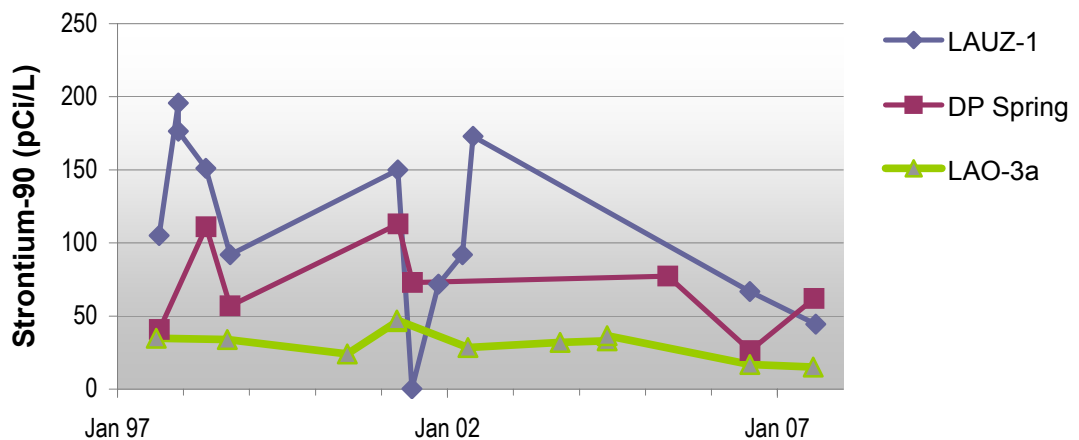


Figure 5-18. Strontium-90 in Los Alamos Canyon alluvial groundwater. For comparison purposes, the EPA MCL screening level (which does not apply to these samples) is 8 pCi/L.

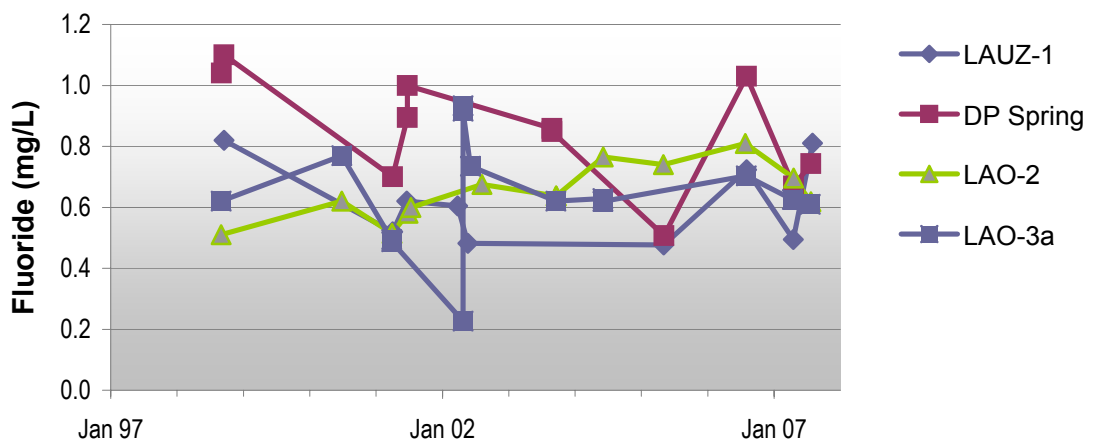


Figure 5-19. Fluoride in Los Alamos Canyon alluvial groundwater. The NM groundwater standard is 1.6 mg/L.

Basalt Spring, which is fed by intermediate groundwater, is in lower Los Alamos Canyon on Pueblo de San Ildefonso land. Alluvial well LLAO-1b is located nearby. The nitrate (as nitrogen) results from samples at both locations were near or above the NM groundwater standard of 10 mg/L (Figure 5-14, Figure 5-15). The source of nitrate may be releases into Pueblo Canyon from the present and former Los Alamos County sanitary treatment plants.

In Los Alamos Canyon, molybdenum in LAO-2 and LAO-3a has dropped to 30% of the NM groundwater standard, which is for irrigation use. The molybdenum came from cooling towers at TA-53 (LANSCE). Use of sodium molybdate was discontinued in June 2002. Molybdenum concentrations in Los Alamos Canyon alluvial groundwater have been quite variable in recent years, perhaps because of large variation in stream flow caused by drought conditions.

3. Sandia Canyon

Sandia Canyon has a small drainage area that heads at TA-3. The canyon receives the largest liquid discharges of any canyon at the Laboratory from the cooling tower at the TA-3 power plant (Table 5-10). Treated effluents from the TA-46 SWWS Plant have been routed to Sandia Canyon since 1992. Chromate was used to treat cooling water at the power plant until 1972 (ESP 1973). These earlier discharges are tentatively identified as the source for hexavalent chromium concentrations discovered in the regional aquifer beneath Sandia and Mortandad Canyons that are above the NM groundwater standard (Figure 5-20). The standard of 50 µg/L applies to dissolved chromium (regardless of the chemical form). Sandia and Mortandad Canyons lie close together, and water percolating downward beneath Sandia Canyon may have been diverted to the south by southwesterly dipping basalts prior to reaching the regional aquifer (ERSP 2006).

Table 5-10
Summary of Groundwater Contamination in Sandia Canyon

| Canyon | Contaminant Sources | Groundwater Contaminants | | |
|---------------|----------------------------|---|---------------------------------------|---|
| | | Alluvial | Intermediate | Regional |
| Sandia Canyon | Multiple liquid discharges | Chloride at 80%, fluoride at 65%, TDS at 53%, and chromium at 65% of NM groundwater standard; lead and arsenic above EPA MCL screening levels | TDS at 54% of NM groundwater standard | Chromium at 70% of NM groundwater standard; nitrate at 75% of NM groundwater standard |

In 2007, chromium concentrations in samples from regional aquifer well R-11 in Sandia Canyon were 35 µg/L or 70% of the groundwater standard; other analyses show the chromium is in the hexavalent form (Table 5-11, Figure 5-21). Nitrate (as nitrogen) in R-11 was up to 74% of the NM groundwater standard, apparently due to past Laboratory sanitary effluent releases (Figure 5-14, Figure 5-22).

Newly sampled intermediate well SCI-1 had total dissolved solids (TDS) up to 53% of the NM groundwater standard. Two new alluvial wells, SCA-1 and SCA-2, had results for chloride and TDS that approached values for standards. These findings likely relate to quality of effluent discharged in upper Sandia Canyon. The dissolved chromium concentration in one sample at SCA-1 was 64% of the NM groundwater standard and was the highest of four measurements made in 2006 and 2007.



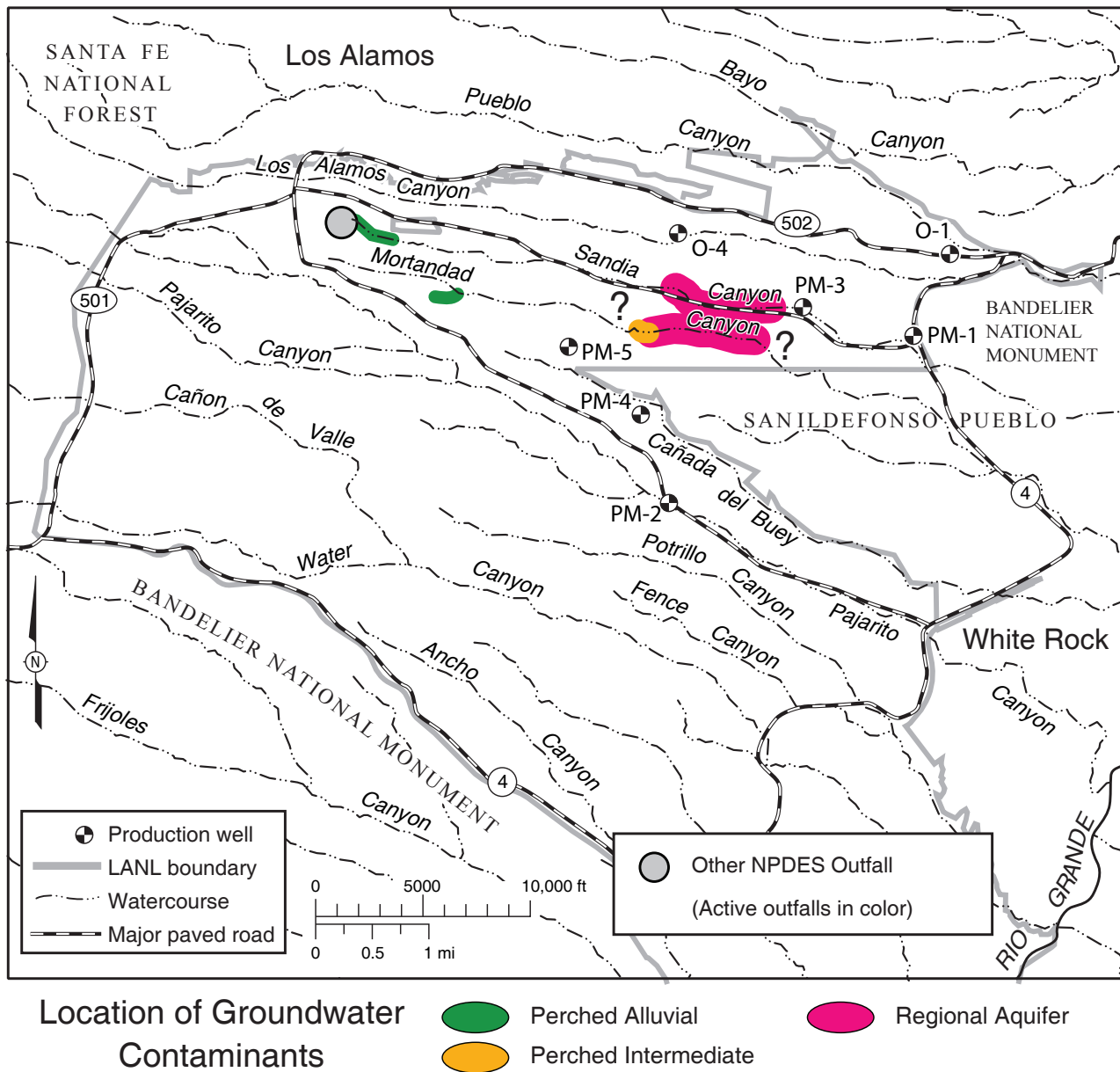


Figure 5-20. Location of groundwater containing dissolved or hexavalent chromium above one half of the 50 µg/L NM groundwater standard. Different colors indicate the affected groundwater zones.

Table 5-11
Groundwater Quality in Sandia Canyon

| Chemical | Location | Result | Trends |
|----------------|---------------------------------------|---|---|
| Chromium | Regional aquifer monitoring well R-11 | 35 µg/L, below NM groundwater standard of 50 µg/L | Increased by 75% over three years of sampling |
| Nitrate (as N) | Regional aquifer monitoring well R-11 | 4.5 mg/L to 7.4 mg/L, below NM groundwater standard of 10 mg/L | Highest value to date, results have doubled over three years of sampling |
| TDS | Intermediate well SCI-1 | 455 mg/L to 536 mg/L, below NM groundwater standard of 1,000 mg/L | First sampled in 2007, values fairly steady |
| Chloride | Alluvial wells SCA-1 and SCA-2 | 84 mg/L to 197 mg/L, below NM groundwater standard of 250 mg/L | Variable results over one or two years of samples |
| TDS | Alluvial wells SCA-1 and SCA-2 | 498 mg/L to 531 mg/L, below NM groundwater standard of 1000 mg/L | Steady results over one or two years of samples |
| Nitrate (as N) | Alluvial well SCA-4 | 729 mg/L in November, above NM groundwater standard of 10 mg/L | Field preservation error, result is above TDS of 312 mg/L |
| Fluoride | Alluvial well SCA-4 | 1.04 mg/L and 1.07 mg/L, below NM groundwater standard of 1.6 mg/L | Two measurements at location |
| Perchlorate | Alluvial well SCA-1 | 6.2 µg/L, below EPA DWEL of 24.5 µg/L | False positive due to analytical interference- result by more sensitive method was nondetect |
| Chromium | Alluvial well SCA-1 | Filtered result of 32 µg/L, below NM groundwater standard of 50 µg/L | Highest value in two years of samples |
| Chromium | Alluvial wells SCA-2 and SCA-4 | Unfiltered concentrations of 552 µg/L and 90 µg/L, near or above EPA drinking water screening level of 100 µg/L | Two results at each location; one detect at SCA-2 and two at SCA-4; one higher result at each related to higher turbidity |
| Arsenic | Alluvial well SCA-4 | 13 µg/L to 19 µg/L, above EPA MCL screening level of 10 µg/L, below NM groundwater standard of 100 µg/L | Two measurements at location |
| Lead | Alluvial wells SCA-2 and SCA-4 | Unfiltered concentrations of 19.8 µg/L to 38.1 µg/L, above EPA drinking water screening level of 15 µg/L, below NM groundwater standard of 100 µg/L | Two results at each location; one detect at SCA-2 and two at SCA-4; higher results related to higher turbidity |

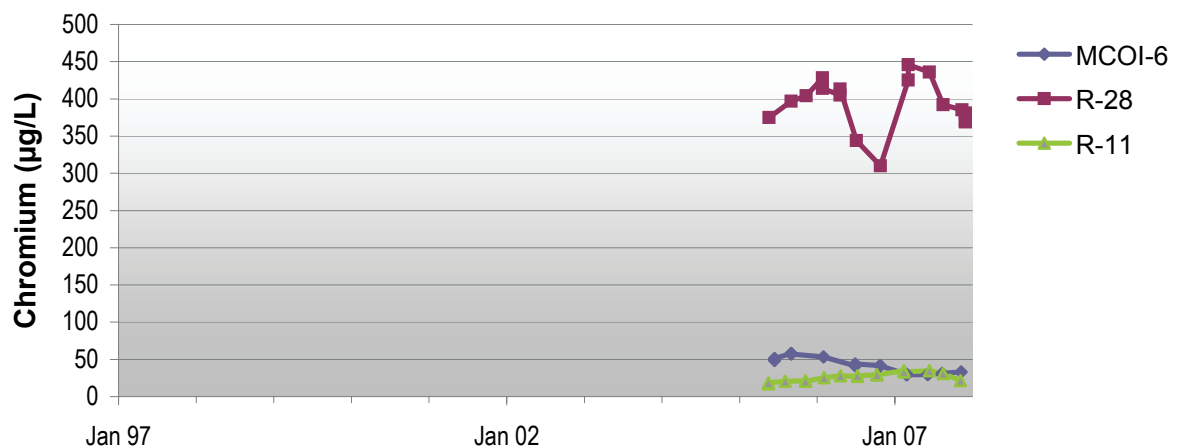


Figure 5-21. Filtered chromium in Sandia and Mortandad Canyon intermediate and regional aquifer groundwater. The NM groundwater standard is 50 µg/L.

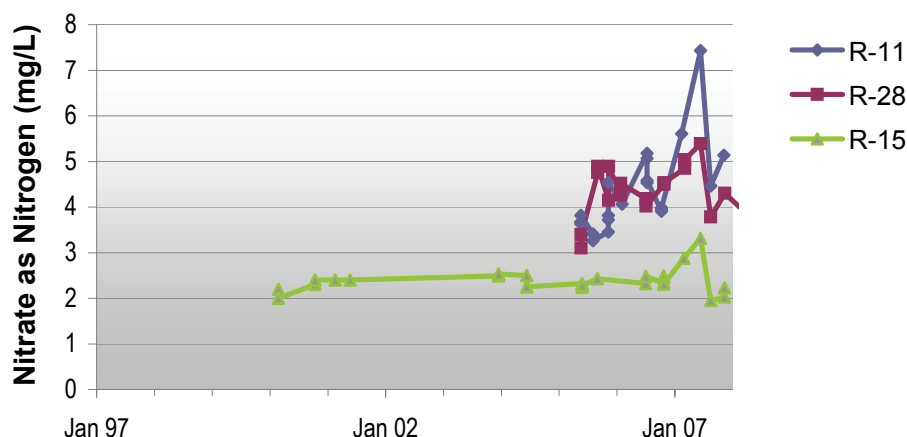


Figure 5-22. Filtered and unfiltered nitrate (as nitrogen) in Sandia and Mortandad Canyon regional aquifer groundwater. The NM groundwater standard is 10 mg/L.

4. Mortandad Canyon (includes Ten Site Canyon and Cañada del Buey)

Mortandad Canyon has a small drainage area that heads at TA-3. This drainage area receives inflow from natural precipitation and a number of National Pollutant Discharge Elimination System (NPDES) outfalls, including one from the Radioactive Liquid Waste Treatment Facility (RLWTF) at TA-50. Past discharges into tributary Ten Site Canyon included a previous radioactive effluent treatment plant at TA-35 (Table 5-12). These discharges have affected groundwater quality in the canyons (Table 5-13).

Table 5-12
Summary of Groundwater Contamination in Mortandad Canyon
(includes Ten Site Canyon and Cañada del Buey)

| Canyon | Contaminant Sources | Groundwater Contaminants | | |
|--------------------------------|---|---|--|--|
| | | Alluvial | Intermediate | Regional |
| Mortandad and Ten Site Canyons | Multiple past and current effluent discharges | Chloride, fluoride, TDS, and mercury above NM ground water standards; strontium-90, arsenic, beryllium, chromium, and lead, above EPA MCL screening levels; gross beta and perchlorate above screening levels | Uranium, hexavalent chromium, and nitrate above fluoride at 88%, and TDS at 55% of ground water standards; bis(2-ethylhexyl)phthalate above and tritium at 65% of EPA MCL screening level, dioxane[1,4-] and perchlorate above screening level | Hexavalent chromium above and nitrate at 55% of NM ground water standards; trace perchlorate |
| Cañada del Buey | Major dry, minor liquid sources | None, little alluvial groundwater | No intermediate groundwater | None |

Table 5-13
Groundwater Quality in Mortandad Canyon (includes Ten Site Canyon and Cañada del Buey)

| Chemical | Location | Result | Trends |
|-----------------------------|---|---|---|
| Chromium | Regional aquifer monitoring well R-28 | 369 µg/L to 446 µg/L, above NM groundwater standard of 50 µg/L | Results in this range over three years of sampling |
| Nitrate (as N) | Regional aquifer monitoring wells R-28 and R-15 | 2.0 mg/L to 5.4 mg/L, below NM groundwater standard of 10 mg/L | Higher values in R-28 with results in this range for three years of sampling |
| Perchlorate | Regional aquifer monitoring well R-15 | 5.3 µg/L to 7.4 µg/L, below EPA DWEL of 24.5 µg/L | Results in this range for four years of sampling |
| Tritium | Intermediate wells MCOI-4, MCOI-5, MCOI-6 | 4,000 to 13,000 pCi/L, below EPA MCL screening level of 20,000 pCi/L | Values steady over three years of sampling; wells sample separate isolated perched zones |
| Nitrate (as N) | Intermediate wells MCOI-4, MCOI-5, MCOI-6 | 4.6 mg/L to 20 mg/L, above NM groundwater standard of 10 mg/L | Values steady over three years of sampling; wells sample separate isolated perched zones |
| Perchlorate | Intermediate wells MCOI-4, MCOI-5, MCOI-6 | 94 µg/L to 190 µg/L, above EPA DWEL of 24.5 µg/L | Results in this range for three years of sampling; slight decreases in MCOI-4, MCOI-6 |
| Chromium | Intermediate well MCOI-6 | 29 µg/L to 33 µg/L, below NM groundwater standard of 50 µg/L | 25% decrease over three years of samples |
| Bis(2-ethylhexyl) phthalate | Intermediate well MCOI-6 | 7.5 µg/L to 12.4 µg/L, above EPA MCL screening level of 6 µg/L | Compound found near this level in seven of eight sample events over three years |
| Dioxane[1,4-] | Intermediate wells MCOI-4 and MCOI-6 | Volatile organic results are 37 µg/L to 64 µg/L, near or above EPA risk level of 61 µg/L; more precise semivolatile results are 5 µg/L to 38 µg/L | Semivolatile results at each location fairly steady over two years of samples |
| Uranium | Intermediate Pine Rock Spring (Pueblo de San Ildefonso) | 29.6 µg/L, below NM groundwater standard of 30 µg/L | Steady over two years, may be leached from bedrock by percolation of sanitary effluent used to irrigate Overlook Park athletic fields |
| Nitrate (as N) | Intermediate Pine Rock Spring (Pueblo de San Ildefonso) | 14.4 mg/L, above NM groundwater standard of 10 mg/L | Highest result; other values range from 3.6 mg/L to 8.9 mg/L over two years |
| Fluoride | Intermediate Pine Rock Spring (Pueblo de San Ildefonso) | 0.89 mg/L to 1.4 mg/L, below NM groundwater standard of 1.6 mg/L | Highest result; values increasing over two years |
| TDS | Intermediate Pine Rock Spring (Pueblo de San Ildefonso) | 531 mg/L to 572 mg/L, below NM groundwater standard of 1,000 mg/L | Values steady over two years |
| Strontium-90 | Alluvial wells MCO-4B, MCO-5, MCO-6 | 41 pCi/L to 65 pCi/L, above EPA drinking water screening level of 50 pCi/L and 40 pCi/L 4-mrem DOE DCG screening level | Fairly stable for 10 years due to retention on sediments |
| Gross beta | Alluvial wells MCO-4B, MCO-5, MCO-6 | 105 pCi/L to 150 pCi/L, above EPA drinking water screening level of 50 pCi/L | Gross beta mainly due to presence of strontium-90 |

Table 5-13 (continued)

| Chemical | Location | Result | Trends |
|--|--------------------------------------|---|---|
| Fluoride | Eight alluvial wells | 0.83 mg/L to 1.7 mg/L, above NM groundwater standard of 1.6 mg/L | Results stable and generally below standard since 1999 treatment upgrades |
| Chloride | Alluvial well MCO-0.6 | 354 mg/L to 377 mg/L, above NM groundwater standard of 250 mg/L | Results up to 759 mg/L over three years of samples |
| TDS | Alluvial wells MCO-0.6, MCO-2, MCO-3 | 546 mg/L to 1,030 mg/L, above NM groundwater standard of 1,000 mg/L | Highest results in MCO-0.6; generally above standard for three years of samples |
| Nitrate (as N) | Alluvial wells MCO-4B, MCO-6, MCO-7 | 5.6 mg/L to 241 mg/L, above NM groundwater standard of 10 mg/L | Values not supported by duplicate analyses and reflect improper field preservation or possible analytical error; no corresponding changes in effluent quality |
| Perchlorate | Eight alluvial wells | 11 µg/L to 31 µg/L, above EPA DWEL of 24.5 µg/L | Results generally decreasing since 2002 treatment upgrades |
| Total arsenic, beryllium, chromium, lead | Alluvial well MCO-2 | Concentrations above respective EPA MCL screening levels | Results similar to total metals results in 2006, few sampling events due to little water |
| Chromium | Alluvial well MCO-2 | 41 µg/L, below NM groundwater standard of 50 µg/L | One prior measurement in 2000 was 13 µg/L |
| Total mercury | Alluvial well MCO-7 | 4.9 µg/L, above NM groundwater standard of 2 µg/L | One prior detection in 2002, eight sample events were nondetect |
| Benzo(a)pyrene and other PAH compounds | Alluvial well MCO-7 | 0.83 µg/L to 31 µg/L, above EPA MCL screening level of 0.2 µg/L | Analytes not detected in field duplicate or prior samples; likely result of analytical laboratory contamination |

Cañada del Buey, a tributary to Mortandad Canyon, contains a shallow alluvial groundwater system of limited extent, and only two observation wells have ever contained water. Because treated effluent from the Laboratory's SWWS 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 1992 within the upper and middle reaches of the drainage. Past discharges included accidental releases from experimental reactors and laboratories at TA-46.

a. 2007 Radioactive Liquid Waste Treatment Facility Discharges

Data on the RLWTF's yearly radionuclide discharge into Mortandad Canyon from 2004 through 2007 appear in Supplemental Data [Table S5-13](#). [Table S5-13](#) shows mean annual levels in effluent for each radionuclide and the ratio of this to the 100-mrem DOE DCG for public dose. Figures 5-23 and 5-24 show the relationship of RLWTF average annual radionuclide activities and selected general inorganic chemical concentrations (fluoride, nitrate) in discharges to DOE DCGs or NM groundwater standards since 1996. The 2007 discharges from the RLWTF met all DOE, EPA, and NM requirements for permits and standards. Beginning in 1999, LANL made significant upgrades to the RLWTF treatment system. As a result, for the last eight years the RLWTF has met all DOE radiological discharge standards and all NPDES requirements, and for all but two weeks in 2003, the RLWTF has voluntarily met NM groundwater standards for fluoride, nitrate, and TDS. Two weekly composite samples exceeded the fluoride standard in 2003.

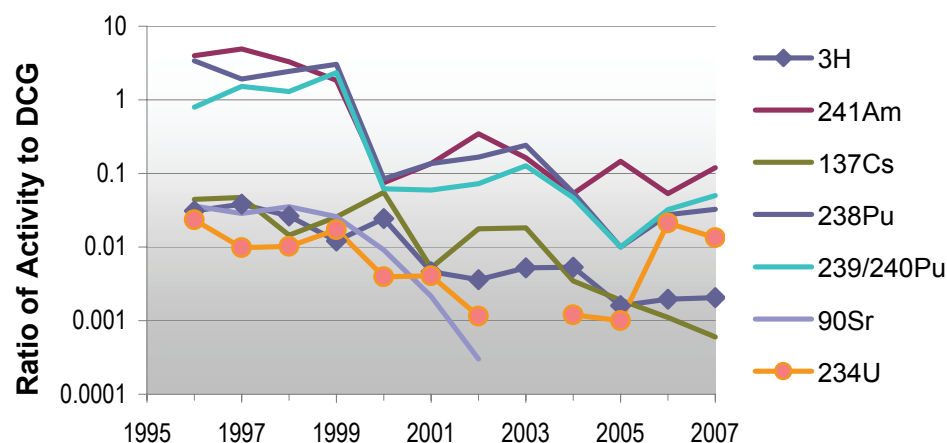


Figure 5-23. Ratio of 1996–2007 average annual radionuclide activity in RLWTF discharges to the 100-mrem public dose DOE DCGs, which are applicable to effluent releases.

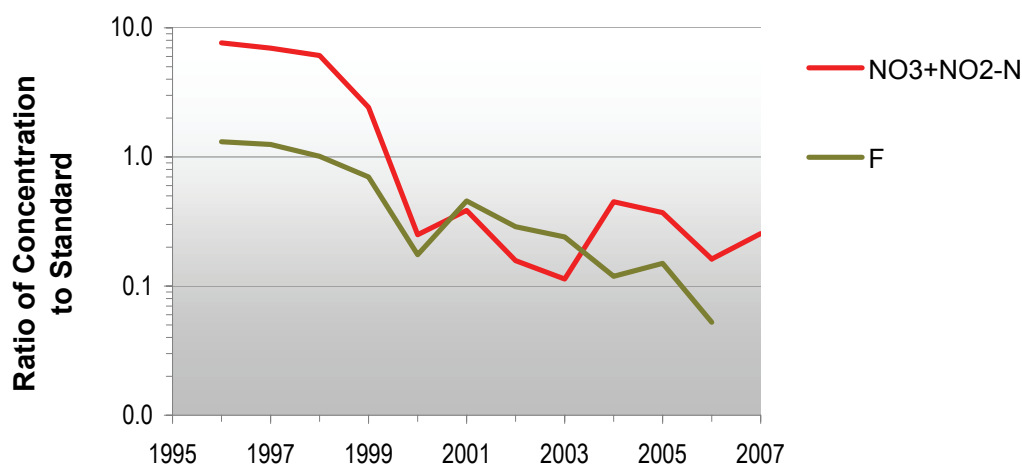


Figure 5-24. Ratio of 1996–2007 average annual nitrate plus nitrite (as nitrogen) and fluoride concentrations in RLWTF discharges to the NM groundwater standards.

During 2007, the nitrate + nitrite (as nitrogen) concentrations of all monthly analyses of effluent discharges from the RLWTF were less than the NM groundwater standard for nitrate (as nitrogen) of 10 mg/L, as has been the case since 2000 (Figure 5-25). The average 2007 effluent total nitrate + nitrite (as nitrogen) concentration was 2.55 mg/L. In 2007, the highest nitrate concentration in a Mortandad Canyon base flow grab sample collected below the outfall in Effluent Canyon was 6.4 mg/L.

The fluoride concentration in the discharge has also declined over the last few years (Figure 5-26). The 2007 effluent fluoride concentration (average value of 0.13 mg/L) was below the NM groundwater standard of 1.6 mg/L. In 2007, the fluoride concentration at the surface water station E-1E in Effluent Canyon just below the outfall was 0.36 mg/L.

A system for removing perchlorate from the RLWTF effluent became operational on March 26, 2002; no perchlorate has been detected in the effluent after this date. For 2007, no perchlorate was detected in effluent samples.

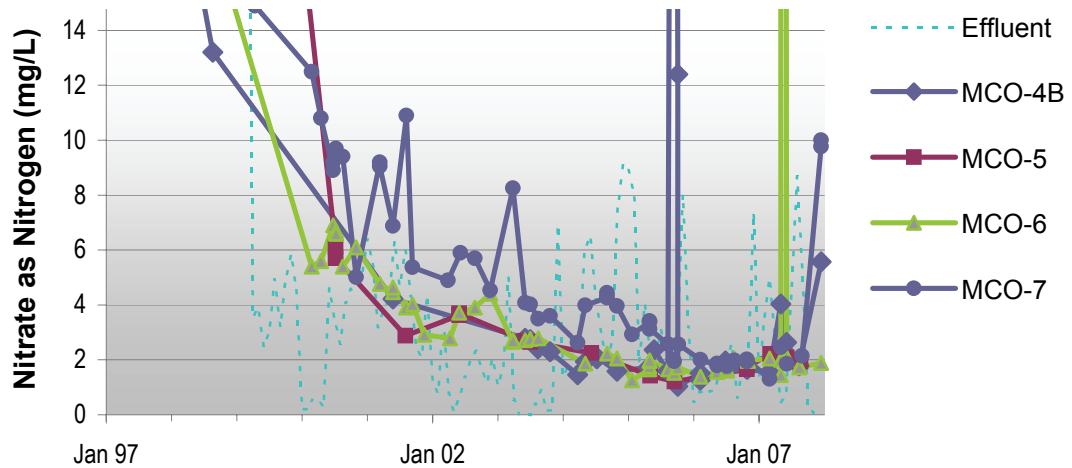


Figure 5-25. Filtered and unfiltered nitrate (as nitrogen) in RLWTF effluent and Mortandad Canyon alluvial groundwater; the NM groundwater standard is 10 mg/L. Groundwater results above about 3 mg/L taken after 2005 reflect field preservation errors.

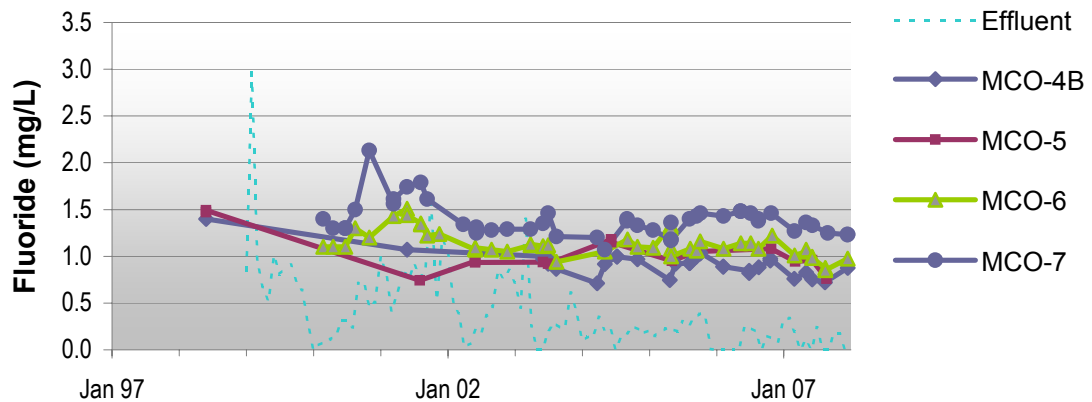


Figure 5-26. Fluoride in RLWTF effluent and Mortandad Canyon alluvial groundwater; the NM groundwater standard is 1.6 mg/L.

b. Mortandad Canyon Intermediate Groundwater and Regional Aquifer

The regional aquifer beneath Mortandad Canyon shows impacts from past LANL discharges; intermediate groundwater shows a generally larger effect. In 2007, sampling at regional aquifer monitoring well R-28 in Mortandad Canyon continued to show contamination by hexavalent chromium above the NM groundwater standard of 50 $\mu\text{g/L}$ (which applies to any dissolved form of chromium) (Figure 5-20, Figure 5-21). The Laboratory began investigation of this issue in cooperation with NMED and identified past cooling tower discharges in Sandia Canyon as the likely source (ERSP 2006).

The nitrate concentration in R-28 is at about 55% of the NM groundwater standard (Figure 5-22). In regional aquifer monitoring well R-15, results for tritium, perchlorate, and nitrate are higher than in unaffected wells but are below standards or screening levels. Of these chemicals in R-15, nitrate shows the highest concentrations relative to a standard or screening level (Figure 5-22).

Contaminants found in Mortandad Canyon intermediate groundwater indicate an impact by LANL effluents, with some concentrations near or exceeding regulatory standards. MCOI-6, an intermediate groundwater well in Mortandad Canyon, consistently shows chromium in filtered samples at concentrations just below the NM groundwater standard (Figure 5-21). Nitrate (Figures 5-14, 5-27, 5-28), dioxane[1,4-] (Figure 5-29), bis(2-ethylhexyl) phthalate, and perchlorate (Figures 5-30 and 5-31) are consistently near or above standards or screening levels in some monitoring wells.

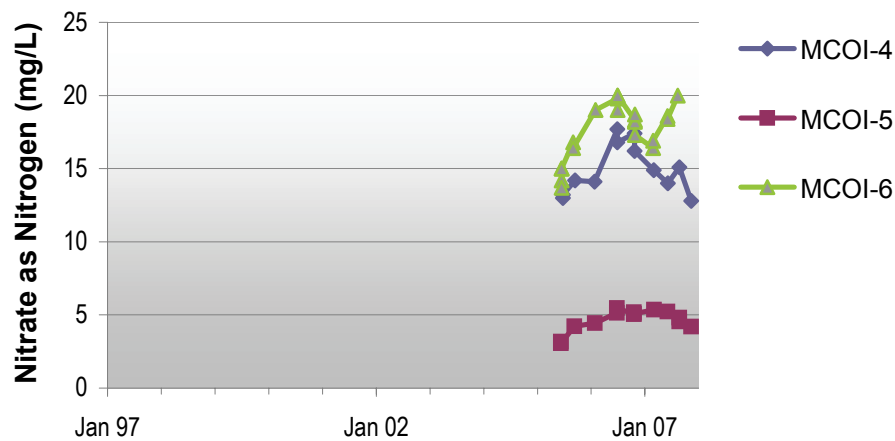


Figure 5-27. Filtered and unfiltered nitrate (as nitrogen) in Mortandad Canyon intermediate groundwater; the NM groundwater standard is 10 mg/L.

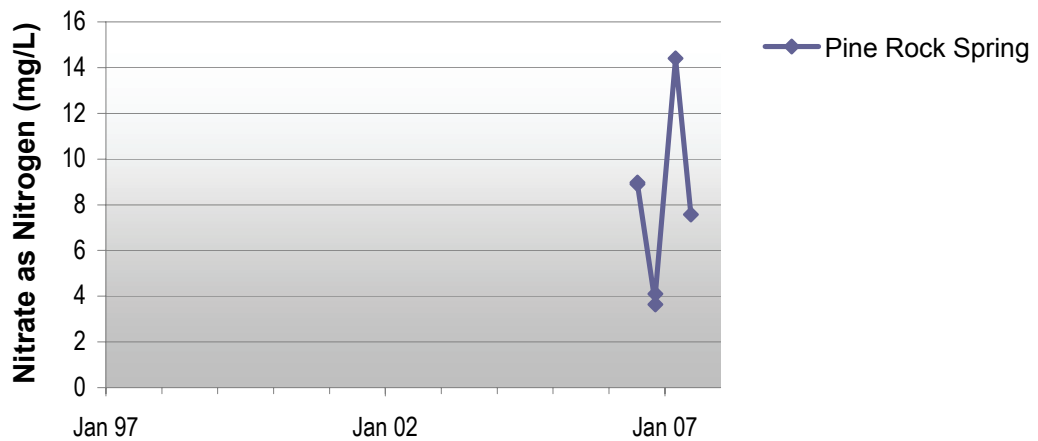


Figure 5-28. Filtered and unfiltered nitrate (as nitrogen) in Mortandad Canyon intermediate groundwater at Pine Rock Spring on Pueblo de San Ildefonso land; the NM groundwater standard is 10 mg/L.

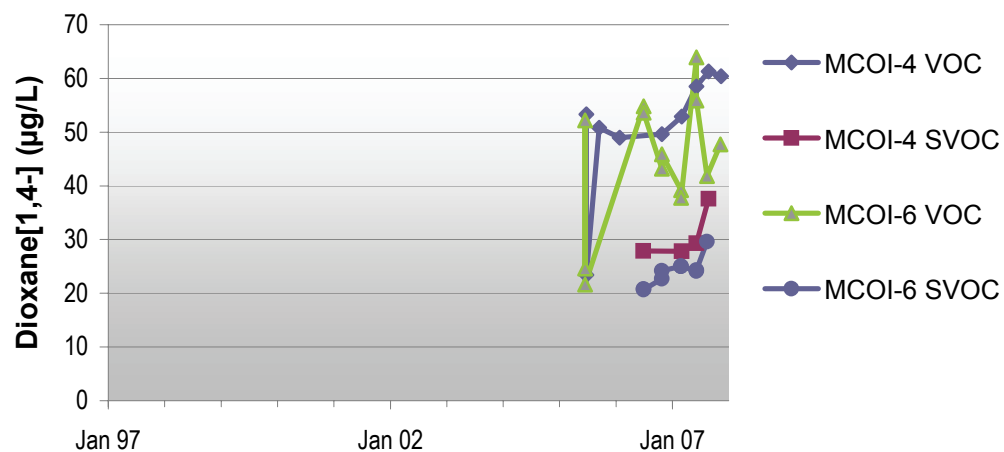


Figure 5-29. Dioxane[1,4-] in Mortandad Canyon intermediate groundwater; the EPA Region 6 10^{-5} risk value is 61.1 µg/L. The results using the Volatile Organic Compound (VOC) method are higher but have much less accuracy than lower results from the Semi-Volatile Organic Compound (SVOC) method.

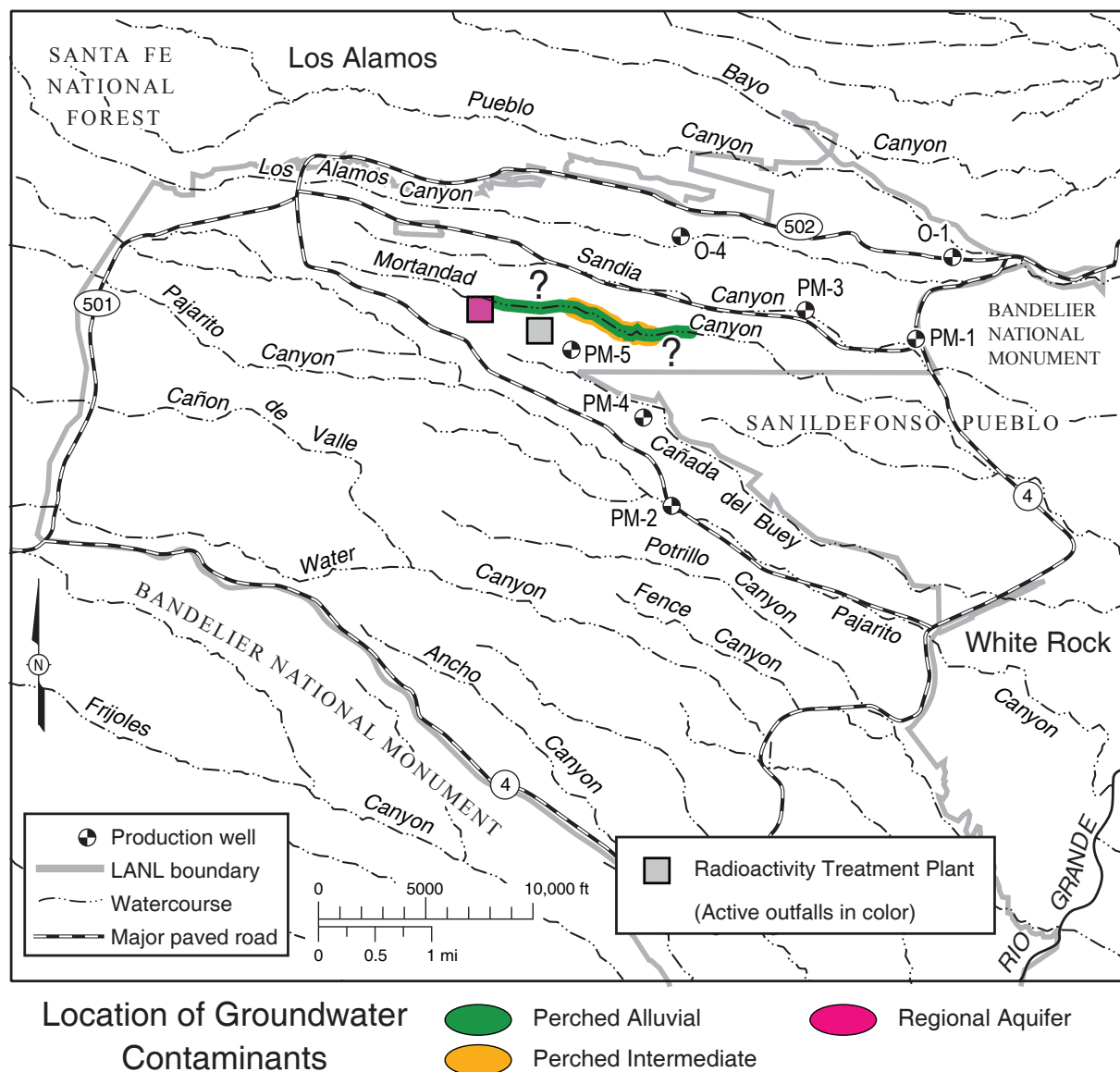


Figure 5-30. Location of groundwater contaminated by perchlorate; there is no applicable groundwater standard, but for comparison purposes, the concentrations in the areas indicated are above the 24.5 µg/L EPA Drinking Water Equivalent Level. Different colors indicate the affected groundwater zones.

Three intermediate wells in Mortandad Canyon (MCOI-4, MCOI-5, and MCOI-6) had tritium activities that ranged from 20% to 65% of the EPA MCL screening level of 20,000 pCi/L (Figure 5-32, 5-33). Tritium has a short half-life of about 12.3 years, so these values will decline rapidly because the tritium activity in effluent has decreased. Another intermediate well, MCOBT-4.4, had construction problems that affected sampling. As a result, we have not sampled the well for several years, and it will be plugged and abandoned. MCOI-4 was drilled nearby as a replacement.

Pine Rock Spring on Pueblo de San Ildefonso land had uranium concentrations near and nitrate concentrations (Figure 5-28) above the NM groundwater standards. Fluoride and TDS were also near the standards. These concentrations appear to be caused by the contribution of effluent to spring flow. The uranium values may be caused by dissolution of uranium from the bedrock by sanitary effluent used to water athletic fields at nearby Overlook Park (Teerlink 2007).

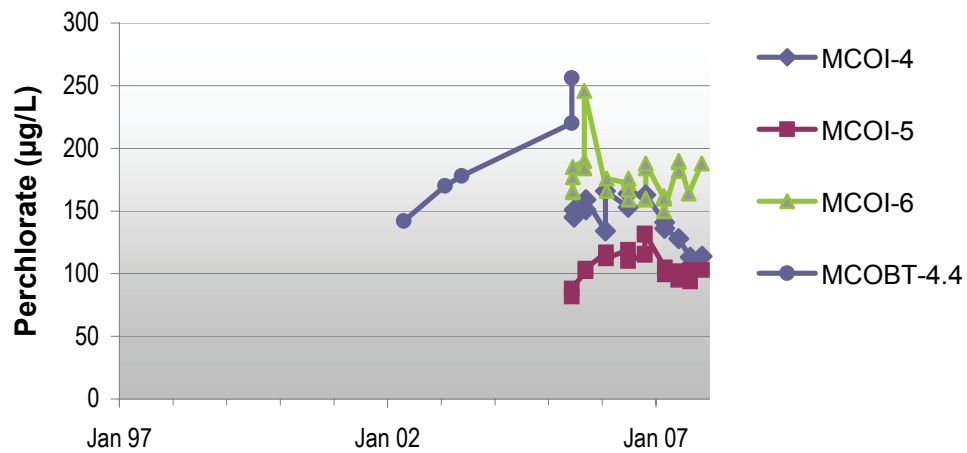


Figure 5-31. Perchlorate in Mortandad Canyon intermediate groundwater; while there is no applicable groundwater standard, for comparison purposes, the EPA DWEL is 24.5 µg/L.

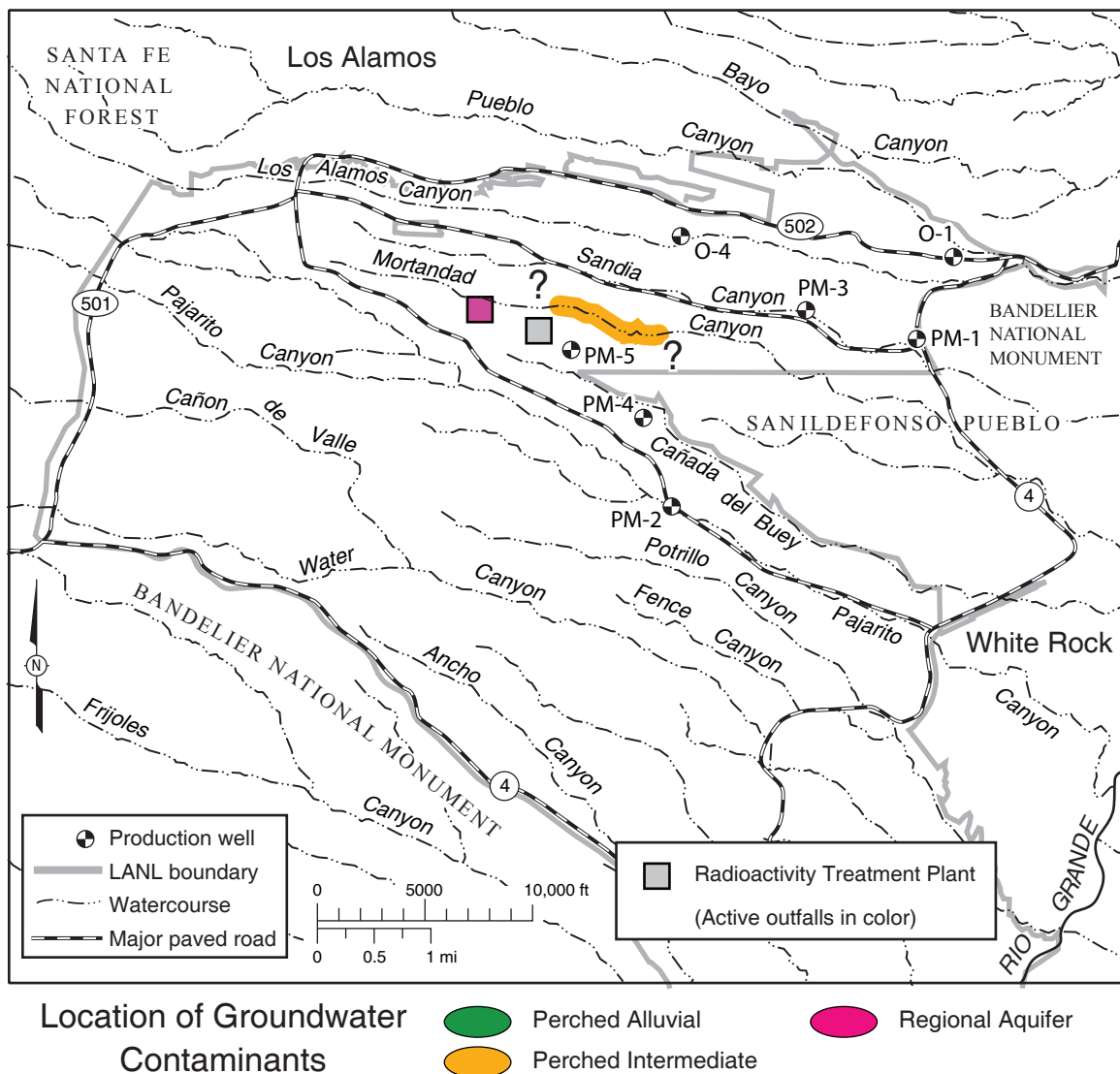


Figure 5-32. Location of groundwater contaminated by tritium. While there is no applicable groundwater standard, for comparison purposes, the area indicated has tritium activity above one-half of the 20,000 pCi/L EPA MCL screening level. Different colors indicate the affected groundwater zones.

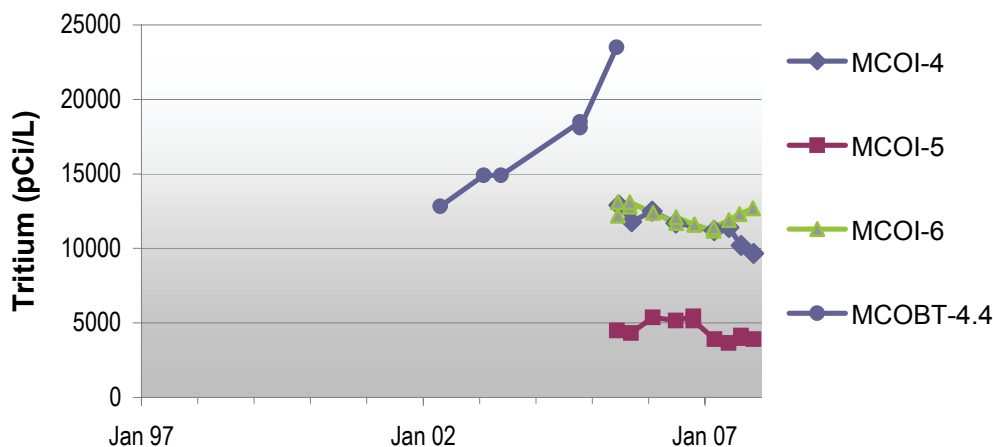


Figure 5-33. Tritium in Mortandad Canyon intermediate groundwater. For comparison purposes, the EPA MCL screening level (which does not apply to these samples) is 20,000 pCi/L.

In 2005, dioxane[1,4-] was measured and detected for the first time in two intermediate wells in Mortandad Canyon (Figure 5-29). There is no applicable groundwater standard for dioxane[1,4-]. However, for comparison purposes, the EPA Region 6 dioxane[1,4-] 10^{-5} risk value is 61 $\mu\text{g/L}$. This compound has been measured by two methods. The less-precise volatile organic compound method SW-846:8260B has a practical quantitation limit (PQL) of 50 $\mu\text{g/L}$ (the MDL is 20 $\mu\text{g/L}$). Many measured results by this method are above the EPA Region 6 risk value. A more sensitive semivolatile organic compound method SW-846:8270C has a PQL of 10 $\mu\text{g/L}$ (the MDL is 1 $\mu\text{g/L}$). Results measured by this method are below the EPA Region 6 risk value.

Bis(2-ethylhexyl)phthalate continues to be detected in samples from MCOI-6; there is no applicable groundwater standard for this compound, but for comparison purposes the concentrations were above the 6 $\mu\text{g/L}$ EPA MCL screening level. The source of this chemical at this well is not known; it has been found in seven of eight samples from MCOI-6.

c. Alluvial Groundwater

Radionuclide levels in Mortandad Canyon alluvial groundwater are, in general, highest just below the TA-50 RLWTF outfall at well MCA-5 and decrease down the canyon. Most radionuclides are adsorbed to sediment closer to the outfall and subsequently move with sediment rather than in groundwater. There are no applicable groundwater standards for these radionuclides; but for comparison purposes, since the early 1990s, radionuclide levels in groundwater samples have not exceeded the 100-mrem DOE DCGs for public dose (applicable to effluent discharges).

There are no applicable groundwater standards for most radioactivity in alluvial groundwater. However, for comparison purposes, in 2007, total LANL-derived radioactivity exceeded the 4-mrem DOE DCG screening level in Mortandad Canyon alluvial groundwater samples from wells MCO-4B, MCO-5, MCO-6 and MCO-7 (Figure 5-11). Strontium-90 was the main contributor to dose in these samples. For comparison purposes in absence of an applicable groundwater standard, for radioactivity from a DOE source, 2007 results for the strontium-90 exceeded the 4-mrem DOE DCG screening level in all four wells. Again for comparison purposes in absence of an applicable groundwater standard, the levels of strontium-90 also exceeded the EPA MCL screening level (Figure 5-10, Figure 5-34).

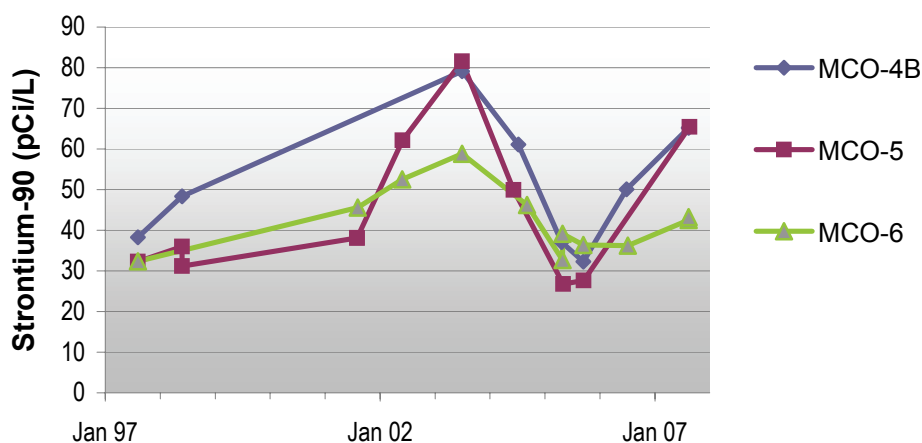


Figure 5-34. Strontium-90 in Mortandad Canyon alluvial groundwater. For comparison purposes, the EPA MCL screening level (which does not apply to these samples) is 8 pCi/L.

It appears that strontium-90 has been retained by cation exchange on sediment within the upstream portion of the alluvium. The level of strontium-90 has risen gradually at downstream alluvial wells MCO-5 and MCO-6 during the last 20 years, suggesting that the mass of the radionuclide is moving slowly downstream. However, the inventory of strontium-90 should be declining, since discharge amounts have decreased significantly and, as noted earlier, the half-life of strontium-90 is 28.8 years. Gross beta values (probably reflecting strontium-90 activity) in samples from most alluvial wells were high; there is no applicable groundwater standard, but for comparison purposes the results were near or exceeded the EPA 50 pCi/L drinking water screening level.

As shown in Figures 5-25 and 5-26, the nitrate (as nitrogen) and fluoride concentrations of effluent discharge from the RLWTF after March 1999 are below the NM groundwater standards. Under the groundwater discharge plan application for the RLWTF, the Laboratory collected additional quarterly samples for nitrate, fluoride, perchlorate, and TDS during 2007 from four alluvial monitoring wells below the outfall in Mortandad Canyon: MCA-5 (or MCO-3), MCO-4B, MCO-6, and MCO-7.

With some exceptions, nitrate (as nitrogen) concentrations in these wells were below the NM groundwater standard of 10 mg/L (Figure 5-25), and fluoride concentrations were below the NM groundwater standard of 1.6 mg/L (Figure 5-26). In May 2007, a sample collected from MCO-6 had a nitrate (as nitrogen) result of 241 mg/L; the result of a field preservation error. A duplicate sample had 2 mg/L, and a reanalysis of the sample gave 1.5 mg/L. Though the reanalysis was done when the sample was out of holding time, it would have shown that such a high nitrate concentration was present in the sample. As well, the TDS for the sample was 308 mg/L, in line with usual measurements and indicating the nitrate result is not valid. Other nitrate measurements in December 2007 at MCO-4B of 5.7 mg/L and at MCO-7 of 10 mg/L are much higher than usual results and indicate a field or analytical error though the source of this could not be found. Variations in effluent quality do not appear to be large enough to account for these results (Figure 5-25).

All of the alluvial groundwater samples collected below the RLWTF outfall had fluoride concentrations above 50% of the NM groundwater standard, with some above the standard (Figures 5-13, 5-26). One downstream well (MCO-7.5) had a fluoride result exceeding the standard, a result of past effluent discharge.

Mortandad Canyon alluvial groundwater samples from wells downstream of the RLWTF outfall had high perchlorate concentrations (Figures 5-30 and 5-35). There is no applicable groundwater standard for perchlorate, but for comparison purposes, the 2007 concentrations at some wells were above the EPA's DWEL of 24.5 µg/L. Alluvial groundwater concentrations of perchlorate have dropped, especially near the outfall, following the removal of perchlorate from RLWTF effluent in March 2002.

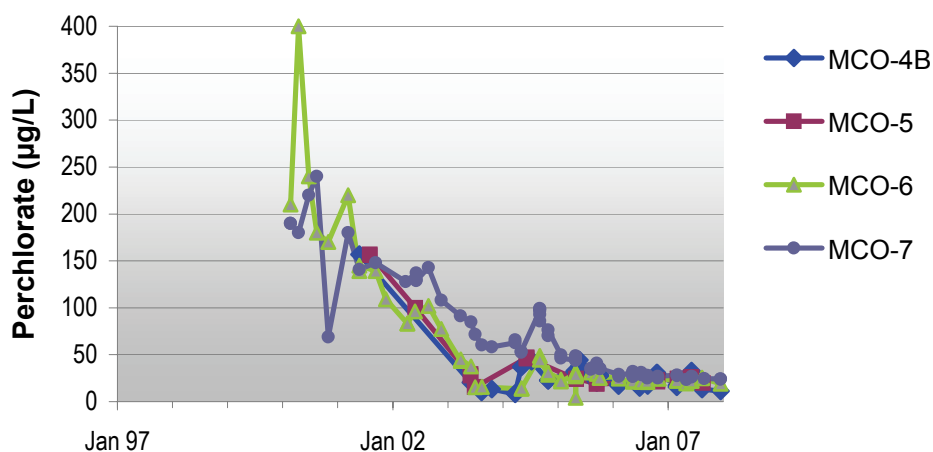


Figure 5-35. Perchlorate in Mortandad Canyon alluvial groundwater; while there is no applicable standard, for comparison purposes, the EPA DWEL is 24.5 µg/L.

e. Cañada del Buey

Water supply wells PM-4 and PM-5 are on the mesa top just south of Cañada del Buey. PM-4 operates as a backup well and in any year may have fewer sample events.

Alluvial well CDBO-6 in Cañada del Buey was sampled three times in 2007 with no chemicals near regulatory standards or screening levels.

5. Pajarito Canyon (includes Twomile and Threemile Canyons)

Pajarito Canyon has a drainage that extends into the Sierra de los Valles, west of the Laboratory. In lower Pajarito Canyon near the eastern Laboratory boundary, saturated alluvium occurs but does not extend beyond the boundary. In the past, the Laboratory released small amounts of wastewater into tributaries of Pajarito Canyon from several HE-processing sites at TA-9 (Table 5-14). Some firing sites border portions of tributaries Twomile and Threemile canyons. A nuclear materials experimental facility occupied the floor of Pajarito Canyon at TA-18. Waste management areas at TA-54, used for disposal of organic solvents and low-level radioactive waste, occupy the mesa north of the lower part of the canyon. A small contaminated body of shallow intermediate groundwater occurs behind a former Laboratory warehouse location at TA-3, where the Laboratory disposed of waste materials. The main water quality impacts are from organic chemicals released at the TA-3 warehouse and from HE (Table 5-15).

**Table 5-14
Summary of Groundwater Contamination in Pajarito Canyon
(includes Twomile and Threemile Canyons)**

| Canyon | Contaminant Sources | Groundwater contaminants | | |
|--|--|---|---|-----------|
| | | Alluvial | Intermediate | Regional |
| Pajarito, Twomile, and Threemile Canyons | Major dry sources, past major but minor present liquid sources | Mercury and chloride above and TDS at 86% of NM groundwater standards | Dichloroethene[1,1-], trichloroethane[1,1,1-], chloride and TDS above and mercury at 85% of NM groundwater standards; dioxane[1,4-] and RDX above EPA screening levels; lead at 84% of drinking water system screening level; trichloroethene, dichloroethane[1,1-] at trace levels | Trace RDX |

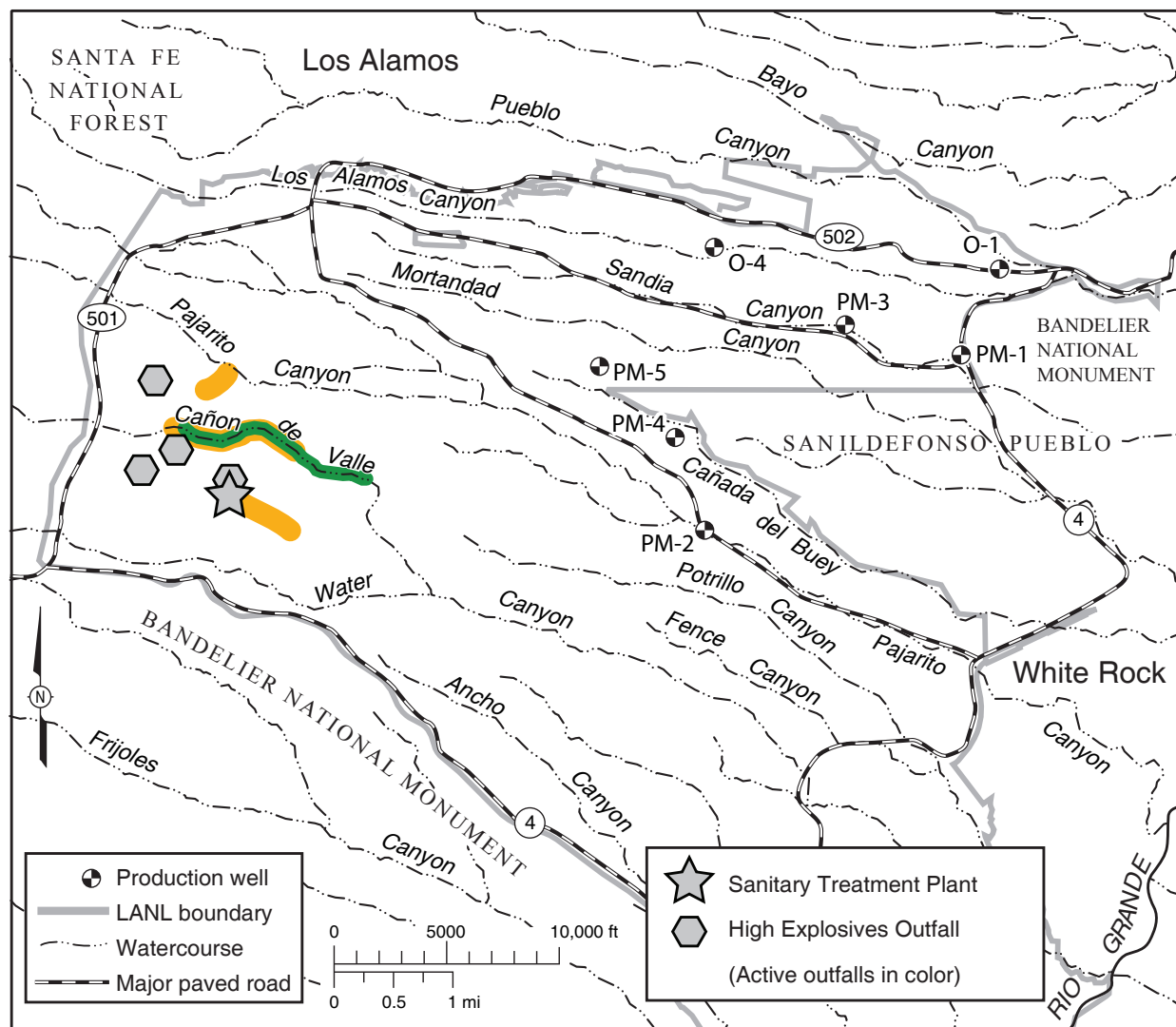
Table 5-15
Groundwater Quality in Pajarito Canyon (includes Twomile and Threemile Canyons)

| Chemical | Location | Result | Trends |
|--------------------------|---|--|---|
| RDX | Regional aquifer well R-18 | 0.14 µg/L to 0.25 µg/L, below EPA risk level of 6.1 µg/L | Found in all 5 sample events since August 2006; not found in three prior sample events |
| Chloride | Intermediate wells 03-B-9, 03-B-10, 03-B-13 | 350 mg/L to 610 mg/L, above NM groundwater standard of 250 mg/L | Highest results over two years of sampling in March and December; usually 50 mg/L; perhaps from road salt |
| TDS | Intermediate wells 03-B-9, 03-B-10, 03-B-13 | 800 mg/L to 1230 mg/L, above NM groundwater standard of 1,000 mg/L | March and December 2007 results highest over two years of sampling ; usually 200 mg/L to 500 mg/L; perhaps from road salt |
| Mercury | Intermediate well 03-B-10 | 1.7 µg/L, below NM groundwater standard of 2 µg/L | Highest result by an order of magnitude out of five samples during two years of sampling |
| Lead | Intermediate wells 03-B-10, 03-B-13 | 8.8 µg/L to 12.6 µg/L, below EPA drinking water system screening level of 15 µg/L | In range of variable results over two years of sampling |
| Dichloroethene [1,1-] | Intermediate wells 03-B-9, 03-B-10, 03-B-13 | 2 µg/L to 11 µg/L, above NM groundwater standard of 5 µg/L | Detected in every sample at similar levels over two years; except that 03-B-9 only had water for two sampling events |
| Trichloroethane [1,1,1-] | Intermediate wells 03-B-9, 03-B-10, 03-B-13 | 41 µg/L to 206 µg/L, above NM groundwater standard of 60 µg/L | Detected in every sample at similar levels over two years; except that 03-B-9 only had water for two sampling events |
| Dioxane[1,4-] | Intermediate wells 03-B-9, 03-B-10, 03-B-13 | Volatile organic results are 39 µg/L to 450 µg/L, above EPA Region 6 screening level of 61 µg/L; more precise semivolatile results are 20 µg/L to 146 µg/L | Results fluctuate over this range for two years of samples |
| Dichloroethane [1,1-] | Intermediate wells 03-B-9, 03-B-10, 03-B-13 | 1.2 µg/L to 5.9 µg/L, below NM groundwater standard of 25 µg/L | Detected in every sample at similar levels over two years; except that 03-B-9 only had water for two sampling events |
| Trichloroethene | Intermediate wells 03-B-9, 03-B-10, 03-B-13 | 0.8 µg/L to 2.0 µg/L, below EPA MCL screening level of 5 µg/L | Detected in all but two samples at similar levels over two years; except that 03-B-9 only had water for two sampling events |
| RDX | Intermediate Kieling and Bulldog Springs | 0.14 µg/L to 6.4 µg/L, above EPA Region 6 screening level of 6.1 µg/L | Found in three of seven sample events at Kieling Spring, in all seven events at Bulldog Spring |
| Chloride | Alluvial wells 18-MW-18, PCO-2, PCO-3 | 130 mg/L to 320 mg/L, above NM groundwater standard of 250 mg/L | Highest results over two years of sampling in 18-MW-18 and over 20 years in PCO-2; similar to variable results in PCO-3 over 15 years |
| TDS | Alluvial wells 18-MW-18, PCO-3 | 515 mg/L to 859 mg/L, below NM groundwater standard of 1000 mg/L | Similar results for two years in 18-MW-18, for 20 years in PCO-3 |
| Mercury | Alluvial wells 18-MW-8, PCO-3 | 1.8 µg/L to 6.7 µg/L, above NM groundwater standard of 2 µg/L | Fourth and highest detection over 20 years at PCO-3; second detection in five samples over two years at 18-MW-8 and found in both filtered and unfiltered samples |

RDX was detected at Pajarito Canyon regional well R-18 near the detection limit and at 4% of the EPA 10^{-5} excess cancer risk tap water screening level. RDX is listed as a toxic pollutant in the New Mexico groundwater regulations (NMWQCC 2002).

5. Groundwater Monitoring

Samples from several of the intermediate groundwater springs in Upper Pajarito Canyon contained RDX, HMX, and other HE compounds as in prior years. One RDX result from Bulldog Spring was above the EPA 10^{-5} excess cancer risk tap water screening level (Figure 5-36).



Location of Groundwater Contaminants

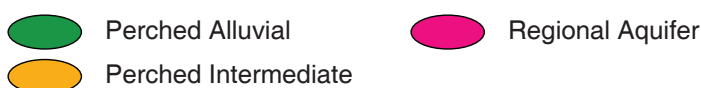


Figure 5-36. Location of groundwater containing RDX above one half of the EPA Region 6 10^{-5} excess cancer risk tap water screening level of $6.1 \mu\text{g/L}$. Different colors indicate the affected groundwater zones.

Samples from SWMU 03-010a intermediate groundwater wells 03-B-9, 03-B-10, and 03-B-13 had TDS and chloride results that were above groundwater standards. The TDS results from samples for these wells during the remainder of the year were about half the highest values. Samples from these wells also contained several organic chemicals including four chlorinated solvents (Table 5-15). Several organic chemicals were at concentrations exceeding NM groundwater standards. This SWMU is currently under investigation and the organic chemicals are some of the contaminants identified in the investigation (LANL 2005b). Compounds found in the wells included dichloroethane[1,1-], dichloroethene[1,1-], and trichloroethane[1,1,1-], and dioxane[1,4-].

6. Water Canyon (includes Cañon de Valle, Potrillo, Fence, and Indio Canyons)

Water Canyon and Cañon de Valle (a tributary) pass through the southern portion of LANL where the Laboratory conducts explosives development and testing. In the past, the Laboratory released wastewater into both canyons from several HE-processing sites in TA-16 and TA-9 (Table 5-16). In 1997, the Laboratory consolidated these individual NPDES outfalls into one outfall from the High Explosives Wastewater Treatment Facility. This outfall discharges a much smaller amount of water that generally meets NPDES permit requirements. Alluvial groundwater in Cañon de Valle shows barium above 1,000 µg/L, the NM groundwater standard (Table 5-17, Figure 5-37), and RDX above the EPA Region 6 screening level of 6.1 µg/L, corresponding to a 10^{-5} excess cancer risk (Figure 5-36). Intermediate perched groundwater in this area also shows RDX at concentrations above 6.1 µg/L. The Potrillo, Fence, and Indio canyon watersheds contain several open-burning/open-detonation and firing sites used for testing of weapons system components. These three small canyons have surface water only in response to precipitation events, and no known alluvial or intermediate groundwater.

Table 5-16
Summary of Groundwater Contamination in Water Canyon
(includes Cañon de Valle, Potrillo, Fence, and Indio Canyons)

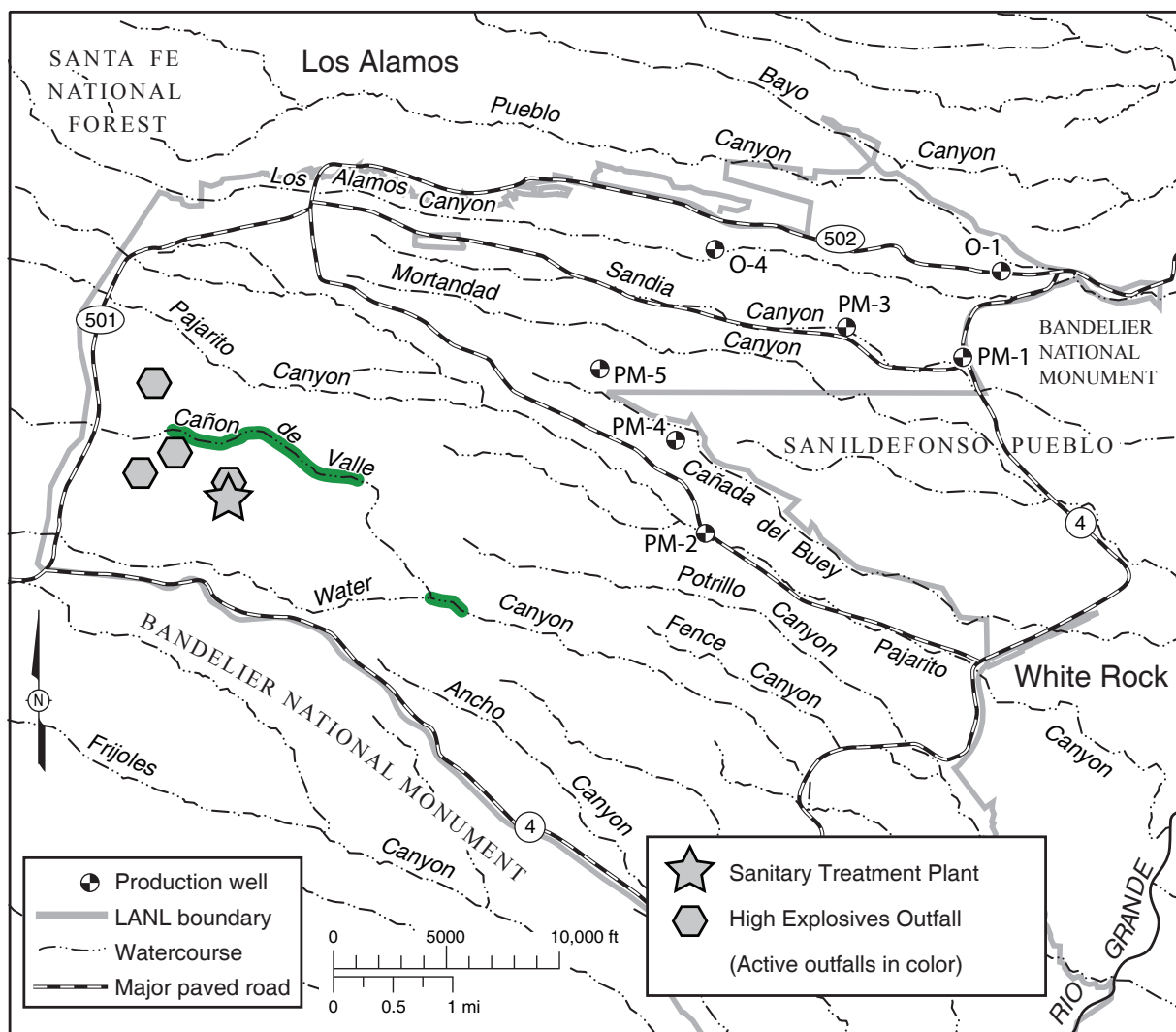
| Canyon | Contaminant Sources | Groundwater contaminants | | |
|------------------------------------|--|--|---|----------|
| | | Alluvial | Intermediate | Regional |
| Cañon de Valle | Multiple dry and past effluent sources | Barium above NM groundwater standard, RDX above EPA excess cancer risk level | Boron above NM groundwater standard, lead above tap water screening level; RDX above EPA excess cancer risk level; tetrachloroethene at 33% and trichloroethene at 34% of EPA MCL screening level | None |
| Water Canyon | Multiple dry and past effluent sources | None, little alluvial groundwater | No intermediate groundwater | None |
| Potrillo, Fence, and Indio Canyons | Minor dry sources | No alluvial groundwater | No intermediate groundwater | None |

Table 5-17
Groundwater Quality in Water Canyon (includes Cañon de Valle, Potrillo, Fence, and Indio Canyons)

| Chemical | Location | Result | Trends |
|-------------------|---|--|---|
| RDX | Regional aquifer well R-25 | 0.13 µg/L to 0.71 µg/L, below EPA risk level of 6.1 µg/L | Likely present due to well construction delays in 2000; levels have since decreased significantly |
| Boron | Intermediate Martin Spring | 1250 µg/L to 1310 µg/L, above NM groundwater standard (for irrigation use) of 750 µg/L | Consistent with results collected over 17 year period |
| Lead | Intermediate Fish Ladder Spring, CdV-16-2(i)r | 11 µg/L to 16 µg/L, above EPA drinking water system screening level of 15 µg/L | Highest value in CdV-16-2(i)r, spring value is consistent with 12 years of data |
| RDX | Five intermediate springs, five wells or well ports | Up to 137 µg/L, above EPA risk level of 6.1 µg/L | Present for 12 years in springs, during several years of sampling of wells |
| Tetrachloroethene | Three intermediate springs, three wells or well ports | 0.4 µg/L to 1.7 µg/L, below EPA MCL screening level of 5 µg/L | Present for 12 years in springs, during several years of sampling of wells |

Table 5-17 (continued)

| Chemical | Location | Result | Trends |
|-----------------|--|--|--|
| Trichloroethene | Four intermediate springs, two wells or well ports | 0.26 µg/L to 1.7 µg/L, below EPA MCL screening level of 5 µg/L | Present for 12 years in springs, during several years of sampling of wells |
| Barium | One spring and five alluvial wells in Cañon de Valle | 620 µg/L to 8700 µg/L, above NM groundwater standard of 1,000 µg/L | Present at these levels for 10 years in Cañon de Valle wells, only one sample taken at Fish Ladder Canyon well and WA-625 Spring |
| RDX | Four alluvial wells in Cañon de Valle, one in Water Canyon | 0.38 µg/L to 36 µg/L, above EPA Region 6 screening level of 6.1 µg/L | Present at these levels for 10 years in Cañon de Valle wells, in both samples taken at WCO-2 |



Location of Groundwater Contaminants

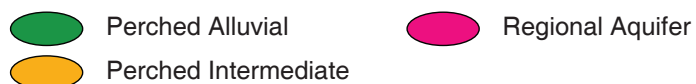


Figure 5-37. Location of groundwater containing barium above one half of the NM groundwater standard of 1,000 µg/L. Different colors indicate the affected groundwater zones.

Boron was found in samples from Martin Spring and other nearby springs at concentrations above the NM groundwater standard (for irrigation use), a reflection of past effluents (Figure 5-38).

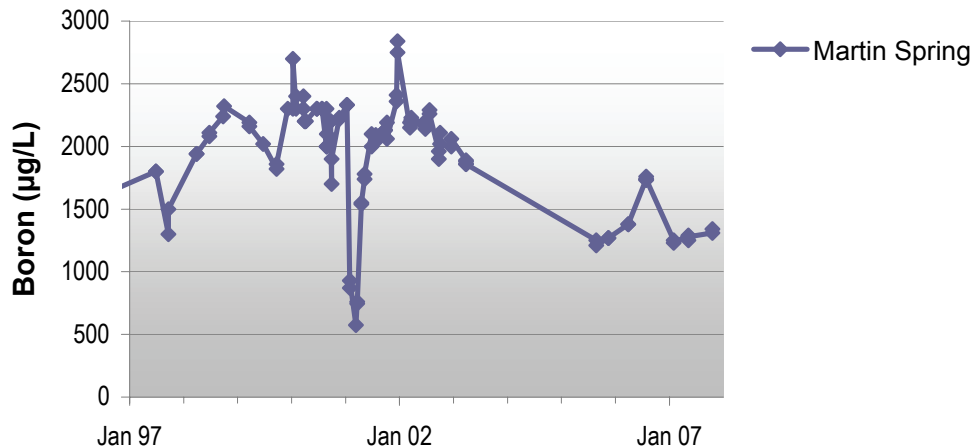


Figure 5-38. Boron in Cañon de Valle intermediate groundwater; the NM groundwater standard (for irrigation use) is 750 µg/L.

Intermediate perched zone well and spring samples contained several HE compounds. Of these compounds, RDX (Figures 5-36, 5-39, 5-40, 5-41) was present at the highest concentrations compared to risk levels, above the 6.1 µg/L EPA 10^{-5} excess cancer risk tap water screening level in springs and wells. The RDX levels have been fairly steady at most monitoring sites, though they show some seasonal fluctuation, for example, at Martin Spring (Figure 5-41). As seen in Figure 5-40, samples from two ports at regional aquifer well R-25 were apparently switched on February 7, 2007. The concentrations of RDX and several other organic chemicals at depths of 755 ft. and 892 ft. appear to be reversed in this sampling event and continue at usual values in later events.

The chlorinated solvents tetrachloroethene (also known as tetrachloroethylene, perchloroethylene [PERC]) and trichloroethene (or trichloroethylene [TCE]) continue to be found in several wells and springs (Table 5-17).

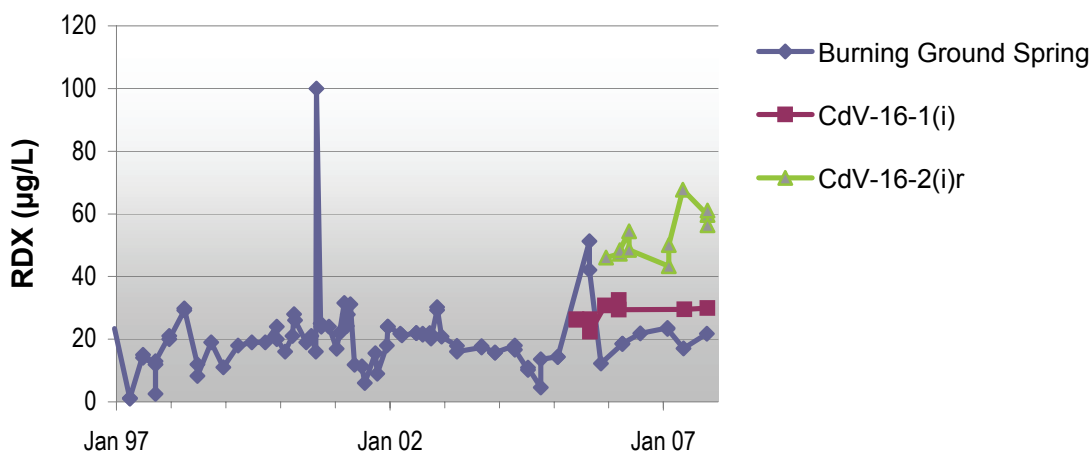


Figure 5-39. RDX in Cañon de Valle intermediate groundwater; the EPA Region 6 tap water screening level is 6.1 µg/L.

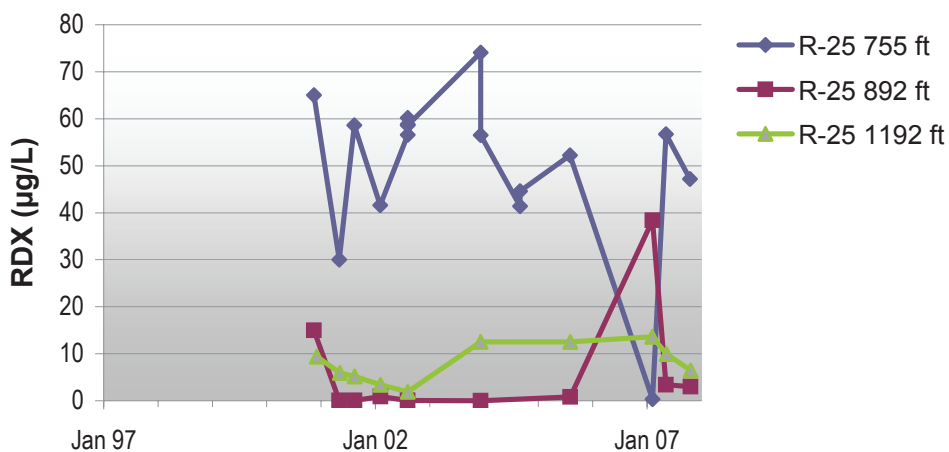


Figure 5-40. RDX in Cañon de Valle intermediate groundwater; the EPA Region 6 tap water screening level is 6.1 µg/L.

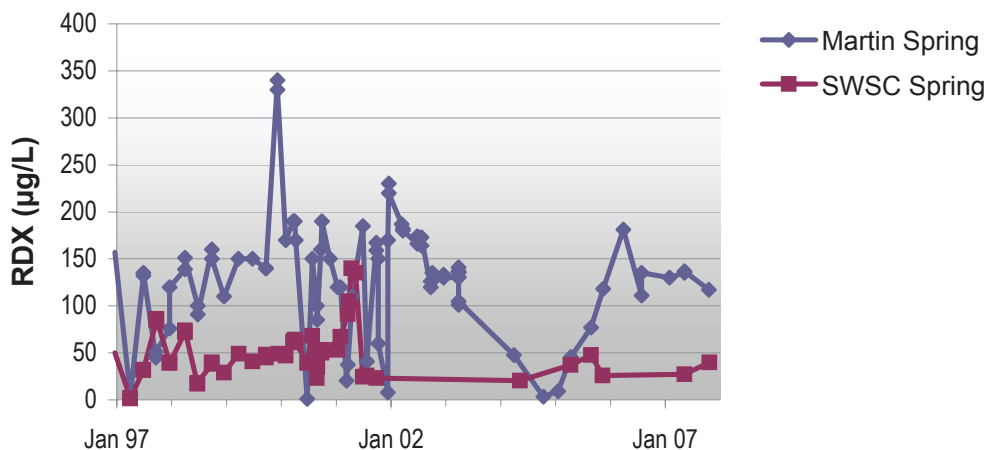


Figure 5-41. RDX in Cañon de Valle intermediate groundwater; the EPA Region 6 tap water screening level is 6.1 µg/L.

Barium, present due to past HE wastewater discharges, exceeded the NM groundwater standard in numerous alluvial wells in Cañon de Valle (Figures 5-37, 5-42). Alluvial well samples also contained several HE compounds. As with intermediate perched groundwater, RDX was the HE compound present at the highest concentrations compared to risk levels, some above the 6.1 µg/L EPA Region 6 10^{-5} screening level (Figures 5-36, 5-43).



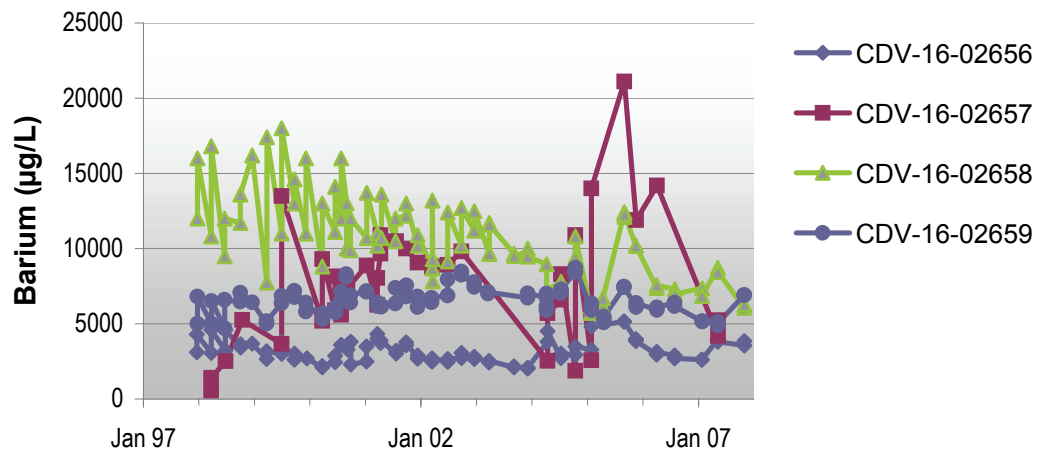


Figure 5-42. Barium in Cañon de Valle alluvial groundwater; the NM groundwater standard is 1,000 µg/L.

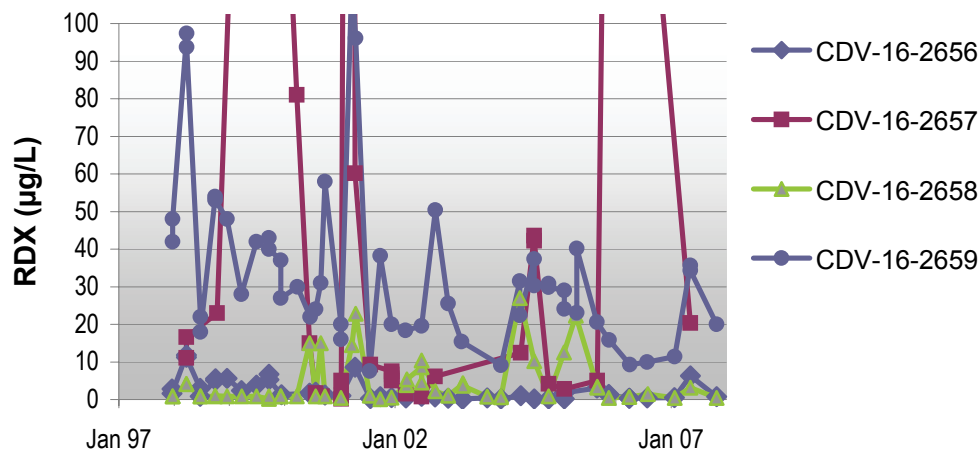


Figure 5-43. RDX in Cañon de Valle alluvial groundwater; the EPA Region 6 tap water screening level is 6.1 µg/L.

7. Ancho Canyon

Area AB at TA-49 was the site of underground nuclear weapons component testing from 1959 to 1961 (Purtymun and Stoker 1987; ESP 1988). The tests involved insufficient HEs and fissionable material to produce a nuclear reaction. The canyons in the watershed are mainly dry with little alluvial and no known intermediate groundwater. In 1960, the US Geological Survey drilled three deep wells (Test Wells DT-5A, DT-9, and DT-10) to monitor regional aquifer water quality. Another regional aquifer well, R-31, lies downstream from firing sites at TA-39. No contaminants were found in these wells at concentrations near or above standards (Table 5-18).

Table 5-18
Summary of Groundwater Contamination in Ancho Canyon

| Canyon | Contaminant Sources | Groundwater contaminants | | |
|--------------|---|-----------------------------------|-----------------------------|----------|
| | | Alluvial | Intermediate | Regional |
| Ancho Canyon | Minor dry sources and past effluent sources | Little or no alluvial groundwater | No intermediate groundwater | None |

8. White Rock Canyon Springs

The springs that issue along the Rio Grande in White Rock Canyon represent the principal discharge of regional aquifer groundwater that flows underneath the Laboratory (Purtymun et al., 1980). The White Rock Canyon springs serve as boundary monitoring points for evaluating the Laboratory's impact on the regional aquifer and the Rio Grande (Table 5-19). A few springs such as Spring 2B appear to represent discharge of intermediate perched groundwater; that spring is supplied by municipal sanitary effluent discharge or irrigation with effluent of athletic fields near White Rock.

Table 5-19
Summary of Groundwater Contamination in White Rock Canyon Springs

| Canyon | Contaminant Sources | Groundwater contaminants | | |
|----------------------------|------------------------------|--------------------------|---------------------------------|------------------------------------|
| | | Alluvial | Intermediate | Regional |
| White Rock Canyon: Springs | Sources in tributary canyons | No alluvial groundwater | Little intermediate groundwater | Natural fluoride, arsenic, uranium |

Other than tritium, the only radionuclide detection of note in White Rock Canyon springs was natural uranium in La Mesita Spring (Table 5-20). Naturally occurring uranium is commonly detected in this spring and a few other nearby wells and springs. The tritium values in the White Rock Canyon springs are similar to results measured during the last decade. The highest results have been found at the Spring 4 group of springs. Activities there have decreased since 2002 and are now about 8 pCi/L at Spring 4 and Spring 4C and 32 pCi/L at Spring 4B. These springs discharge within a hundred yards of each other near the Rio Grande.

Table 5-20
Groundwater Quality in White Rock Canyon Springs

| Chemical | Location | Result | Trends |
|----------|---|--|---------------------|
| Uranium | Regional aquifer La Mesita Spring, east of Rio Grande on San Ildefonso Pueblo lands | 12.5 µg/L, below NM groundwater standard of 30 µg/L | Naturally occurring |
| Arsenic | Regional aquifer springs 2, 4, 4C, 6A, 6AAA | Up to 11.5 µg/L, above EPA MCL screening level of 10 µg/L; NM groundwater standard is 100 µg/L | Naturally occurring |

Results for White Rock Spring perchlorate samples collected in 2007 are consistent with prior data; concentrations are below background levels observed in extensive sampling of NM groundwater by Plummer et al. (2006). The highest perchlorate value occurs east of the Rio Grande at La Mesita Spring on Pueblo de San Ildefonso land at a concentration of 0.85 µg/L. This spring has also had high nitrate and uranium values; it is not located near any apparent sources of contamination. Several of the springs in the Spring 4 series had perchlorate values of 0.5 to 0.6 µg/L, the highest concentrations for springs on the west side of the Rio Grande.

Spring 2 samples had fluoride concentrations at 0.6 mg/L, below the NM groundwater standard of 1.6 mg/L. The fluoride in this and nearby springs occurs naturally in groundwater near the Rio Grande and in the Española Basin.

9. Pueblo de San Ildefonso

This section covers results from Pueblo de San Ildefonso supply wells that lie near and east of the Rio Grande (Table 5-21). Other Pueblo de San Ildefonso wells and springs were covered in prior sections. The groundwater data for these wells and springs indicate the widespread presence of naturally occurring uranium at levels approaching the NM groundwater standard of 30 µg/L (Table 5-22). These measurements are consistent with previous samples. Naturally occurring uranium concentrations near or exceeding the NM groundwater standard are prevalent in well water throughout the Pojoaque area and Pueblo de San Ildefonso lands. The high gross alpha readings for these wells are related to naturally occurring uranium.

Table 5-21
Summary of Groundwater Contamination in White Rock Canyon Wells

| Canyon | Contaminant Sources | Groundwater contaminants | | |
|--|---------------------|--------------------------|-----------------------------|--|
| | | Alluvial | Intermediate | Regional |
| White Rock Canyon: San Ildefonso Pueblo and Buckman Well field | None | No alluvial groundwater | No intermediate groundwater | Natural TDS, fluoride, chloride, arsenic, boron, uranium |

Table 5-22
Groundwater Quality in White Rock Canyon Wells

| Chemical | Location | Result | Trends |
|-------------|---|---|---|
| Uranium | Regional aquifer Pueblo de San Ildefonso and Buckman supply wells | Up to 27 µg/L at Pueblo de San Ildefonso and 200 µg/L at Buckman No. 2, above NM groundwater standard of 30 µg/L | Naturally occurring |
| Gross alpha | Regional aquifer Pueblo de San Ildefonso and Buckman supply wells | Up to 12 µg/L at Pueblo de San Ildefonso and 102 µg/L at Buckman No. 2, above EPA drinking water system screening level of 15 µg/L (not applicable to gross alpha from uranium) | Naturally occurring, due to natural uranium |
| Fluoride | Westside and Eastside Artesian wells at Pueblo de San Ildefonso | Up to 4.8 mg/L, above NM groundwater standard of 1.6 mg/L | Naturally occurring |
| Chloride | Westside Artesian Well and Pajarito Well (Pump 1) at Pueblo de San Ildefonso | Up to 322 mg/L, above NM groundwater standard of 250 mg/L | Naturally occurring |
| TDS | Westside Artesian Well and Pajarito Well (Pump 1) at Pueblo de San Ildefonso, Buckman No. 2 | 600 mg/L to 1,150 mg/L, above NM groundwater standard of 1,000 mg/L | Naturally occurring |
| Arsenic | Regional aquifer Pueblo de San Ildefonso wells and Buckman No. 8 | Up to 14.6 µg/L, above EPA MCL of 10 µg/L | Naturally occurring |
| Boron | Westside Artesian Well and Pajarito Well (Pump 1) at Pueblo de San Ildefonso | Up to 1,780 µg/L, above NM groundwater standard (for irrigation use) of 750 µg/L | Naturally occurring |

Eastside Artesian and Westside Artesian wells have levels of sodium, chloride, fluoride, and TDS near or above NM groundwater standards or EPA health advisory levels. Westside Artesian well is not used as a drinking water source. Perchlorate concentrations in these wells ranged from nondetect to 0.57 µg/L.

The boron concentrations in the Eastside and Westside Artesian wells were above the NM groundwater standard of 750 µg/L (for irrigation use), similar to the values of past years. Several of the wells had arsenic concentrations that were near or above the 10 µg/L EPA MCL. These findings are also similar to results from past years and occur naturally.

10. Buckman Well Field

In 2007, we sampled three wells in the City of Santa Fe's Buckman Field (Table 5-21, 5-22). As in past samples, these wells, particularly Buckman well No. 2, contain high uranium relative to the NM groundwater standard of 30 µg/L. The gross alpha levels in these wells are attributable to the presence of uranium.

The water in some of these wells has high TDS, so concentrations of several chemicals including chloride are near or above NM groundwater standards or EPA health advisory levels. Naturally occurring metals such as arsenic and boron are also high in some wells.

G. QUALITY ASSURANCE OF GROUNDWATER, SURFACE WATER, AND SEDIMENT ANALYSES

1. Introduction

Environmental sampling incorporated QA in 2007 in accordance with DOE Order 414.1C, which prescribes a risk-based, graded approach to QA. To maximize effective resource use, this process promotes the selective application of QA and management controls based on the risk associated with each activity.

The LANL water quality database (<http://wqdbworld.lanl.gov/>) contains all the surface water and groundwater analytical data received from our contract analytical laboratories. None of the data are censored or removed. If analytical results were inconsistent with prior data, we investigated the laboratory records, and the sample may be reanalyzed or the location resampled. Both the initial sample and the follow-up sample analyses are kept in the database and are available to the public. In some cases, comments were appended to the records to indicate existence of recognized analytical issues. The primary documentation of analytical issues for data from a given year is provided in this report.

In 2007, the majority of the collected data were of high quality. The analytical laboratories qualified 8% of the data for potential data use issues; 40% (3% of the qualified data) of these qualifiers were because the results were between the quantitation and detection limits. The remaining approximately 5% of the results were qualified by the laboratory for potential data quality reasons. After data validation by the independent contractor AQA, 98% of all results were of sufficient quality for use. Overall, 22% of the accepted results were qualified for data quality reasons, including holding time violations, potential cross contamination, instrument calibration, and other reasons.

There are several interrelated components of the quality assurance efforts in the groundwater and surface water programs:

- Ensuring the quality and consistency of work processes at LANL used to collect and ship samples and to assess and validate data.
- Use of QC samples to measure the quality of sample collection processes and analytical results.
- Qualification and performance assessment of contract analytical laboratories.
- Validation of data packages.
- Review of analytical results.
- Audits and assessments of program and analytical laboratories.

2. Procedures for Work Processes

a. Methods

All sampling, data reviews, and data package validations were conducted using standard operating procedures that are part of a comprehensive QA program. The LANL quality program and procedures may be viewed at <http://www.lanl.gov/environment/all/qa.shtml>. Completed chain-of-custody forms serve as an analytical request form and include the requester or owner, sample number, program code, date and time of sample collection, total number of bottles, list of analytes to be measured, bottle sizes, and preservatives for each analysis required.

b. Results

Field quality assurance procedures and the quality plan documents were revised in 2006 and implemented for 2007 sampling for most of the affected documents. Together, these plans and procedures describe or prescribe all the planned and systematic activities believed necessary to provide adequate confidence that processes perform satisfactorily.

See Supplemental [Table S5-14](#), [Table S5-15](#), and [Table S5-16](#) for the analytes, analytical methods, and detection limits used for analysis of surface water, sediment, and groundwater samples, respectively, during 2007.

3. Quality Control for Samples and Analytical Results**a. Methods**

We submitted quality control samples along with environmental samples so that we can detect possible field or analytical laboratory contamination and track analytical laboratory performance. Differences in analytical results between field duplicate samples, for example, may indicate that the samples were not uniform or that there was significant variation in analyses. Detection of analytes in deionized water field blanks could indicate contamination of our deionized water source or sample bottles or contamination from the analytical laboratory. We evaluated the results from QC samples along with the environmental sample results to understand whether the results truly represent environmental measurements.

The required analytical laboratory batch QC is defined by the analytical method, the analytical statement of work (SOW), and generally accepted laboratory practices. The laboratory batch QC is used in the data-validation process to evaluate the quality of individual analytical results, to evaluate the appropriateness of the analytical methodologies, and to measure the routine performance of the analytical laboratory.

In addition to batch QC performed by laboratories, we submitted field QC samples to test the overall sampling and analytical laboratory process and to spot-check for analytical problems. These samples included equipment blanks, field blanks (deionized water), performance evaluation blanks (deionized water), and field trip blanks (described below). Duplicate analyses of selected samples were also conducted at the laboratory.

Equipment and Field Blanks: Equipment and field blanks were submitted for metals, organic chemicals, general inorganic, and radiochemistry analyses to monitor for contamination during sampling and decontamination of equipment. Contamination in the equipment and field blanks could be from either field contamination or contamination after sample collection. Any contamination in equipment or field blanks was reviewed to determine if a cause could be found.

Performance Evaluation Blanks: Performance evaluation blanks are deionized water blanks submitted as regular samples, without any indication that they are QC samples. These go through the same analytical process as the regular field samples. The deionized water blanks are measured with the same background contributions from reagents and biases as the regular samples, give an estimate of background and systematic analytical errors, and aid in the determination of false detections in associated environmental samples.

Field Trip Blanks: Trip blanks are a special case of performance evaluation blanks applicable to volatile organic compound measurements. They are kept with the samples from collection to analysis. Field trip blanks are used to help identify volatile organic compound cross contamination that may occur during sample handling, shipping, and storage, or at the analytical laboratory.

Field Duplicates: Field duplicates are split samples that provide information about field variation of sample results as well as analytical laboratory variation. Field duplicates can indicate sampling techniques with poor reproducibility.

b. Results

i. PCB and other organic chemical false positives results

In 2007, one recurring issue was the random detection of PCBs, pesticides, and polycyclic aromatic hydrocarbons (analyzed as part of the semivolatile organic suite) in many groundwater samples. These organic chemicals were often detected in just a field blank or in just one of a pair of field duplicates.

In nine groundwater samples, an Aroclor was detected resulting from analytical laboratory contamination (Aroclor in method blank) or laboratory cross-contamination. The samples are all from deep wells where the presence of PCBs is highly unlikely. Aroclors were also detected in 13 groundwater samples (including one field blank) in 2006, in four samples in 2005, and in four samples in 2004. These numbers suggest that analytical laboratory sample contamination by Aroclors is increasing.

Pesticides detected in one sample, but not in the duplicate, were rejected because the results were false positives caused by the presence of Aroclors. Aroclor-1242 was found in two other samples and in their analytical method blanks, indicating analytical contamination. Pesticide detections in another sample were rejected because the laboratory detected essentially the entire pesticide target analyte list which clearly indicates laboratory contamination.

An investigation of the source of the cross-contamination at GEL analytical laboratory determined that two non-LANL waste samples, containing extremely high concentrations of Aroclor-1242, -1254, and -1260, were extracted immediately before the LANL samples were processed. To correct the problems, GEL will not process LANL samples with those of other clients and has implemented more thorough glassware cleaning and segregation practices.

ii. Radionuclide false positive results

In late 2006 and early 2007, the number of apparent false positives for radioactivity analyses of groundwater samples using alpha spectroscopy seemed to have increased substantially. The alpha spectroscopy method is used to measure plutonium-238, plutonium-239/240, and americium-241. Other radionuclide analyses were not affected. A new MDA calculation process at GEL resulted in MDAs for plutonium-239/240 more than a factor of two lower than in 2005. This increased the number of detections in samples, making false positives more likely. The evident rate of false positives for plutonium-239/240 was 1% in 2005 and 2006 but is above 7% for the first part of 2007 (Table 5-23). False positives were identified as results from locations where plutonium is seldom detected. In many of these cases of apparent false positives, plutonium-239/240 was detected in only one of several samples collected on one date. As an example, at Sandia Canyon intermediate well SCI-1, plutonium-239/240 was detected in the equipment blank but not the original sample or duplicate. These inconsistencies indicate that the detection is a false positive or possibly from field contamination.

Table 5-23
Plutonium-239/240 False Positive Rate

| Year | Number of Results | Number of False Positives | Percent of False Positives | Number of Detects | Percent of Detects |
|------|-------------------|---------------------------|----------------------------|-------------------|--------------------|
| 2005 | 332 | 3 | 0.9 | 17 | 5.1 |
| 2006 | 467 | 5 | 1.1 | 21 | 4.5 |
| 2007 | 104 | 8 | 7.7 | 8 | 7.7 |

Figure 5-44 shows the MDAs by year for all groundwater plutonium-239/240 results for 2005 through February of 2007. The plot shows the plutonium-239/240 MDA vs. 2 sigma (analytical uncertainty). The 1:1 line is for comparison purposes. Over the past three years, the MDAs have fallen significantly (with respect to analytical uncertainty) for results that are near the MDA. Figure 5-45 shows that for data collected between June 27, 2006, and February 26, 2007, the analytical laboratory reported results for plutonium-239/240 that

showed a systematic step decrease followed by a step increase in the lower limit (red line) for the reported MDA relative to the analytical uncertainty. Before and after these dates the analytical laboratory reported MDA values that were above the 3 sigma line, while many results between the dates fell closer to the 2 sigma line. A number of results always fall below these lines; these are cases with very large analytical results and small analytical uncertainties and are clearly detections.

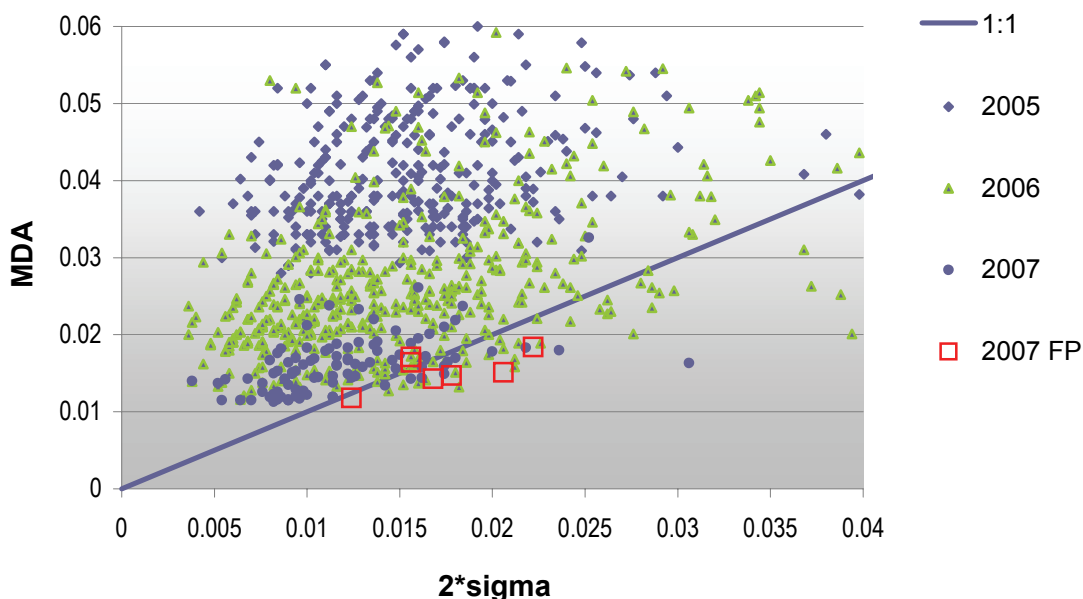


Figure 5-44. Minimum detectable activities (MDAs) for plutonium-239/240 for recent groundwater samples by year, showing a significant decrease in MDA relative to measurement uncertainty. The eight false positive results from 2007 (through February) are shown by square symbols.

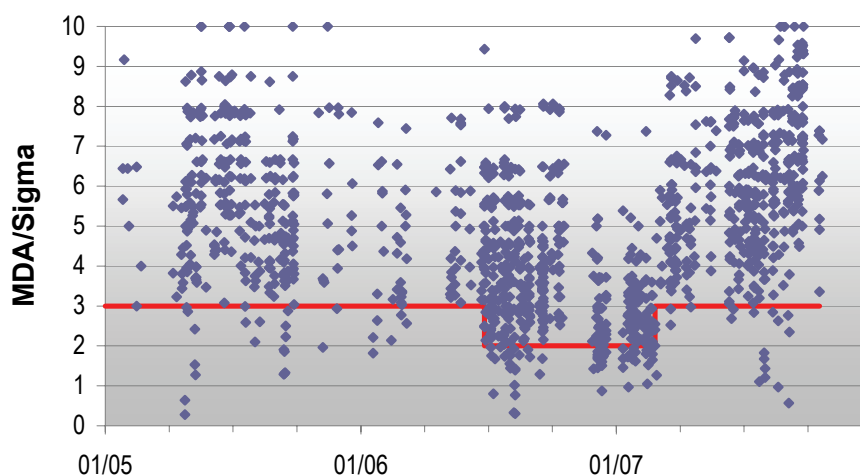


Figure 5-45. Ratio of MDA to the one-sigma analytical uncertainty for all groundwater plutonium-239/240 results from 2005 through October 29, 2007. For samples collected between June 27, 2006, and February 26, 2007, the analytical laboratory reported results that showed a systematic decrease in the lowest values for the ratio of reported MDA relative to the analytical uncertainty (red line).

This pattern of a lower MDA between June 27, 2006, and February 26, 2007, is also the case with results for plutonium-238 and americium-241. It appears that GEL changed its MDA calculation process between June 27, 2006, and February 26, 2007. The change on the latter date coincided with an inquiry from the Laboratory regarding this variation in alpha spectroscopy MDAs. The result of the variation in MDA calculation after June 27, 2006, was that many plutonium and americium measurements that were nondetects were inconsistently reported by the analytical laboratory as detections. One such sample was the plutonium-238 result of 0.0436 pCi/L (uncertainty 0.0193 pCi/L and MDA 0.035 pCi/L) collected on July 12, 2006, from Buckman Well No. 1. This result received widespread publicity as evidence of plutonium detection in the Santa Fe public water supply.

Though a root cause was not found for the change in MDA calculation process that resulted in increased false positives, GEL took actions to help prevent potential future false positives by improving their laboratory practices for glassware reuse and general laboratory cleanliness.

iii. Diesel range organics results

GEL did not correctly calculate the DRO MDL and many of the 2006/2007 results initially reported as detections were not detections. GEL had a false positive rate as indicated by method blank detections in excess of 50%. GEL will be increasing their DRO MDL from 16 µg/L to approximately 33 µg/L.

DRO detections in several 2006 and 2007 samples may be incorrect based on the very low signal level present on the chromatograms and because of the presence of DRO in the analytical laboratory method blanks.

The laboratory has agreed to use more standard reporting procedures for the DRO method for groundwater samples. As outlined in the analytical method, results will be reported to the PQL and more detailed information will be provided on blanks and detected results to help determine the reliability of the reported detections. These changes will make it less likely that false positive results will be reported and provide more defensible data for this method. GEL will also examine the method blank populations periodically to ensure that background levels are accurately reflected, use disposable pipettes instead of syringes, and perform more thorough cleaning of glassware and equipment.

4. Qualification and Performance Assessment of Analytical Laboratories

a. Methods

The Laboratory is responsible for acquiring analytical services that support monitoring activities. The Statement of Work (SOW) for analytical services follows the National Nuclear Security Administration Service Center's Analytical Management Program's Model SOW. The SOW provides to the contract analytical laboratories the general QA guidelines and includes specific requirements and guidelines for analyzing surface water, groundwater, and sediment samples.

Analytical laboratories undergo a pre-award assessment to evaluate their ability to perform the needed analyses.

LANL requires most analytical laboratories to participate in independent national performance evaluation programs. These programs measure each laboratory's performance when analyzing analytes in different media. The laboratories participate in the Mixed Analyte Performance Evaluation Program (MAPEP) and other pertinent programs as available for the analytical methods conducted under contract with LANL. For 2007, GEL, Paragon, and Severn-Trent Los Angeles (STLA) participated in both MAPEP and proficiency testing offered by Environmental Resource Associates, but STLA did not provide any water analyses for the covered analytes. STLA, Paradigm, and ALTA Analytical Laboratory did not participate in either of these programs.

b. Results

To provide access to additional laboratories and meet the requirements of the NMED Consent Order, analytical laboratory contracts were combined with the contracts within the LANL Environmental Programs Directorate under control of the Sample Management Office (SMO). Three additional laboratories were added to address specific needs created by the Consent Order and by the chromium issue.

- To address the need for polychlorinated dibenzodioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs), GEL subcontracted with Paradigm Analytical Laboratories. Due to performance problems with Paradigm Analytical Laboratories on the PCDDs and PCDFs analysis, the SMO transferred the work to ALTA Analytical Lab.
- To address the need for analysis of the biodegradation products of Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX), Severn-Trent Laboratories was selected to do the analysis for mononitroso-RDX (MNX), dinitroso-RDX (DNX), and trinitroso-RDX (TNX) due to their previous experience with this method. The method development was conducted at the direction of the SMO for the Environmental Restoration Program and the first analyses conducted in 2001. The first analyses for the Water Stewardship Program were conducted in 2006 and were continued in 2007.

GEL participated in many different performance evaluation studies that addressed a majority of the parameters for which they conduct analysis. There are no performance evaluation programs for the specialty analyses conducted at STLA (hexavalent chromium-VI), ALTA (dioxins and furans), Paradigm (dioxins and furans), and Severn-Trent Saint Louis (STSL) (RDX breakdown products). Therefore, performance on groundwater samples at STLA, ALTA, Paradigm, and STSL was not assessed through performance evaluation programs.

Results for the applicable 2007 performance evaluation programs at GEL are given in Table 5-24 for water and soil samples. (Soil PE sample results are applicable to sediment samples.) Only results that were found deficient are discussed. The majority of results were found sufficient and these are not included.

Table 5-24
2007 Performance Evaluation Results at GEL Laboratories LLC

| Evaluation | Analytes Affected | Results and Actions Taken |
|--|--|--|
| 1st Quarter 2007 Performance Evaluations | | |
| ERA WP-142 | 1,2-Dichloroethane by SW846 8260B and EPA Method 624 | Reported value = < 1.00 µg/L; acceptance limits = 34.8 – 66.3 µg/L. False negative reported. No further corrective action was reported. |
| 2nd Quarter 2007 Performance Evaluations | | |
| ERA WS-126 | Ortho-Phosphate by EPA 300.0 | Reported value = 5.42 mg/L; acceptance limits = 4.20 – 5.33 mg/L. No corrective action reported. All batch quality control measures were acceptable. GEL determined that the error was introduced at either the initial dilution of the performance test sample or when the sample was diluted 10X during analysis. |
| ERA WS-126 | Carbon tetrachloride by EPA 524.2 | Reported value = 8.40 µg/L; acceptance limits = 8.64 – 13.0 µg/L. All quality control indicators were acceptable. No further corrective action was reported. |
| ERA WS-126 | Methylene chloride by EPA 524.2 | Reported value = 14.0 µg/L; acceptance limits = 14.9 – 22.3 µg/L All quality control indicators were acceptable. No further corrective action was reported. |

Table 5-24 (continued)

| Evaluation | Analytes Affected | Results and Actions Taken |
|------------|--|---|
| ERA WS-129 | Ortho-Phosphate by EPA 365.2 | Reported value = 1.91 mg/L; acceptance limits = 1.26 – 1.68 mg/L. No corrective actions were reported for the above PT failures. |
| ERA WS-129 | 1,1-Dichloroethylene by EPA 524.2 | Reported value = 15.7 µg/L; acceptance limits = 10.4 – 15.6 µg/L. No corrective actions were reported for the above PT failures. |
| ERA WS-129 | Methylene chloride by EPA 524.2 | Reported value = 23.8 µg/L; acceptance limits = 15.8 – 23.6 µg/L. No corrective actions were reported for the above PT failures. |
| ERA WS-129 | Ethylbenzene by EPA 524.2 | Reported value = 18.2 µg/L; acceptance limits = 12.0 – 18.0 µg/L. No corrective actions were reported for the above PT failures. |
| NY300 | Biochemical oxygen demand by EPA 405.1 | Reported value = 263 mg/L; acceptance limits = 59.8 – 177 mg/L. The cause of the failure is reported as unknown by the laboratory. |
| NY300 | Nitrate as N by EPA 353.2 | Reported value = 18.4 mg/L; acceptance limits = 11.1 – 17.2 mg/L. All quality control indicators were acceptable. It was noted that the sample was analyzed at a 50X dilution. No further corrective action was reported. |
| NY300 | Silver by EPA 200.8 | Reported value = 312 µg/L; acceptance limits = 411 – 549 µg/L. All quality control indicators were acceptable. No further corrective action was reported. |
| NY300 | Silver by EPA 6020 | Reported value = 38.1 mg/kg; acceptance limits = 56.7 – 103 mg/kg. No corrective action was reported. |
| NY300 | 2-Nitrophenol by SW8270C | Reported value = < 10.0 µg/L; acceptance limits = 21.7 – 102 µg/L. The instrument quantitation software, Target, assigned this compound as a detection; however, the analyst mistakenly deleted the detection of this compound, determining that co-elution with 2,4-dimethylphenol had caused a false positive. Both 2-nitrophenol and 2,4-dimethylphenol were included in the PT sample. |
| NY300 | 2,4-Dinitrophenol by SW8270C | Reported value = < 667 µg/kg; acceptance limits = 644 – 790 µg/kg. The true value for this analyte is 398 µg/kg, which is less than the reported quantitation limit of 667 µg/kg. |
| NY300 | Total cyanide by EPA 335.3 | Reported value = 0.82 mg/L; acceptance limits = 0.30 – 0.723 mg/L. All quality control indicators were acceptable. It was noted that the sample was analyzed at a 10X dilution. No further corrective action was reported. |
| NY300 | Hexavalent chromium by SW7196A | Reported value = 0.749 µg/L; acceptance limits = 407 – 589 µg/L. The laboratory reported the result as if the reporting units were mg/L rather than µg/L. The reported result should have been 749 µg/L, which is a high bias. All quality control indicators were acceptable. It was noted that the sample was analyzed at a 10X dilution. No further corrective action was reported. |
| NY300 | Total sulfide by EPA 376.1 | Reported value = 1.50 mg/L; acceptance limits = 2.47 – 8.28 mg/L. All quality control indicators were acceptable. It was noted that the reported result was low by a factor of two, indicating an improper dilution. No further corrective action was reported. |
| NY300 | Aluminum and copper by EPA 200.8 and carbon tetrachloride by SW8260B | These results were acceptable but were reported outside the warning limits (i.e., check for error results). |

Table 5-24 (continued)

| Evaluation | Analytes Affected | Results and Actions Taken |
|--|---|--|
| MAPEP Study 17 | Selenium in soil by SW6020 | Selenium was reported as a false positive. No corrective action was reported. |
| MAPEP Study 17 | Nickel-63 in soil, Uranium-234/233 in vegetation, and Zinc-65 in vegetation | These analytes were acceptable but were reported outside the warning limits. No corrective action was reported. |
| NY302 | Fluoride by EPA 300.0 | Reported value = 2.36 mg/L; acceptance limits = 2.48 – 3.03 mg/L. The laboratory reports that the batch quality control was acceptable and that no apparent cause for the error was found. |
| ERA WP-147 | Titanium by EPA 200.8/SW6020 | Reported value = 163 µg/L; acceptance limits = 172 – 227 µg/L. No corrective action was reported. |
| ERA SOIL-58 | Silver Ag by SW6020 | Reported value = 18.5 mg/kg; acceptance limits = 52.4 – 110 mg/kg. No corrective action was reported. |
| ERA SOIL-58 | Tin by 6020 | Reported value = 40.3 mg/kg; acceptance limits = 69.1 – 148 mg/kg. No corrective action was reported. |
| ERA SOIL-58 | Methoxychlor by SW8081A | Reported value = 451 µg/kg; acceptance limits = 17.7 – 348 µg/kg. No corrective action was reported. |
| ERA SOIL-58 | Diesel range organics by SW8015B | Reported value = 3,540 mg/kg; acceptance limits = 202 – 3,150 mg/kg. No corrective action was reported. |
| ERA SOIL-58 | Total petroleum hydrocarbons by SW9071A and SM5520F | Reported value = 2,700 mg/kg; acceptance limits = 0.00 – 2,330 mg/kg. No corrective action was reported. |
| 3rd Quarter 2007 Performance Evaluations | | |
| ERA WS-132 | Ortho-Phosphate by EPA 300.0 | Reported value = 4.00 mg/L; acceptance limits = 3.03 – 3.88 mg/L. There were no apparent quality control failures observed in the associated analytical batch. No further corrective actions were stated. |
| ERA WS-132 | Thallium by EPA 200.7 | Reported value = 14.9 µg/L; acceptance limits = 6.36 – 11.8 µg/L. The true value of 9.09 µg/L is below GEL's reporting limit for this analyte. |
| ERA WS-132 | Vanadium by EPA 200.8 | Reported value = 276 µg/L; acceptance limits = 286 – 350 µg/L. A remedial PT sample was analyzed with acceptable results. |
| ERA WS-132 | Zinc by EPA 200.8 | Reported value = 1090 µg/L; acceptance limits = 871 – 1060 µg/L. A remedial PT sample was analyzed with acceptable results. |
| ERA WS-132 | Uranium (Natural) by EPA 200.7 | Reported value = 91.5 µg/L; acceptance limits = 59.6 – 84.6 µg/L. This analyte is commonly not analyzed using Method 200.7. |
| ERA WS-132 | Tert-Butyl benzene by EPA 524.2 | Reported value = 14.9 µg/L; acceptance limits = 36.0 – 54.0 µg/L. There were no apparent quality control failures observed in the associated analytical batch. Since >80% of the target analytes were acceptable, no further corrective actions are required. |

Table 5-24 (continued)

| Evaluation | Analytes Affected | Results and Actions Taken |
|------------|---|---|
| ERA WS-132 | Ethylene dibromide by EPA 504.1/EPA 8011 | Reported value = 0.314 µg/L; acceptance limits = 0.343 – 0.801 µg/L. This PT sample was analyzed on an instrument not normally used for this method. Although a method detection limit study was analyzed and all quality control results were acceptable, use of this instrument may have contributed to the failed results. A remedial PT sample was analyzed with acceptable results. |
| ERA WS-132 | Total residual chlorine by EPA 330.5/SM 4500 Cl G | Reported value = 0.853 mg/L; acceptance limits = 1.30 – 1.77 mg/L. There were no apparent quality control failures observed in the associated analytical batch. No further corrective actions were stated. |
| NY305 | Acenaphthylene by EPA 8310 | Reported value = 11.5 µg/L; acceptance limits = 13.9 – 46.3 µg/L. The failures for Method 8310 have been attributed to the extraction process. While the laboratory control sample (LCS) passed for the stated analytes, their recoveries were on the low end of the acceptance limits. The same is true for the LCS duplicate, with the exception of naphthalene, which did not meet acceptance limits at 60.4% (61-100%). The sample was not re-extracted due to the lack of sample volume available for re-extraction. |
| NY305 | Naphthalene by EPA 8310 | Reported value = 19.9 µg/L; acceptance limits = 20.4 – 88.1 µg/L. The failures for Method 8310 have been attributed to the extraction process. While the LCS passed for the stated analytes, their recoveries were on the low end of the acceptance limits. The same is true for the LCS duplicate, with the exception of naphthalene, which did not meet acceptance limits at 60.4% (61-100%). The sample was not re-extracted due to the lack of sample volume available for re-extraction. |
| NY305 | Acenaphthylene by EPA 8270C | Reported value = 1.64 µg/L; acceptance limits = 1.80 – 4.73 µg/L. Each of the failed analytes for Method 8270C were under 10% Drift (%D) in the daily continuing calibration verification standard. The problem has been isolated to the instrument on which the samples were analyzed, MSD7, which is the oldest GC/MS and has exhibited sensitivity issues at the low end of the calibration range. Review of the initial calibration exhibited that the ratio between the 1 µg/mL standard and the 10 µg/mL standard for these compounds was not optimal. GEL is considering replacing this instrument during 2008. |
| NY305 | Benzo(a)anthracene by EPA 8270C | Reported value = 1.11 µg/L; acceptance limits = 1.12 – 1.94 µg/L. Each of the failed analytes for Method 8270C were under 10%D in the daily continuing calibration verification standard. The problem has been isolated to the instrument on which the samples were analyzed, MSD7, which is the oldest GC/MS and has exhibited sensitivity issues at the low end of the calibration range. Review of the initial calibration exhibited that the ratio between the 1 µg/mL standard and the 10 µg/mL standard for these compounds was not optimal. GEL is considering replacing this instrument during 2008. |
| NY305 | Benzo(b)fluoranthene by EPA 8270C | Reported value = 0.385 µg/L; acceptance limits = 0.398 – 1.14 µg/L. Each of the failed analytes for Method 8270C were under 10%D in the daily continuing calibration verification standard. The problem has been isolated to the instrument on which the samples were analyzed, MSD7, which is the oldest GC/MS and has exhibited sensitivity issues at the low end of the calibration range. Review of the initial calibration exhibited that the ratio between the 1 µg/mL standard and the 10 µg/mL standard for these compounds was not optimal. GEL is considering replacing this instrument during 2008. |

Table 5-24 (continued)

| Evaluation | Analytes Affected | Results and Actions Taken |
|--|---|---|
| NY305 | Benzo(k)fluoranthene by EPA 8270C | Reported value = 0.814 µg/L; acceptance limits = 0.833 – 1.80 µg/L. Each of the failed analytes for Method 8270C were under 10%D in the daily continuing calibration verification standard. The problem has been isolated to the instrument on which the samples were analyzed, MSD7, which is the oldest GC/MS and has exhibited sensitivity issues at the low end of the calibration range. Review of the initial calibration exhibited that the ratio between the 1 µg/mL standard and the 10 µg/mL standard for these compounds was not optimal. GEL is considering replacing this instrument during 2008. |
| NY305 | Dibenzo(a,h)anthracene by EPA 8270C | Reported value = 2.2 µg/L; acceptance limits = 0.521 – 2.17 µg/L. Each of the failed analytes for Method 8270C were under 10%D in the daily continuing calibration verification standard, with the exception of dibenzo(a,h)anthracene, which had a %D of -25%. The problem has been isolated to the instrument on which the samples were analyzed, MSD7, which is the oldest GC/MS and has exhibited sensitivity issues at the low end of the calibration range. Review of the initial calibration exhibited that the ratio between the 1 µg/mL standard and the 10 µg/mL standard for these compounds was not optimal. GEL is considering replacing this instrument during 2008. |
| NY305 | Aroclor-1016 by EPA 8082 | Reported value = false negative; acceptance limits = 2.51 – 12.8 µg/L. This Aroclor was misidentified by an inexperienced data peer reviewer. GEL has stated a more experienced reviewer will be used in the future. This is GEL's second Aroclor failure. Close scrutiny in the future is warranted. |
| NY305 | Aroclor-1242 by EPA 8082 | Reported value = false positive; acceptance limits = not applicable. This Aroclor was misidentified by an inexperienced data peer reviewer. GEL has stated a more experienced reviewer will be used in the future. This is GEL's third Aroclor failure. Close scrutiny in the future is warranted. |
| NY305 | Acetone by EPA 8260B | Reported value = false negative; acceptance limits = 32.0 – 888 µg/L. There was no corrective action reported for this analyte. |
| NY305 | Total Sulfide by EPA 376.1 | Reported value = 13.0 mg/L; acceptance limits = 3.46 – 10.4 mg/L. The true value for this analyte is 6.95 mg/L. The unacceptable result has been attributed to a dilution error; the reported value is twice as high as the true value. Attention to detail was re-iterated to the analyst. |
| 4th Quarter 2007 Performance Evaluations | | |
| ERA WP-153 | Turbidity by EPA 180.1/SM2130 B | Reported value = 7.80 NTU; acceptance limits = 3.14 – 4.60 NTU. This PT sample failure is currently under investigation by GEL. |
| ERA WP-153 | Settleable Solids by EPA 160.5/SM2540 F | Reported value = 40 mL/L; acceptance limits = 23.6 – 38.4 mL/L. This PT sample failure is currently under investigation by GEL. |
| ERA WP-153 | Titanium by EPA 200.8/SW6020 | Reported value = 113 µg/L; acceptance limits = 130 – 172 µg/L. This PT sample failure is currently under investigation by GEL. |
| ERA WP-153 | Sulfide by SW9030/9034 | Reported value = 5.01 mg/L; acceptance limits = 0.635 – 4.25 mg/L. These PT sample failures are currently under investigation by GEL. |
| ERA WP-153 | 4-Methylphenol by EPA 625/ SW8270C | Reported value = < 10 µg/L [false negative]; acceptance limits = 17.4 – 223 µg/L. This PT sample failure is currently under investigation by GEL. |

Table 5-24 (continued)

| Evaluation | Analytes Affected | Results and Actions Taken |
|------------|--|---|
| ERA WP-153 | Surfactants (MBAS) by EPA 425.1/SM5540 C | Reported value = 0.526 mg/L; acceptance limits = 0.193 – 0.485 mg/L. This PT sample failure is currently under investigation by GEL. |
| NY307 | Chloride by EPA 300.0 | Reported value = 52.7 mg/L; acceptance limits = 54.7 – 66.3 mg/L. This PT sample failure is currently under investigation by GEL. |
| NY307 | Sulfate by EPA 300.0 | Reported value = 195 mg/L; acceptance limits = 197 – 247 mg/L. This PT sample failure is currently under investigation by GEL. |
| NY307 | Isopropylbenzene by EPA 524.2 | Reported value = 48.5 µg/L; acceptance limits = 31.0 – 46.4 µg/L. This PT sample failure is currently under investigation by GEL. |
| NY307 | 1,1,1-Trichloroethane by EPA 524.2 | Reported value = 15.8 µg/L; acceptance limits = 10.4 – 15.6 µg/L. This PT sample failure is currently under investigation by GEL. |
| NY307 | 1,1-Dichloroethane by EPA 524.2 | Reported value = 40.0 µg/L; acceptance limits = 25.8 – 38.6 µg/L. This PT sample failure is currently under investigation by GEL. |
| NY307 | 1,1-Dichloropropene by EPA 524.2 | Reported value = 40.0 µg/L; acceptance limits = 25.6 – 38.4 µg/L. This PT sample failure is currently under investigation by GEL. |
| NY307 | cis-1,2-Dichloroethene by EPA 524.2 | Reported value = 27.5 µg/L; acceptance limits = 17.8 – 26.8 µg/L. This PT sample failure is currently under investigation by GEL. |
| NY307 | 1,3-Dichloropropane by EPA 524.2 | Reported value = 22.9 µg/L; acceptance limits = 15.1 – 22.7 µg/L. This PT sample failure is currently under investigation by GEL. |
| NY307 | 2,2-Dichloropropane by EPA 524.2 | Reported value = 27.4 µg/L; acceptance limits = 17.2 – 25.8 µg/L. This PT sample failure is currently under investigation by GEL. |
| NY307 | Bromochloromethane by EPA 524.2 | Reported value = 53.0 µg/L; acceptance limits = 33.0 – 49.4 µg/L. This PT sample failure is currently under investigation by GEL. |
| NY307 | Carbon Tetrachloride by EPA 524.2 | Reported value = 20.7 µg/L; acceptance limits = 13.1 – 19.7 µg/L. This PT sample failure is currently under investigation by GEL. |
| NY307 | Chloromethane by EPA 524.2 | Reported value = 24.4 µg/L; acceptance limits = 9.72 – 22.7 µg/L. This PT sample failure is currently under investigation by GEL. |
| NY307 | Dibromomethane by EPA 524.2 | Reported value = 27.2 µg/L; acceptance limits = 17.4 – 26.2 µg/L. This PT sample failure is currently under investigation by GEL. |
| NY307 | Dichlorodifluoromethane by EPA 524.2 | Reported value = 44.0 µg/L; acceptance limits = 16.4 – 38.4 µg/L. This PT sample failure is currently under investigation by GEL. |
| NY307 | Methylene chloride by EPA 524.2 | Reported value = 14.3 µg/L; acceptance limits = 9.44 – 14.2 µg/L. This PT sample failure is currently under investigation by GEL. |
| NY307 | Trans-1,2-Dichloroethene by EPA 524.2 | Reported value = 26.5 µg/L; acceptance limits = 16.9 – 25.3 µg/L. This PT sample failure is currently under investigation by GEL. |

All other water and sediment analytes not shown in the table were acceptable



5. Validation of Data Packages

a. Methods

We verify that analytical data used to support monitoring activities are defensible and of known quality. Analytical data packages sent to us by the analytical laboratories undergo a rigorous review and validation process following the guidelines set in the DOE-AL Model standard operating procedure for data validation, which includes review of the data quality and the documentation's correctness and completeness. [Table S5-5](#), [Table S5-6](#), and [Table S5-7](#) include the list of qualifiers and validation reason codes used to qualify the 2007 sediment and water data. When documentation or contract-compliance problems are identified during data validation, the analytical laboratory is contacted and attempts are made to resolve or clarify the problem.

b. Results

AQA validated all of the 2007 data packages. Individual validation memos were issued for each analytical fraction (method) for each data report. The average report had five data validation memos. AQA issued a number of nonconformance reports (NCRs) for Data Validation Memos that had to be reissued. Most of the NCRs were written in response to problems concerning minor documentation and typographical errors on individual memos. These reports were corrected and reissued. Associated sample results were generally not affected.

In 2007, documentation or contract-compliance problems required the largest analytical services provider, GEL, to issue package-specific NCRs. Most of the NCRs written in response to these problems concerned requests for clarification on data results and missing pages in the data packages. GEL reissued corrected documents for all of the reports containing missing documentation or erroneous data.

6. Review of Analytical Results

a. Methods

Radiological Data: Negative values are sometimes reported in radiological measurements. Negative numbers occur because radiochemistry counting instrument backgrounds are subtracted from sample readings to obtain net counts. Because of slight background fluctuations, individual values for samples containing little or no activity can be positive or negative numbers. Although negative values do not represent a physical reality, removing negative values would introduce a positive bias to a data set, so we report them as they are received from the analytical laboratory as required by the "Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance" (DOE 1991). Also see Appendix B.

The precision of radiological analytical results is reported as one standard deviation (one sigma) of the total propagated uncertainty. For most radionuclide measurements, we report a detection as an analytical result that does not include an analytical laboratory (or in some cases, secondary validation) qualifier code of X or U (indicating nondetect). University of Miami tritium data do not have laboratory qualifiers; in which case, a detected result is reported when analytical results are greater than three times the reported (one-sigma) uncertainty.

Nonradiological Data: For organic chemicals and some general inorganic chemistry parameters (that is, major anions, cations, and nutrients), the nondetections are reported at the PQL. For the metals and the rest of the general inorganic chemicals, nondetections are reported at the MDL. Data between the MDL and PQL are qualified as estimated (J) by the analytical laboratory. The analytical laboratory reports nonradiological results below the MDL as nondetections.

Detection-Limit Issues: The LANL analytic services SOW requires that analytical laboratories verify their calculated MDLs empirically. Federal regulations prescribe a process for determining analytical laboratory detection limits that uses standards based on deionized water. For analysis of environmental samples, these detection limits may not be achievable. The additional chemicals present in natural water samples may lead to

matrix interference in the analytical process, which decreases the method sensitivity. Comparing results from these analyses with a detection limit based on deionized water will lead to additional false positive results for environmental samples. Empirical determination of detection limits using natural sample matrices produces a detection limit that is achievable for these samples.

b. Results

In addition to data validation, results are reviewed to assess the need for actions. In some cases, the data review identifies issues with data quality that require action to determine the overall quality of the reported results. Issues with data quality identified either through validation or data review are addressed in this section.

Because of the sensitive nature of organic chemical sampling and analysis, a carefully designed field and analytical laboratory QC program is essential for evaluating the presence of organic chemicals in environmental samples. Organic chemicals may be detected in field QC samples such as field blanks or equipment blanks, indicating that they are not truly present in associated groundwater samples. These analytes may be present in the QC samples because of inadvertent contamination of sampling or analytical laboratory equipment by organic chemicals that come from other sources.

Most analytical methods require the analysis of laboratory-prepared method blanks or instrument blanks with each batch of samples. Target organic chemicals that are detected in these blanks indicate contamination from the sampling or analytical environments. Certain organic chemicals used in analytical laboratories are frequently detected in laboratory blanks, that is, contamination introduced by the analytical process is common for these compounds. These compounds include acetone, methylene chloride, toluene, 2-butanone, di-n-butyl phthalate, di-n-octyl phthalate, and bis(2-ethylhexyl)phthalate (Fetter 1993). Numerous field, trip, and equipment blanks collected during this reporting period contained toluene, acetone, 2-butanone, and 2-hexanone, which indicates inadvertent sample contamination in either the field or analytical laboratory.

7. Department of Energy Contract Analytical Program Audits

a. Methods

The Office of Environmental Management at DOE Headquarters (HQ-EM) mandated participation in the DOE Contract Analytical Program (DOECAP; <https://doecap.oro.doe.gov/>). DOECAP is a consolidated, uniform audit program for conducting annual audits of commercial laboratories to eliminate audit redundancy by involving all DOE program line organizations and field elements, provide a pool of trained auditors sufficient to support consolidated audits, standardize terms and conditions of existing and proposed contracts to allow acceptance of consolidated audit results, and interface with state and federal regulatory agencies, as well as other industry standard-setting groups, such as the National Environmental Laboratory Accreditation Conference. LANL requires participation in DOECAP for all major analytical providers. Smaller or specialty providers are audited following the LANL Waste and Environmental Services Division QA Program.

Table 5-25 below shows the DOECAP audits conducted for 2007 for analytical laboratories used by LANL.

Table 5-25
DOECAP Audits Conducted in 2007 for Analytical Laboratories used by LANL

| Laboratory | Audit Type | Audit Dates |
|---|------------------------------------|---------------------|
| Paragon Analytics, Fort Collins, Colorado | Annual Qualifications Audit | March 20–22, 2007 |
| Severn Trent Laboratories, Inc., Earth City, Missouri | Annual Qualifications Audit | April 10–12, 2007 |
| Severn Trent Laboratories, Inc., Earth City, Missouri | Surveillance of Corrective Actions | May 31–June 1, 2007 |
| GEL, LLC, Charleston, South Carolina | Annual Qualifications Audit | April 24–26, 2007 |

DOECAP audits result in findings and observations when there are items of concern that need to be addressed in the audit report. The DOECAP Policies and Practices document defines the following findings and observations:

- A Priority I finding shall only be issued for a significant item of concern or significant deficiency regarding key management/programmatic control(s), which in and of itself represents a concern of sufficient magnitude to potentially render the audited facility unacceptable to provide services to the DOE if not resolved via immediate and/or expedited corrective action(s).
- A Priority II finding shall be issued to document a deficiency which in and of itself does not represent a concern of sufficient magnitude to render the audited facility unacceptable to provide services to the DOE.
- An observation provides the DOECAP a mechanism for identifying and tracking a deficiency of an isolated nature or lesser significance than that of warranting an issuance of a Priority II finding, as well as an opportunity for improvement identified during a DOECAP audit.

b. Results

The following DOECAP audits were conducted at facilities providing water and sediment data to the Water Stewardship Program:

- Paragon Analytics, Fort Collins, Colorado: This audit occurred on March 20–22, 2007. There were 16 new Priority II findings and 10 new observations. The corrective action plan has been approved and is available from the DOECAP web site.
- Severn Trent, Earth City Missouri: This audit occurred on April 10–12, 2007. There were three new Priority II findings and 1 new observation. The corrective action plan has been approved and is available from the DOECAP web site.
- GEL, LLC, Charleston, South Carolina: This audit occurred April 24–26, 2007. There were 13 new Priority II findings and 14 new observations. The corrective action plan has been approved and is available from the DOECAP web site.

8. Internal Audits

a. Methods

In 2007, the LANL QA organization performed three surveillance-type assessments and one independent assessment of sampling-related activities.

b. Results

Areas for improvement identified by these assessments were in the areas of procedure quality, sampling techniques, training of sampling personnel, and documentation of results. A comprehensive Improvement Plan has been developed to address all issues identified by QA and includes the following:

- Procedures are being upgraded to incorporate industry best practices and/or clarify requirements.
- Training for all sampling personnel is required for the procedure revisions and will include increased emphasis on improving sampling techniques and procedure adherence.
- Increased oversight of sampling activities will be performed by LANL's Water Stewardship Program.

All issues identified in the assessments have been formally documented in the LANL corrective action program and will be tracked to completion. In addition, the QA organization will verify completion of all actions prior to closure of the tracking documents.

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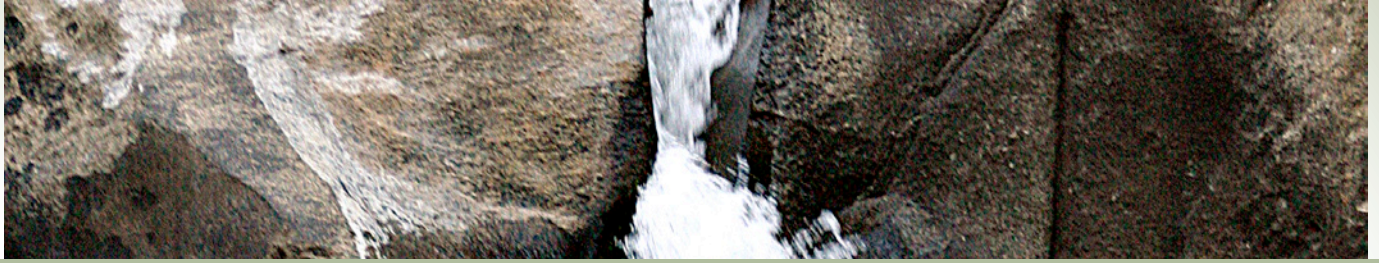
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6. Watershed Monitoring



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A. INTRODUCTION

Los Alamos National Laboratory (LANL or the Laboratory) monitors the quality of surface water, including storm water, and stream sediment in northern New Mexico to evaluate the potential environmental effects of Laboratory operations on affected watersheds. The Laboratory analyzes samples for a variety of parameters, including radionuclides, inorganic and organic chemicals, and general chemistry of surface water. In this chapter, the effects of Laboratory operations on surface water and stream sediment are evaluated geographically and over time. Additionally, the sampling results are compared with criteria established to protect human health and the aquatic environment.

Surface water monitoring and assessments at the Laboratory increased substantially after 2005 following agreements with federal and state regulatory agencies that require widespread monitoring of both perennial and ephemeral stream flows for an extensive list of constituents. As a result, increased sampling of base flow has resulted from the Compliance Order on Consent (the Consent Order) with the New Mexico Environment Department (NMED), discussed in Chapter 2. Additionally, increased sampling of storm water and snowmelt runoff has resulted from the Federal Facility Compliance Agreement (FFCA) and Administrative Order with the US Environmental Protection Agency (EPA) (EPA 2005a, b). In 2007, surface water sampling was conducted at over 160 different locations, yielding a substantial amount of water quality data.

B. HYDROLOGIC SETTING

The Laboratory includes parts or all of seven primary watersheds that drain directly into the Rio Grande, each defined by a master canyon (Figure 6-1). Listed from north to south, the master canyons for these watersheds are Los Alamos, Sandia, Mortandad, Pajarito, Water, Ancho, and Chaquehui Canyons. Each of these canyons includes tributary canyons of various sizes. Three of the primary watersheds have their headwaters west of the Laboratory in the eastern Jemez Mountains (the Sierra de los Valles), mostly within the Santa Fe National Forest (Los Alamos, Pajarito, and Water Canyons), and the remainder head on the Pajarito Plateau. Only the Ancho Canyon watershed is entirely located on Laboratory land. Canyons draining Laboratory property are dry for most of the year, and no perennial surface water extends completely across Laboratory land in any canyon. Approximately two miles of canyon on the Laboratory land have naturally perennial streams fed by springs and approximately three miles have perennial streams created by effluent discharges.

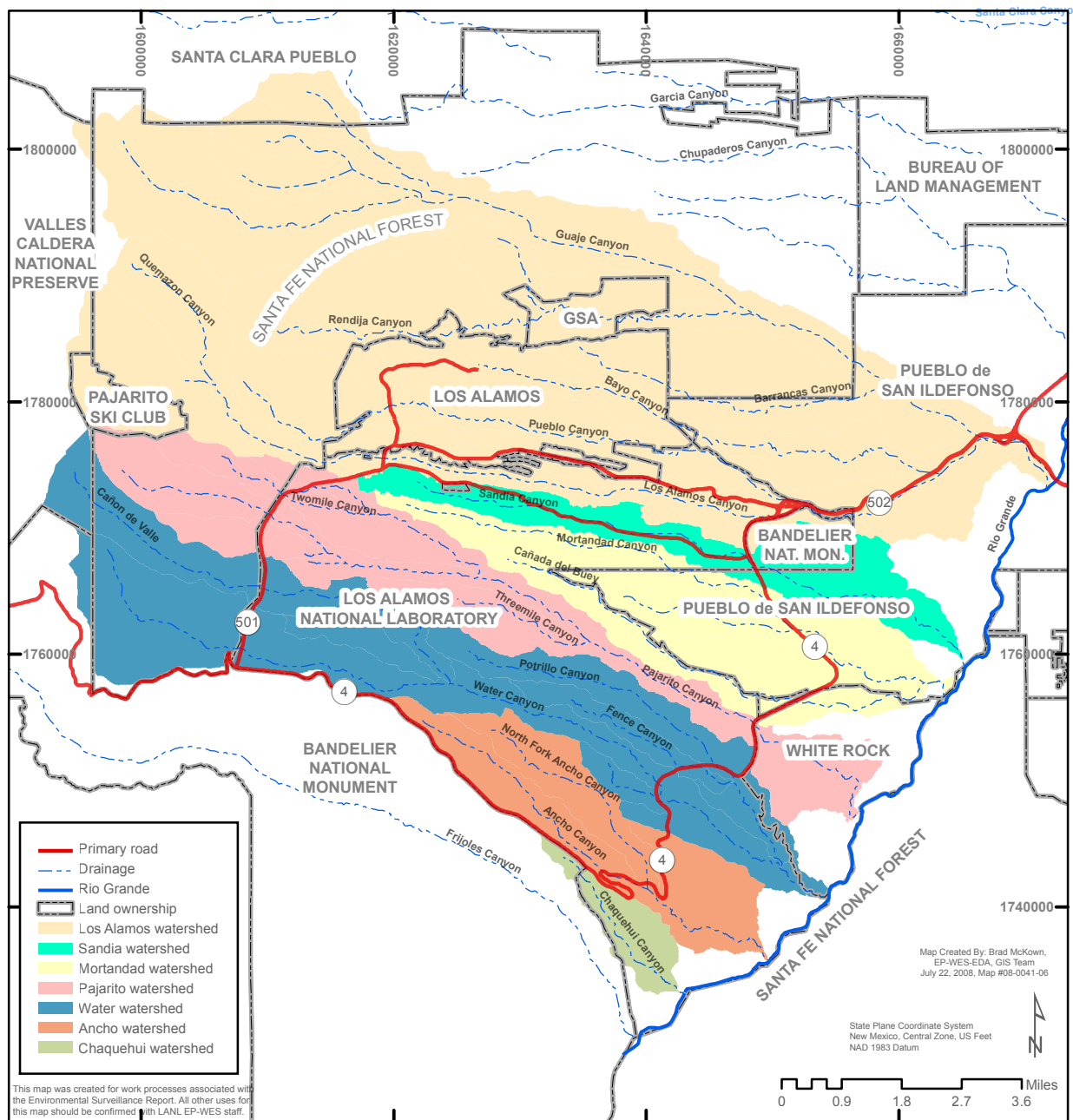


Figure 6-1. Primary watersheds at Los Alamos National Laboratory.

The remaining stream channels are dry for varying lengths of time. The driest segments flow only as runoff from local precipitation or snowmelt, and the stream bed is always above the water table. The flow in these streams is ephemeral. Other streams sometimes have the water table higher than the stream bed and/or experience extensive snowmelt runoff and are considered intermittent. Intermittent streams may flow for several weeks to a year or longer. To aid in water quality interpretation, stream flow is divided into three types. Each of the three flow types might be sampled at a single location within a time span of as little as a week, depending on weather conditions. At times, the flow might represent a combination of several of these flow types.

The three types of stream flow are:

- Base flow—persistent stream flow, but not necessarily perennial water. (This type of flow is generally present for periods of weeks or longer. The water source may be springs, effluent discharge, or alluvial groundwater that emerges along stream beds.)

- Snowmelt runoff—flowing water present because of melting snow. (This type of water may be present for up to a month or more and in some years may not be present at all.)
- Storm water runoff—flowing water present in response to rainfall. (These flow events are generally very short lived, with flows lasting from less than an hour to—rarely—several days.)

Because base flow and snowmelt runoff can be present for extended periods of time, they may be available for potentially longer-term exposures, such as wildlife watering. Storm water runoff may provide a short-term water source for wildlife, particularly when it collects in bedrock pools or other local depressions, although water quality will improve at these locations over time as the suspended sediment settles out. Storm water runoff in particular is capable of transporting Laboratory-derived constituents associated with sediment particles off-site and possibly into the Rio Grande.

None of the streams within the Laboratory boundary average more than one cubic ft per second (cfs) of flow annually. It is unusual for the combined mean daily flow from all LANL canyons to be greater than 10 cfs, although one storm event in late fall of 2007 (November 30 to December 2, 2007) resulted in an estimated combined mean daily runoff from LANL of about 22 cfs on December 1. By comparison, the average daily flow in the Rio Grande at Otowi Bridge during that event was 800 cfs, or approximately 35 times higher. Although most of the streams at LANL are dry throughout the year, occasional floods can redistribute sediment downstream. Stream flow in 2007 on the Pajarito Plateau was dominated by snowmelt runoff from March through May in the larger canyons that head in the Sierra de los Valles, with relatively minor storm water runoff events in the summer and a larger event in late fall. Total runoff measured at downstream gages in the canyons leaving the Laboratory is estimated at about 205 acre-feet (ac-ft), about 91 ac-ft from snowmelt runoff, 70 ac-ft from storm water runoff in the summer, and 44 ac-ft from the late fall event. The volume of storm water runoff in 2007 was the least since the Cerro Grande fire in 2000 and similar to pre-fire runoff volumes. Figure 6-2 shows the estimated storm water runoff at LANL from June through October, and the seasonal precipitation since 1995.

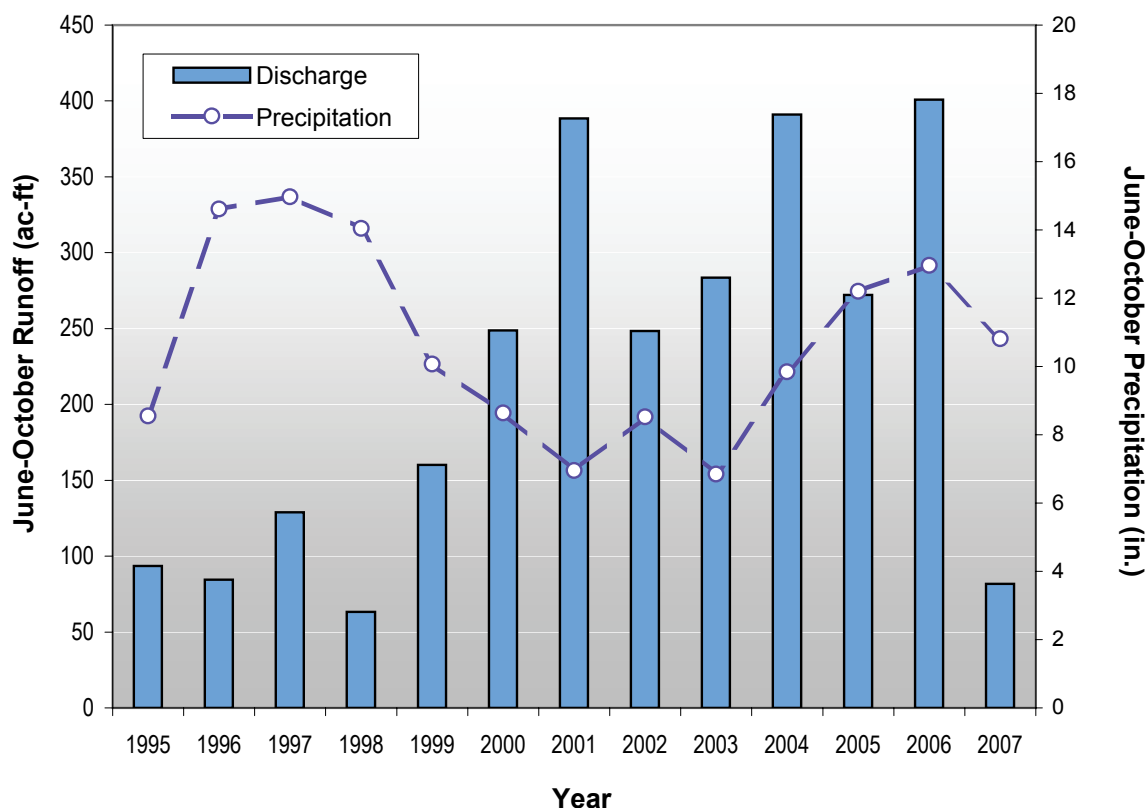


Figure 6-2. Estimated June through October storm water runoff in LANL canyons (Pueblo Canyon to Ancho Canyon) and precipitation at TA-6, 1995-2007.

The snowmelt in 2007 caused continuous stream flow in Los Alamos Canyon, extending from the Jemez Mountains (the Sierra de los Valles), across LANL, and into the Rio Grande for approximately 2.5 months, from mid-March to early June. The estimated total volume of snowmelt runoff measured in Los Alamos Canyon at the Laboratory's eastern boundary was about 91 ac-ft, decreasing to about 29 ac-ft in lower Los Alamos Canyon near the confluence with the Rio Grande. Snowmelt runoff was not recorded in other canyons in 2007 on the eastern Pajarito Plateau.

C. SURFACE WATER AND SEDIMENT SCREENING LEVELS

Table 6-1 summarizes the standards, screening levels, and guides used to evaluate the monitoring data and evaluate potential Laboratory impacts. For brevity, they are all commonly referred to as “screening levels” in this chapter. The surface water screening levels include biota concentration guides (BCGs), water quality standards, maximum contaminant levels (MCLs), risk based screening levels, and water screening action levels (wSALs). The wSALs are established under the FFCA and presented in the Laboratory's annual Storm Water Pollution Prevention Plan (SWPPP; e.g., Veenis et al. 2007). The suite of screening levels for surface water varies, depending on the stream flow conditions and established or potential uses, as discussed further in Section C.1. Results for sediment are compared with background concentrations, human health screening levels, and BCGs. Because some of the criteria are not for current uses, actual impacts can be less than indicated by these comparisons. For example, use of livestock watering standards is required by New Mexico regulations, although there are no livestock at the Laboratory except for some trespassing cows grazing at low elevations near the west bank of the Rio Grande. In addition, comparison of surface water data with groundwater standards and drinking water MCLs is useful as a screening tool to indicate potential impacts to water supply wells, although surface water at the Laboratory is not used as a drinking water supply.

1. New Mexico Surface Water Standards

The New Mexico Water Quality Control Commission (NMWQCC) establishes surface water standards for New Mexico in Standards for Interstate and Intrastate Surface Waters (NMWQCC 2005). Certain watercourses may be ‘classified’ and have segment-specific designated uses. A designated use may be an attainable or an existing use (e.g., wildlife watering, aquatic life) for the surface water. Nonclassified surface water may be described as ephemeral, intermittent, or perennial, each of which also has corresponding designated uses. The designated uses for surface water are associated with use-specific water quality criteria, including numeric criteria. Some of the standards are for total concentrations and some are for dissolved concentrations; data from non-filtered surface water samples are compared to the former, and data from filtered samples are compared to the latter.

Significant changes were made in the NMWQCC stream standards, effective July 17, 2005. The most significant change, with respect to surface water monitoring at the Laboratory, is the classification of all surface water with segment-specific designated uses within the Laboratory boundary. Four stream segments, with designated uses of coldwater aquatic life, livestock watering, wildlife habitat, and secondary contact, are classified as perennial (Figure 6-3). The remaining stream segments, with designated uses of limited aquatic life, livestock watering, wildlife habitat, and secondary contact, are classified as ephemeral or intermittent.

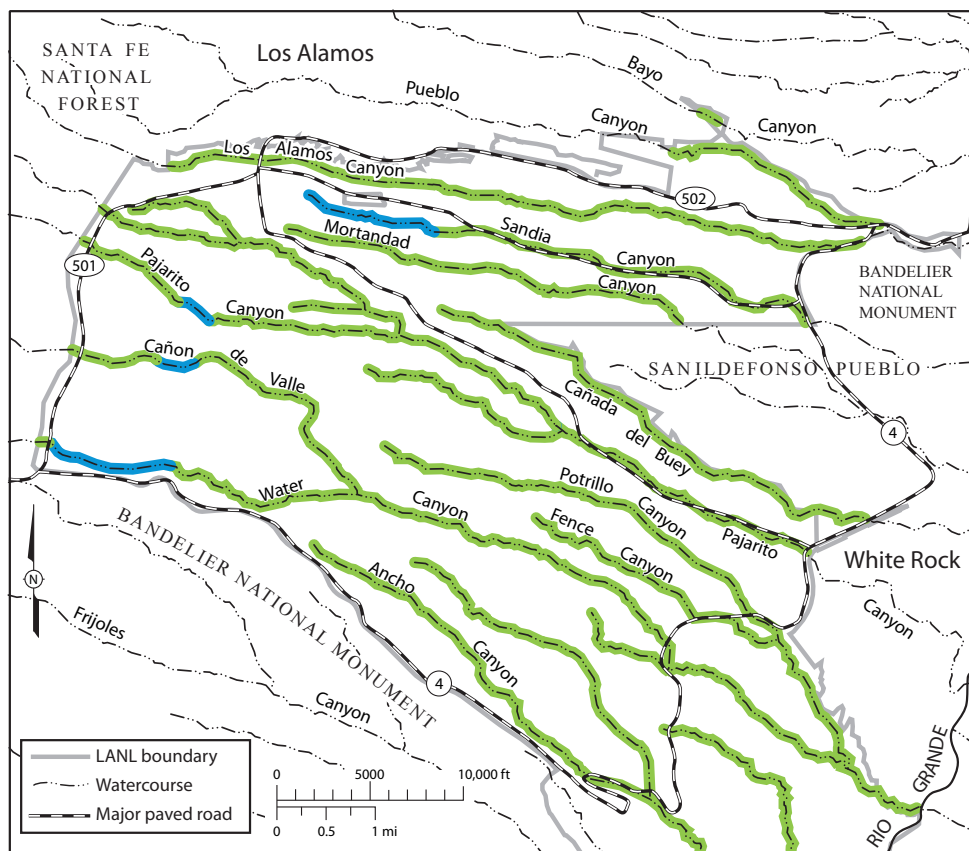


Table 6-1
Application of Surface Water and Sediment Screening Levels to Monitoring Data

| Medium | Standard | Risk- or Dose-Based Screening Level | Reference | Location | Notes |
|---------------------------------|---|---------------------------------------|------------------------|----------------------|--|
| Surface water | | | | | |
| Radionuclides and Radioactivity | State gross alpha water quality standard for surface water (NMWQCC, 2005) | Biota concentration guides (BCGs) | DOE (2002) | On-site and off-site | Surface water is generally present sporadically or is not available for long-term access and does not provide persistent drinking water. The actual exposure pathway is to plants and animals, and not to humans. BCGs are based on 1 rad/day exposure limit for aquatic animals and terrestrial plants, and 0.1 rad/day for terrestrial animals. Comparison with radionuclide criteria is based on time-weighted average over the year per DOE guidance (DOE 2003) and Section 20.3.4 of New Mexico Administrative Code (NMAC). |
| | | | 20.6.4 NMAC | On-site and off-site | Based on the protection of livestock watering for radium-226 + radium-228, tritium, and gross alpha radiation. NMWQCC standards are not specific about exposure frequency or duration; for screening purposes, we compare single sample results with numeric criteria. The gross alpha standard excludes alpha radiation from source, special nuclear, and byproduct material regulated by the Atomic Energy Act. |
| Nonradionuclides | State water quality standards for surface water | Water screening action levels (wSALs) | 20.6.4 NMAC FFCA SWPPP | On-site and off-site | Single sample results are compared with screening levels based on water quality standards, risk based standards, and wSALs. |
| | State water quality standards for groundwater | EPA drinking water MCLs | 20.6.2 NMAC EPA (2007) | On-site and off-site | Single sample result comparisons with groundwater quality criteria and MCLs are used to determine potential for stream flows to impact underlying groundwater bodies. |

Table 6-1 (continued)

| Medium | Standard | Risk- or Dose-Based Screening Level | Reference | Location | Notes |
|------------------|----------|-------------------------------------|--|----------------------|--|
| Radionuclides | None | Human health screening levels | LANL (2005a) | On-site and off-site | Screening levels derived to determine if more detailed assessment is needed to evaluate impacts to the public; comparisons are made for recreational or industrial exposure parameters; based on a dose rate limit of 15 mrem/year (LANL 2005a). Recreational levels are appropriate for Laboratory lands because of public access. There are no residential uses of LANL lands and residential use is impractical at many locations (e.g., active floodplains in canyon bottoms). |
| | | Biota concentration guides | DOE (2002) | On-site and off-site | Dose limit to biota same as for surface water. Individual results compared to BCGs. |
| | | Background | Ryti et al. (1998) or McLin and Lyons (2002) | | Results from Pajarito Plateau stations are compared to plateau-specific background levels (Ryti et al. 1998). Results from regional stations are compared to background levels specific to major rivers and reservoirs within the Rio Grande drainage system (McLin and Lyons 2002). |
| Nonradionuclides | None | Human health screening levels | NMED, EPA Region 6, or LANL | On-site and off-site | Recreational or industrial screening levels derived to determine if more detailed assessment is needed to evaluate impacts to the public. |
| | | Background | Ryti et al. (1998) or McLin and Lyons (2002) | | Results from Pajarito Plateau stations are compared to plateau-specific background levels (Ryti et al. 1998). Results from regional stations are compared to background levels specific to major rivers within the Rio Grande drainage system (McLin and Lyons 2002). |



Stream Type Designated Uses

Perennial (NM 20.6.4.126): Coldwater Aquatic Life, Livestock Watering, Wildlife Habitat, Secondary Contact

Ephemeral and Intermittent (20.6.4.128): Limited Aquatic Life, Livestock Watering, Wildlife Habitat, Secondary Contact

- Perennial
- Ephemeral and Intermittent

Figure 6-3. Designated stream segments and uses at Los Alamos National Laboratory.

The surface water within the Laboratory is not a source of municipal, industrial, or irrigation water, though wildlife does use the water. While direct use of the surface water is minimal within the Laboratory, stream flow may extend beyond the LANL boundary where the potential is greater for more direct use of the water. Stream flows sometimes extend onto Pueblo de San Ildefonso land, particularly flows in Pueblo Canyon derived from treated sanitary effluent discharged from the Los Alamos County Wastewater Treatment Plant (WWTP). Spring water may be used traditionally and ceremonially by Pueblo de San Ildefonso members, and may include ingestion or direct contact.

2. Radionuclides in Surface Water

US Department of Energy (DOE) Order 5400.5 prescribes total dose limits associated with exposure to radionuclides in environmental media. Because of the limited extent of stream flow, there are no drinking water systems on the Pajarito Plateau that rely on surface water supplies. The emphasis of the radiological assessment of surface water is, therefore, on potential exposures to aquatic organisms and terrestrial plants and animals, rather than to humans. For protection of biota, concentrations of radionuclides in surface water are compared with the DOE BCGs (DOE 2002), with site-specific modifications by McNaughton (2005). For screening purposes, single sample results are first compared with BCGs to identify if radionuclides at a location pose a

potential risk to biota. Following DOE guidance (DOE 2003), final evaluations of potential risk at these locations use annual time-weighted radionuclide content of the water rather than individual sample results. Surface water analytical results for gross alpha radiation, radium isotopes, and tritium are also compared with the NMWQCC water quality standard for protection of livestock watering use, which is a designated use for surface water within the Laboratory boundary (NMWQCC 2005). NMWQCC standards are not specific about exposure frequency or duration. Therefore, for screening purposes, single sample results are compared with numeric criteria for these analytes, as discussed in Section C.3. It should be noted that the gross alpha standard does not apply to source, special nuclear, or byproduct material regulated under the Atomic Energy Act, and the gross alpha radiation data discussed in this chapter were not adjusted to remove these sources of radioactivity.

3. Nonradioactive Constituents in Surface Water

Surface water concentrations of nonradioactive constituents are compared with screening levels that correspond to the designated uses for the stream, as discussed in Section C.1. Hardness-dependent aquatic life numeric criteria from NMWQCC (2005) are calculated using a water hardness value of 100 mg CaCO₃/L (EPA 2006). For evaluating the potential impact of chronic exposure to surface water constituents on aquatic life in perennial stream segments, the Laboratory uses the protocol employed by NMED for assessing standards attainment in New Mexico (NMED 2006a). For designated perennial stream segments, single sample results are compared with the chronic screening level which is 1.5 times the chronic aquatic life criterion (NMWQCC 2005).

Surface water results are also compared with the NMWQCC groundwater standards for screening purposes to evaluate the potential for stream flows to impact underlying groundwater bodies (NMWQCC 2002). Similarly, for screening purposes results are also compared with EPA MCLs for drinking water or tap water screening levels (EPA 2007) for analytes without an MCL, although surface water at the Laboratory is not a source of drinking water. For comparisons with MCLs or tap water screening levels, data from filtered surface water samples are used because contaminants adsorbed to sediment particles would be naturally filtered out as water infiltrates from stream channels to deeper groundwater bodies.

Surface water results are also compared with the NMWQCC groundwater standards for screening purposes to evaluate the potential for stream flows to impact underlying groundwater bodies (NMWQCC 2002). Similarly, for screening purposes results are also compared with EPA MCLs for drinking water or tap water screening levels (EPA 2007) for analytes without an MCL, although surface water at the Laboratory is not a source of drinking water. For comparisons with MCLs or tap water screening levels, data from filtered surface water samples are used because contaminants adsorbed to sediment particles would be naturally filtered out as water infiltrates from stream channels to deeper groundwater bodies.

4. Sediment

Sediment analytical results are compared to screening levels to identify concentrations that may require further assessment. The Laboratory's Waste and Environmental Services Division uses screening action levels (SALs) to identify radionuclide concentrations of interest (LANL 2005a). Comparisons with SALs are used to readily distinguish the areas with the most potential concern: concentrations below the SALs are not of concern to public health, whereas concentrations greater than the SALs would trigger more detailed evaluations. Recreation is the dominant use in most canyon bottoms along streams at the Laboratory, and recreational SALs provide the most appropriate comparison to sediment data. Concentrations of nonradioactive compounds in sediment are compared with recreational or industrial soil-screening levels (SSLs) developed by NMED (2006b), EPA Region 6 (EPA 2007), or LANL (2007c). All of these screening levels are protective because they are calculated based on the assumption that humans will be exposed to the chemicals or radionuclides for extended periods of time, which is not the case on LANL property. Sediment data from the Pajarito Plateau are also compared with established plateau-specific background concentrations of metals or radionuclides that are naturally occurring or result from atmospheric fallout (Ryti et al. 1998; McDonald et al. 2003) and sources other than LANL. Data from regional sediment stations are compared to background levels established for the major drainages of the area, the Rio Grande, Rio Chama, and Jemez River (McLin and Lyons 2002; McLin 2004).

D. SAMPLING LOCATIONS AND DATA ANALYSIS METHODS

1. Regional Monitoring Locations

Regional base flow and sediment sampling stations (Figure 6-4) are located in northern New Mexico. Samples from upriver regional stations reflect baseline concentrations and provide a basis for evaluating Laboratory impacts to the Rio Grande drainage system. Regional sediment samples were obtained in 2007 from stations on the Rio Grande, from Abiquiu Reservoir on the Rio Chama, and from Cochiti Reservoir on the Rio Grande. Sampling stations in the Rio Grande drainage system are located up to approximately 37 mi (60 km) upriver of the Laboratory.

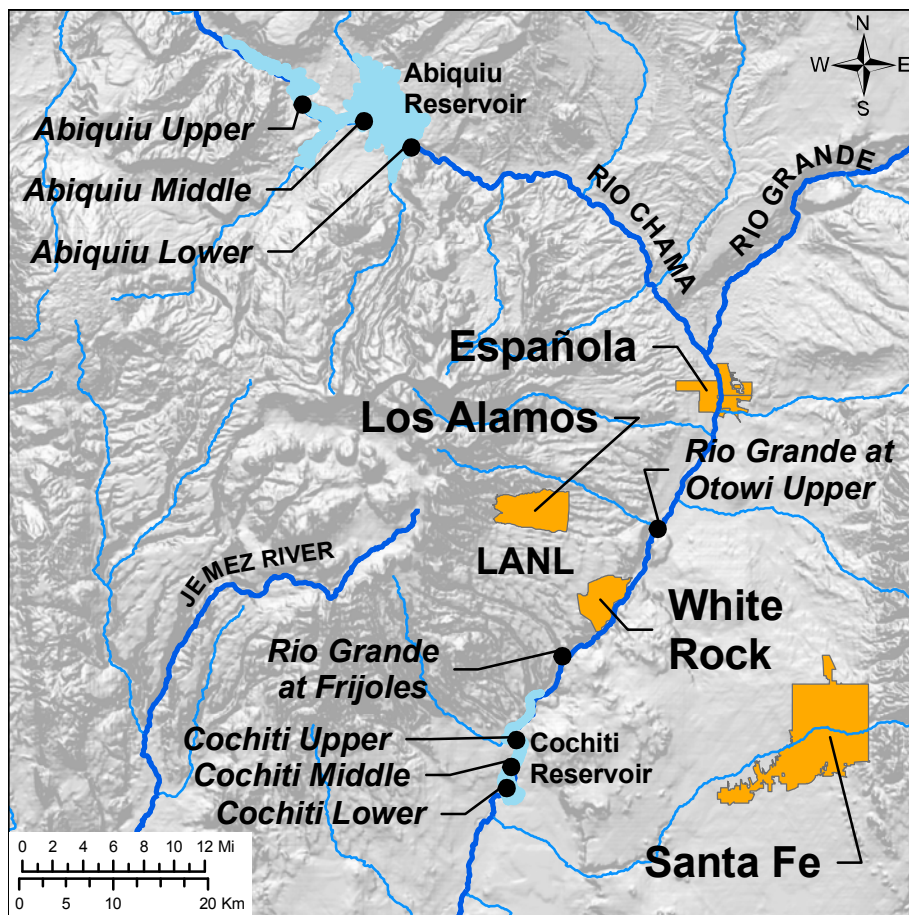


Figure 6-4. Regional base flow and sediment sampling locations.



2. On-Site and Perimeter Monitoring Locations

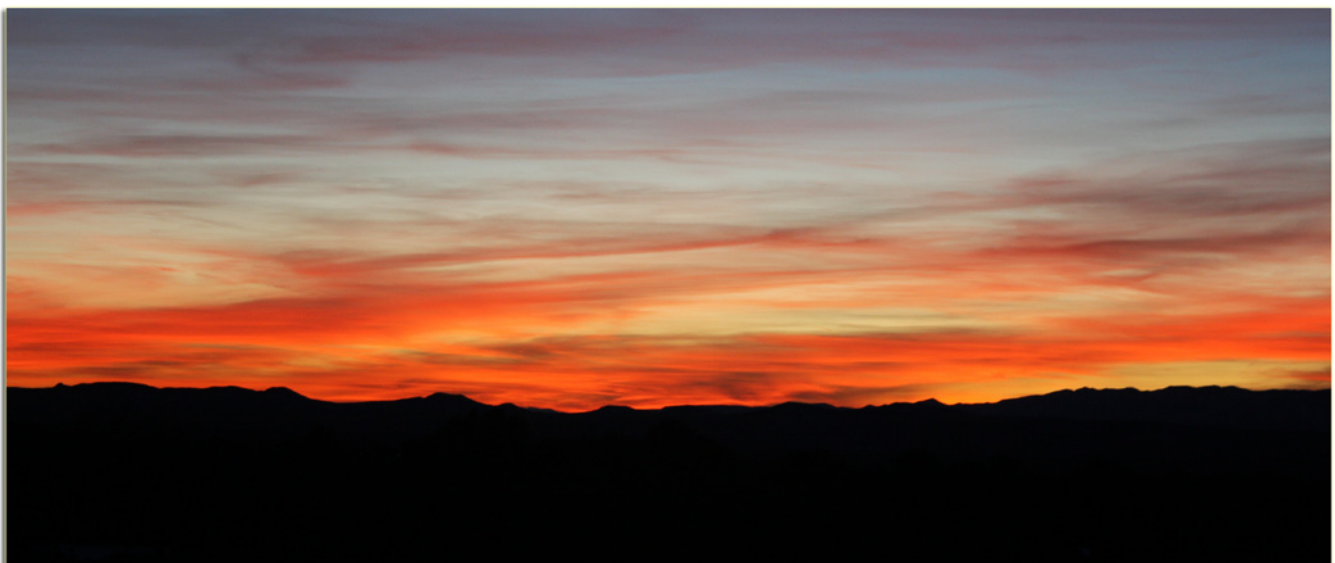
Surface water and sediment are sampled in all major canyons crossing current or former Laboratory lands. Stream channel sediment is sampled to evaluate the accumulation of potential contaminants in the aquatic environment (DOE 1991). Surface water samples are collected across the Pajarito Plateau within and near the Laboratory, with particular emphasis placed on monitoring downstream of potential Laboratory contaminant sources, such as at the downstream Laboratory boundary. The Laboratory collects base flow grab samples from locations where effluent discharges or natural springs maintain stream flow.

Storm water runoff samples in streams are collected at stream-gaging stations using automated samplers (Figure 6-5). Many gaging stations are located near where drainages cross the Laboratory's boundary or New Mexico State Highway 4 (NM 4). Baseflow, snowmelt runoff, or persistent surface water are also sampled at some gaging stations and at other locations along stream channels (Figure 6-6). Storm water runoff is also sampled at many mesa-top and hillside sites ("site monitoring areas" or "SMAs") which allows the Laboratory to evaluate runoff from specific Laboratory sites (Figure 6-7). The SMAs usually have negligible runoff from other sources, although some receive runoff from paved areas in the Los Alamos town site and may include non-LANL contaminants.

Sediment stations on the Pajarito Plateau and vicinity (Figure 6-8) are located within approximately 2.5 mi (4 km) of the Laboratory's boundary, with the majority located within the Laboratory's boundary. Many of the annual sediment-sampling stations on the Pajarito Plateau are located within canyons to monitor sediment in the active channel related to past and/or present effluent discharges. More extensive evaluations of sediment, both active channel and floodplain sediment deposits, have been completed or are in progress in several canyons (LANL 2004a, 2006c, 2007d, 2007e, 2007f; Reneau et al. 2004), and complement the active channel sampling at these annual sediment stations.

Sediment was also collected in 2007 from short tributary drainages to Cañada del Buey and Pajarito Canyon below Material Disposal Area (MDA) G at Technical Area (TA)-54 (Figure 6-9), which is an active waste storage and disposal area. Sampling stations were established outside its perimeter fence in 1982 to monitor possible transport of radionuclides from the area.

Additionally, surface water and sediment were sampled at several locations on Pueblo de San Ildefonso lands. DOE entered into a Memorandum of Understanding with Pueblo de San Ildefonso and the Bureau of Indian Affairs in 1987 to conduct environmental sampling on pueblo land. The drainages passing from LANL onto pueblo lands are Bayo, Los Alamos, Mortandad, and Sandia Canyons and Cañada del Buey.



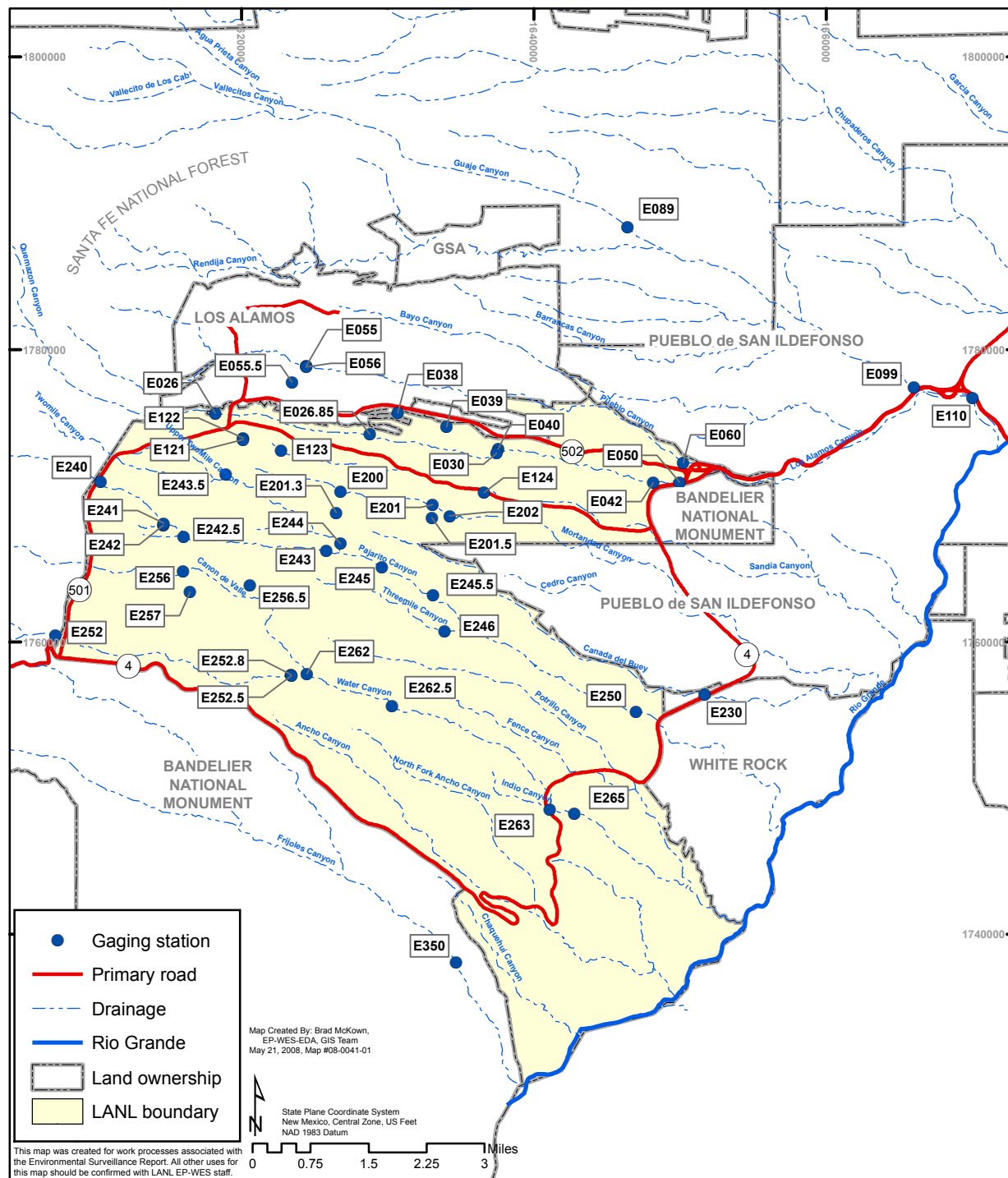


Figure 6-5. Gaging stations sampled in 2007 within and in the vicinity of Los Alamos National Laboratory.

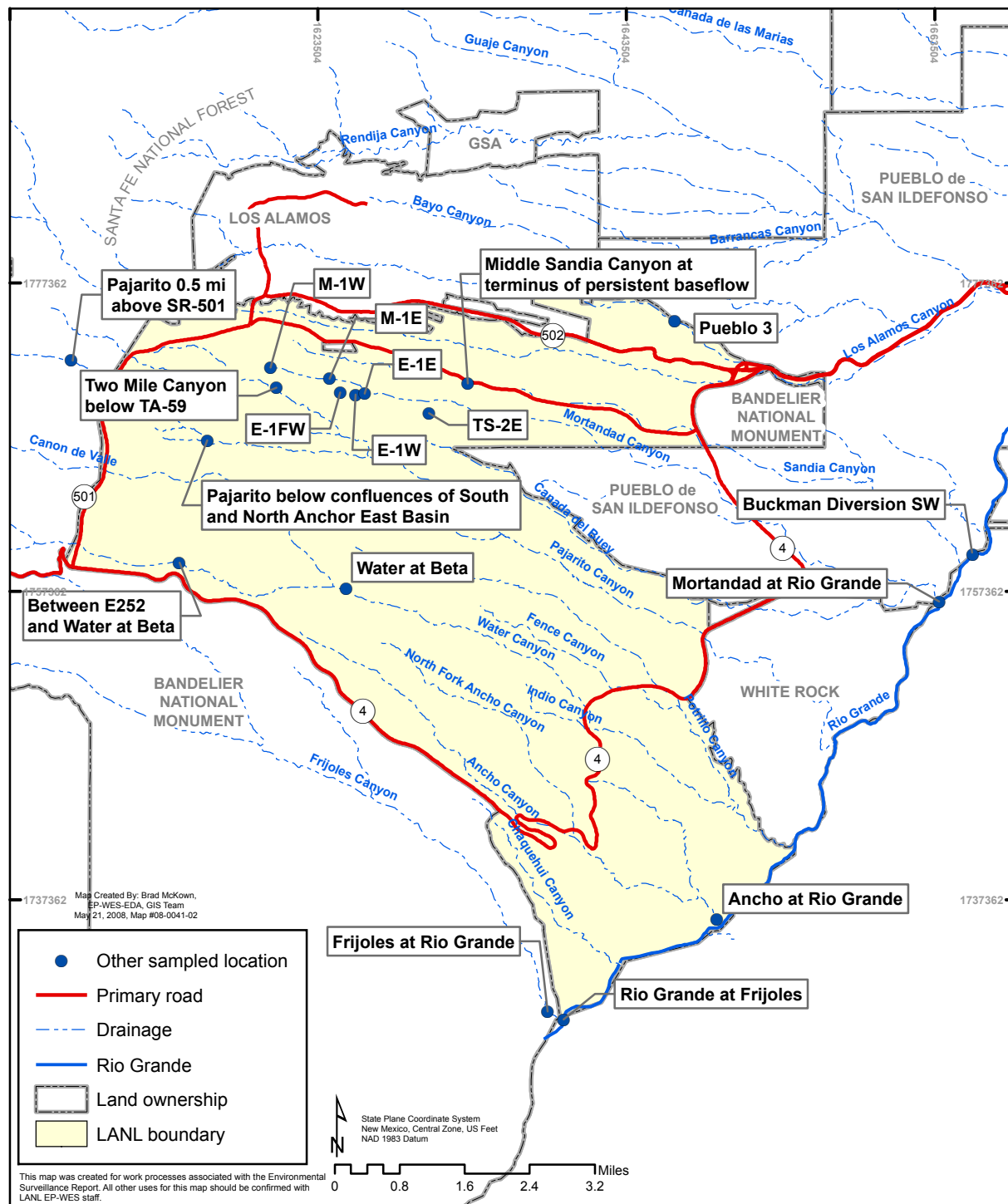


Figure 6-6. Other surface water locations sampled in 2007 within and in the vicinity of Los Alamos National Laboratory.

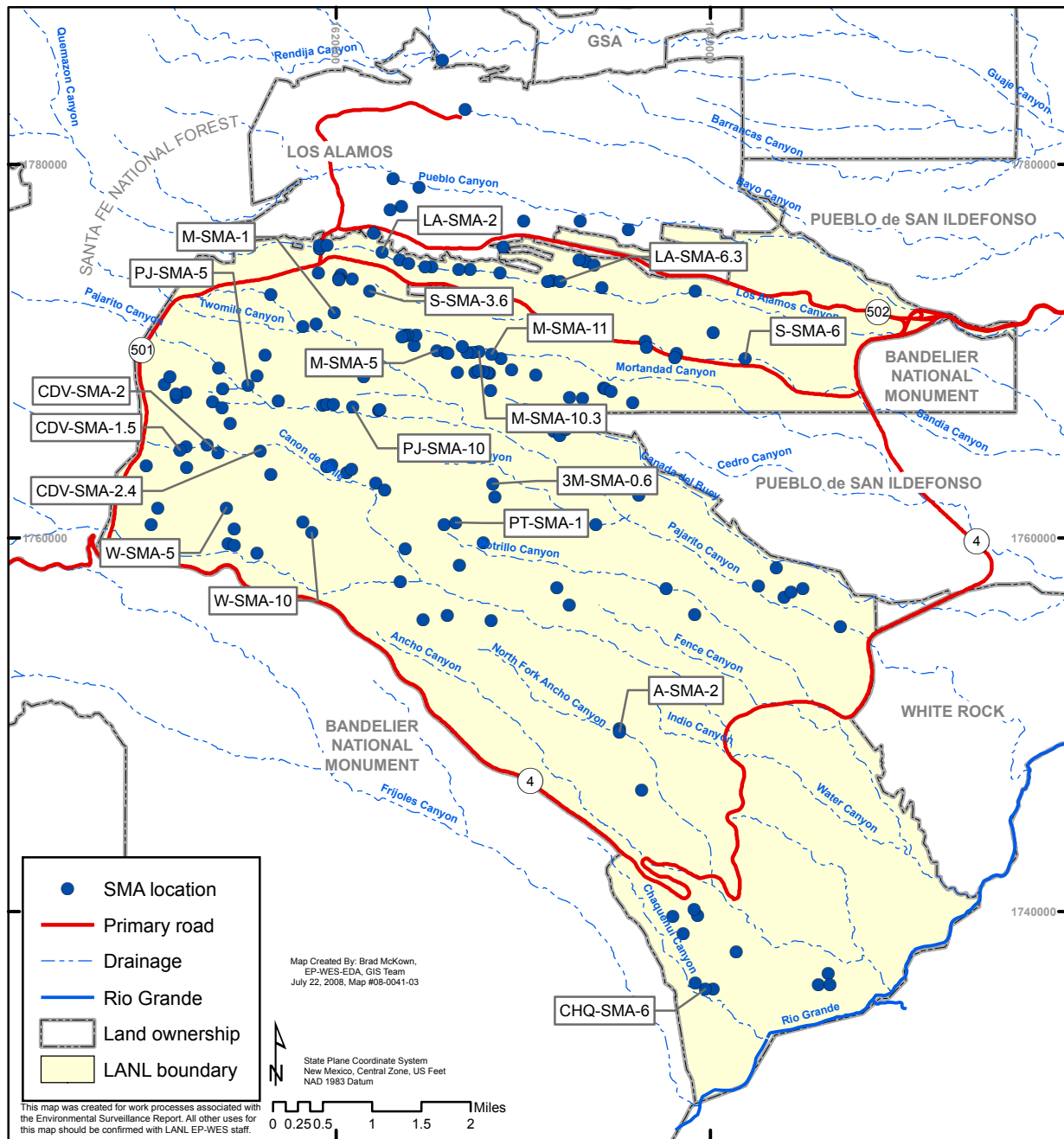


Figure 6-7. Site-specific storm water monitoring stations sampled in 2007 within and in the vicinity of Los Alamos National Laboratory. Labeled stations are referred to in text.

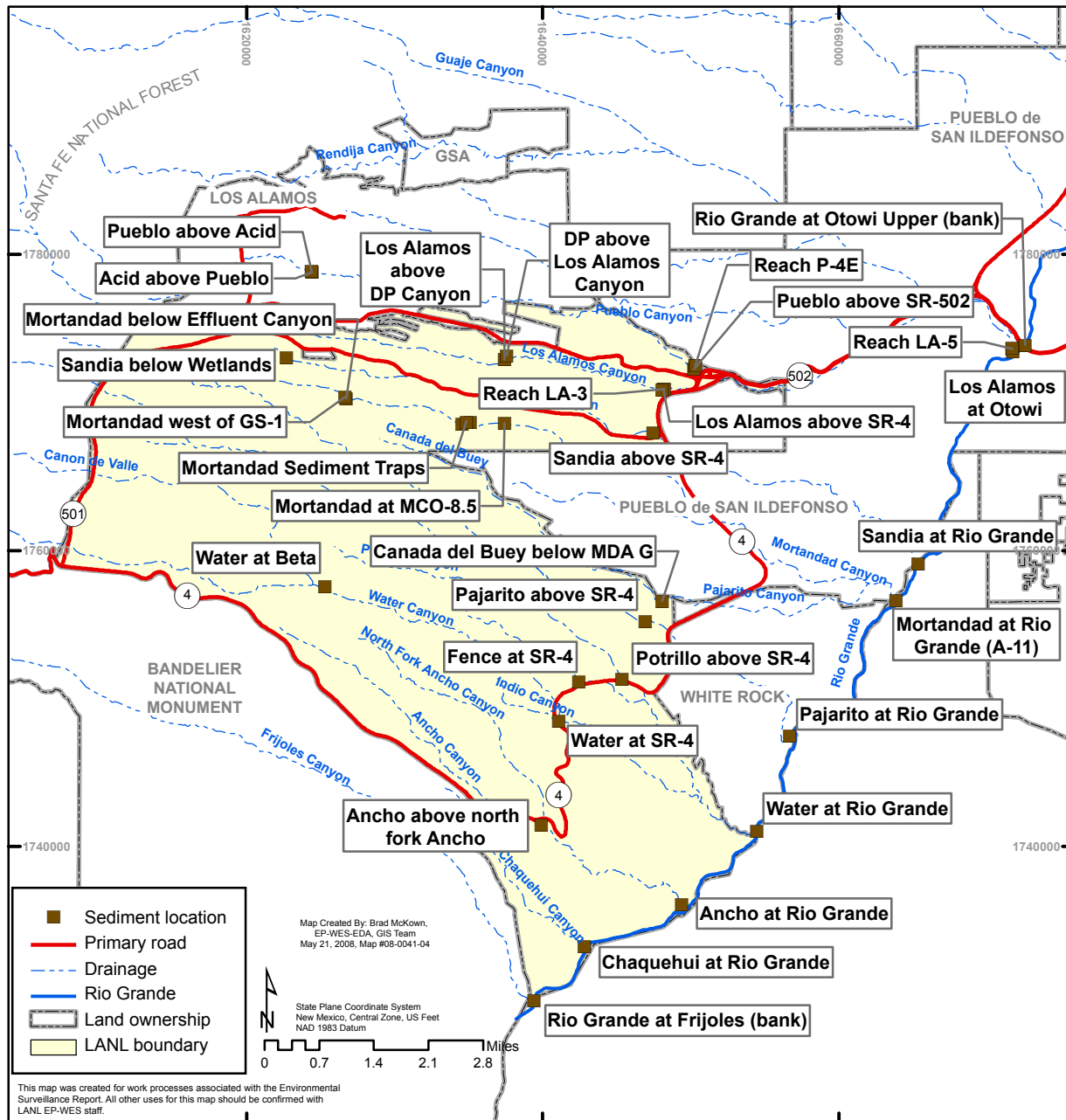


Figure 6-8. Sediment locations sampled in for 2007 within and in the vicinity of Los Alamos National Laboratory. MDA G locations are shown in Figure 6-9.

3. Sampling Procedures

The procedures for sampling depend on the type of stream flow and location. Grab samples of base flow and snowmelt runoff are collected from free-flowing streams near the bank. The grab samples are either filtered or left unfiltered and preserved in the field. The gaging stations, located mostly in canyon bottoms, are equipped with automated samplers that are activated at the start of significant storm water runoff events. Typically, the automated samplers collect water from the first 30 minutes of the runoff event to sample water near the leading edge of flood bores, also called the “first flush.” This is the fourth year that the first flush of storm water has been sampled and it is a significant difference from previous years (2003 and before) when samples were collected over a two-hour period. Higher concentrations are expected in the first flush compared to the average concentration during a flow event because suspended sediment concentration is highest near the flood bore (Malmon et al. 2004, 2007). As a result, the post-2003 data are not directly comparable to data from previous years.

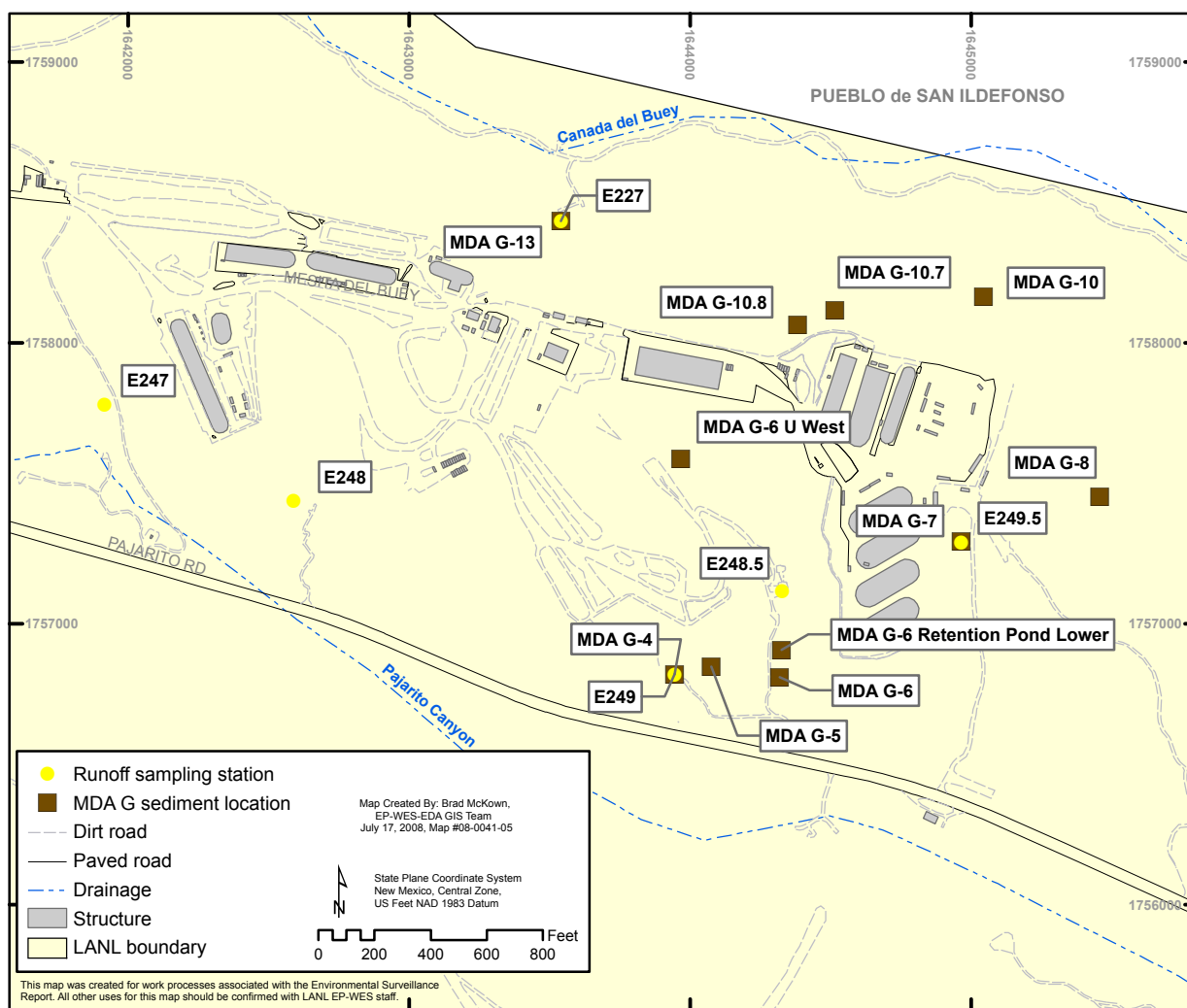


Figure 6-9. Sediment and storm water runoff sampling stations at TA-54, MDA G.

Storm water runoff samples from mesa tops are collected with buried single-stage runoff samplers or automated ISCO samplers at site-specific monitoring areas (SMAs). All storm water samples are filtered and preserved in LANL's storm water operations facility because filtering highly sediment-laden waters in the field is difficult. Samples are then shipped to the commercial analytical laboratory as is, without compositing or splitting.

Sediment samples from dry stream beds are collected across the width of the main channel to a depth of approximately 1 in. (2 cm). For flowing streams, samples are collected from the edge of the main channel. Deposits of fine-grained sediment outside the main channel that resulted from large floods in 2006 were sampled from the sides of shallow hand-dug holes after identifying the base of the 2006 sediment. Sediment samples from reservoirs were collected using a Ponar Grab sampler from a pontoon boat.



E. WATERSHED SAMPLING RESULTS BY CONSTITUENTS

The supplemental data tables on the compact disc included with this report present all the 2007 watershed-related surface water and sediment analytical results. In the tables, radiological results are presented in sequence for each of these media, followed by the results for major water quality analytes, metals, and organic chemicals.

Surface water and sediment samples are analyzed for gross alpha and gross beta radiation and selected radionuclides (americium-241, cesium-137, plutonium-238, plutonium-239/240, strontium-90, uranium-234, uranium-235, uranium-238, tritium, cobalt-60, potassium-40, neptunium-237, radium-226, radium-228, and sodium-22). [Table S6-1](#) lists the results of radiochemical analyses of surface water for 2007. The table also lists the total propagated one-sigma analytical uncertainty and the analysis-specific minimum detectable activity, where available. For most radionuclide measurements, a detection is an analytical result that does not include an analytical laboratory (or in some cases, secondary validation) qualifier codes of X or U (indicating nondetect). Trace-level tritium results for surface water samples are presented in [Table S6-2](#). The results of radiochemical analyses of sediment are presented in [Table S6-3](#).

Concentrations of major chemical constituents in surface water are presented in [Table S6-4](#). [Table S6-5](#) and [Table S6-6](#) present results of metals analyses for surface water and sediment, respectively.

The scope and results of organic chemical analyses are presented in [Table S6-7](#) through [Table S6-10](#). [Table S6-7](#) presents the number and type of organic chemical analyses performed on surface water samples and [Table S6-8](#) presents all detected organic chemical results in surface water. Similarly, [Table S6-9](#) and [Table S6-10](#) present summaries of organic chemical analyses of sediment samples. [Table S6-11](#) presents results of particle size analyses of the sediment samples.

Qualifier codes are shown in some tables to provide additional information on analytical results that are not detections. In some cases, for example, the analyte was found in the laboratory blank, or there were other analytical issues.

The overall quality of most surface water in the Los Alamos area is good, with low levels of dissolved solutes. Of the more than 100 analytes reported in sediment and surface water within the Laboratory, most are at concentrations far below screening levels. However, nearly every major watershed indicates some impact from Laboratory operations, often for just a few analytes. In the following sections, a Laboratory-wide overview of surface water and sediment quality is presented first, and then the key findings are discussed in more detail on a watershed-by-watershed basis. It should be noted that analytical results that are greater than screening levels can be derived from a variety of sources including Laboratory releases, runoff from developed areas such as the Los Alamos town site, naturally occurring radionuclides and chemicals, or “false positives” from analytical laboratories. (Section G of Chapter 5 discusses quality problems that have occurred at analytical laboratories in more detail.) It is not always possible to identify specific sources at present: results greater than standards or screening levels are considered to represent potential Laboratory impacts unless the evidence is compelling for non-LANL sources.

1. Radionuclides in Surface Water and Sediment

a. Surface water

In 2007, concentrations of radionuclides and levels of radiation in surface water and sediment were within ranges measured in recent years. In surface water samples from canyon bottoms, no results for individual radionuclides exceeded DOE BCGs, and annual time-weighted concentrations that consider the combined effects of multiple radionuclides also did not exceed DOE guidelines, as discussed later in this section. For mesa top and hillside storm water monitoring locations (SMAs), two locations had values for uranium isotopes that exceeded BCGs for a storm event on August 6, 2007: PT-SMA-1 in the Potrillo Canyon watershed and

3M-SMA-0.6 in the Threemile Canyon watershed. Maximum results were <5 times greater than BCGs, and because flow is infrequent at these locations, time-weighted averages that consider the extended periods of no flow would also be below BCGs.

Consistent with previous years, most surface water samples in 2007 had gross alpha radiation greater than the NMWQCC surface water standard of 15 pCi/L for livestock watering. Of the 330 non-filtered samples analyzed from the Pajarito Plateau, 57% exceeded 15 pCi/L. However, it has been previously shown that the majority of the alpha radiation in surface water on the plateau is due to the decay of naturally occurring isotopes in sediment and soil from uncontaminated areas carried in storm water runoff, and that Laboratory impacts are relatively small (Gallaher 2007). Naturally occurring alpha emitting radionuclides include isotopes of radium, thorium, and uranium. In addition, as noted previously, no livestock graze at the Laboratory except for some cows trespassing near the Rio Grande.

Figure 6-10 shows the generally a positive correlation between gross alpha radiation and suspended sediment concentration in non-filtered surface water samples collected from streams on the Pajarito Plateau in 2007. Although some samples from canyons that have received discharges of radioactive effluent, such as Mortandad Canyon, have relatively high gross alpha radiation, upstream stations and canyons not receiving radioactive effluent, such as Sandia Canyon, can also have relatively high values. These data support the previous conclusions that gross alpha radiation in suspended sediment is dominated by naturally occurring radionuclides, although some values are probably elevated because of releases from Laboratory sites.

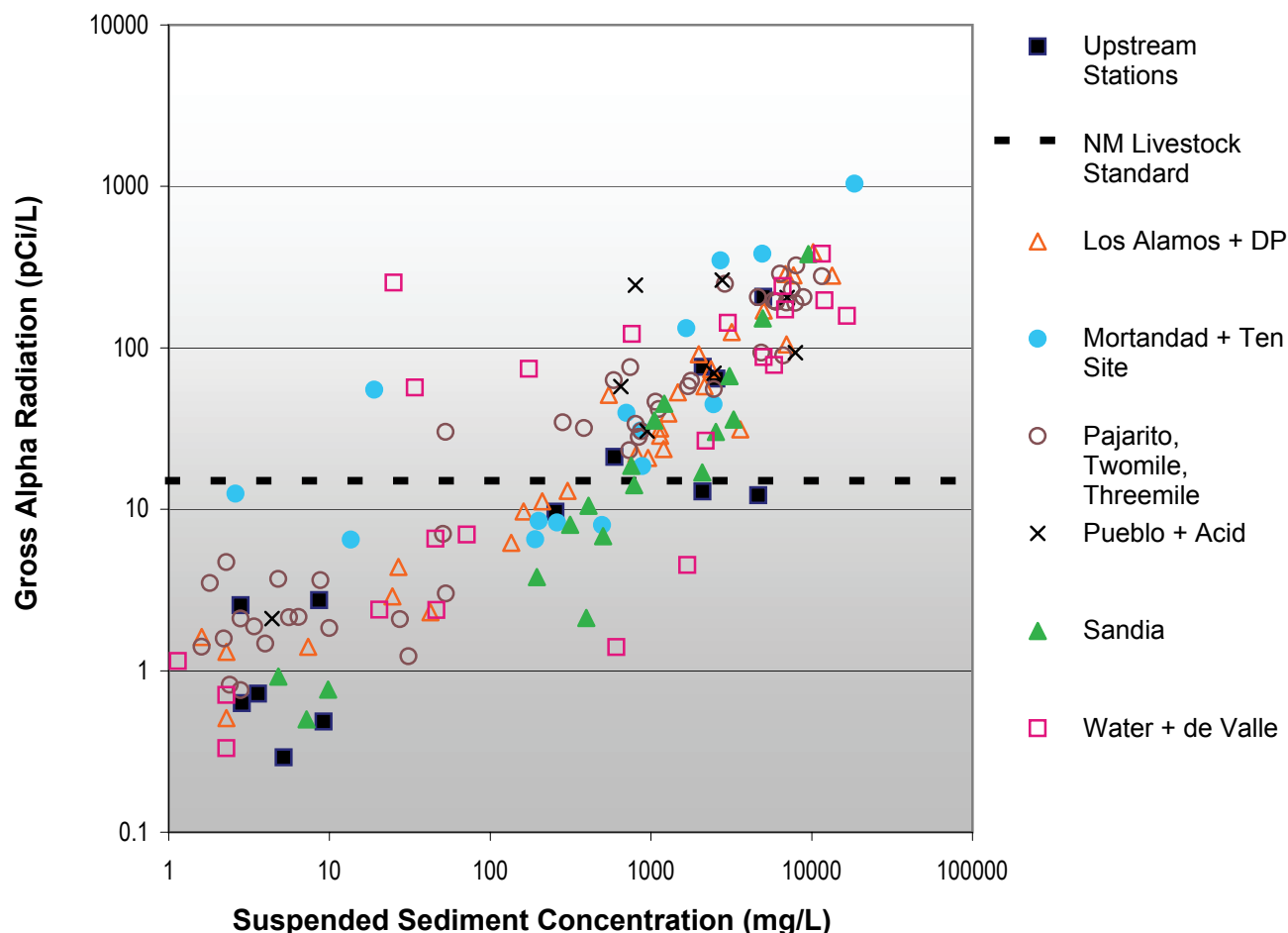


Figure 6-10. Relationship between gross alpha radiation and suspended sediment concentration in surface water samples collected from Pajarito Plateau streams in 2007.

Gross alpha radioactivity is a general screening measurement of limited value in assessing radiological hazards because specific alpha emitters in the water cannot be identified or quantified. Therefore, gross alpha radiation results are not discussed in detail in this report. Instead, this report focuses on specific individual radionuclides identified in LANL waste streams (Watkins and Del Signore 2005) or known to be associated with the nuclear industry (Langmuir 1997).

The highest concentrations of several radionuclides in surface water samples were measured in Mortandad Canyon downstream from the TA-50 Radioactive Liquid Waste Treatment Facility (RLWTF) outfall, including americium-241, cesium-137, plutonium-238, plutonium-239/240, and tritium. These concentrations are below DOE Derived Concentration Guidelines (DCGs) for drinking water, and treated effluent from the RLWTF has always been below the DCGs. The highest concentration of strontium-90 was measured in DP Canyon downstream from a former outfall at TA-21 which also released radioactive effluent. The highest concentrations of uranium-234, uranium-235, and uranium-238 were measured at a SMA location in the Potrillo Canyon watershed associated with a firing site in TA-15 (PT-SMA-1).

Table 6-2 compares the estimated annual average concentrations of specific radionuclides in surface water downstream from past or current radioactive liquid waste discharge locations with the DOE BCGs. In order to compare surface water data with the BCGs, the time-weighted average annual radionuclide concentrations in waters were calculated, focusing on the wetter stream segments. This approach is consistent with DOE guidance (DOE 2003). Time-weighted average concentrations were calculated for the individual radionuclides of primary concern: americium-241, cesium-137, plutonium-238, plutonium-239/240, strontium-90, tritium, uranium-234, uranium-235, and uranium-238. Time-weighted average concentrations were also calculated for the naturally occurring radionuclide radium-226 which can contribute a significant amount of the total dose. Concentrations measured during base flow periods and during storm runoff periods were weighted proportionally after reviewing stream flow records to distinguish the flow regimes; periods with no flow were assigned concentrations of zero.

For waters containing more than one radionuclide, a ratio for each radionuclide was calculated by dividing the concentration of each radionuclide by its particular BCG. To be consistent with DOE Order 5400.5, the sum of the ratios should not exceed 1.0 (DOE 1990). Because the calculations are based on limited sample sets and hydrologic interpretation, these results should be viewed as approximations.

The estimated time-weighted annualized concentrations and sums of ratios for non-filtered surface water in the canyons that have received radioactive effluents were well below the BCGs. Table 6-2 shows the highest concentrations in relation to the BCGs were for radium-226, at 28% of the BCG in lower Pueblo Canyon. Lower Pueblo Canyon also has the highest concentration relative to BCGs for one of the primary radionuclides of concern at LANL, plutonium-239/240, at 11% of the BCG. When the mixtures of isotopes are considered, the largest sum of the ratios was also found in lower Pueblo Canyon at 41% of the BCG.

Although radium-226 measured on the Pajarito Plateau is probably of natural origin, it is of concern because it has the most stringent BCG for all the radionuclides monitored. The BCG was established to protect riparian animals that ingest radium-226 in calcium-deficient waters. However, surface water at Los Alamos is calcium-abundant and the resultant dose from radium-226 is considerably less than calculated as the calcium interferes with the uptake of radium-226.

b. Sediment

In 2007, analytical data on radionuclides in sediment were obtained from 52 samples as part of the annual surveillance program, including 44 samples from the Pajarito Plateau, 2 samples from banks along the Rio Grande, and 6 samples from upriver (Abiquiu) or downriver (Cochiti) reservoirs. The Pajarito Plateau samples included 35 active channel locations that are typically dominated by coarse-grained sediment and 9 locations where fine-grained sediment was deposited from large floods in 2006.

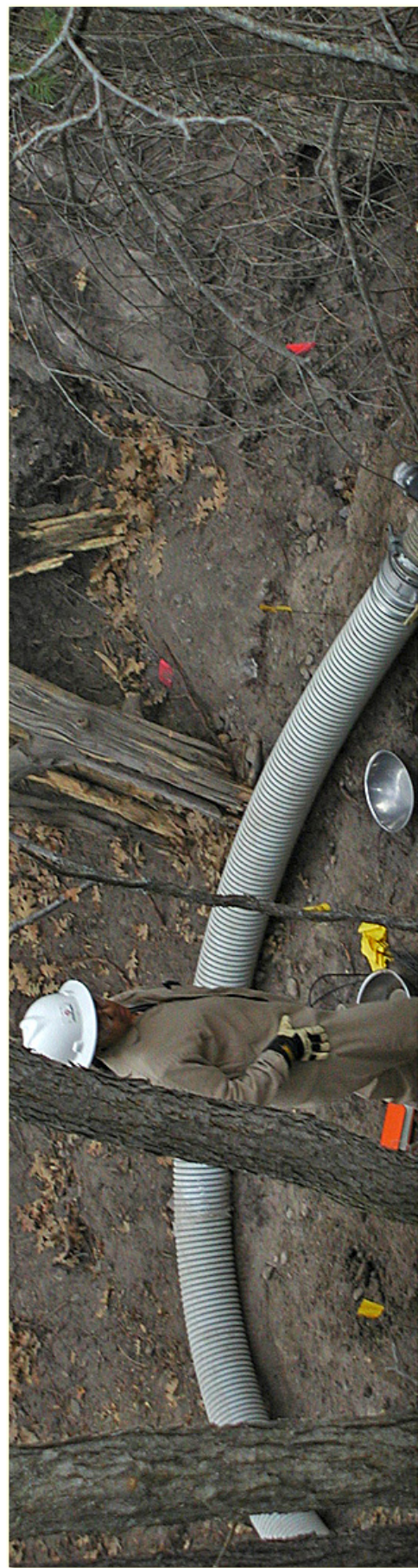
Table 6-2
Comparison of Estimated Annual Average Non-filtered Surface Water Concentrations of Radionuclides in Selected Canyons with DOE Biota Concentration Guides

| Radionuclide | | BCG ^a (pCi/L) | Acid Canyon above Pueblo Canyon | | Lower Pueblo Canyon (pCi/L) | DP Canyon below TA-21 (pCi/L) | Los Alamos Canyon between DP Canyon and NM 4 (pCi/L) | Los Alamos Canyon at Rio Grande (pCi/L) | Mortandad Canyon below Effluent Canyon (pCi/L) | Maximum percent of BCG |
|-----------------------|--|-----------------------------|------------------------------------|-------------------|--------------------------------|-------------------------------------|---|---|---|------------------------------|
| | | | BCG ^a (pCi/L) | Canyon (pCi/L) | | | | | | |
| Am-241 | | 400 | | 0.59 | 0.08 | 0.4 | 0.3 | 0.02 | 0.9 | 0.2% |
| Cs-137 ^b | | 20,000 | | ND ^c | ND | ND | 2 | ND | 10 | 0.05% |
| H-3 (tritium) | | 300,000,000 | | 17 | 1.6 | 23 | 16 | 22 | 853 | <0.01% |
| Pu-238 | | 200 | | 0.04 | 0.00 | 0.03 | 0.03 | ND | 1.5 | 0.7% |
| Pu-239/240 | | 200 | | 5.6 | 22 | 0.2 | 0.6 | 0.2 | 2 | 11% |
| Sr-90 | | 300 | | 0.5 | 0.02 | 35 | 2 | 0.08 | 1.9 | 12% |
| U-234 | | 200 | | 1.0 | 3 | 2 | 0.9 | 1.4 | 1.0 | 1% |
| U-235,236 | | 200 | | 0.06 | 0.01 | 0.01 | 0.05 | 0.09 | 0.05 | 0.1% |
| U-238 | | 200 | | 0.8 | 2 | 2 | 0.8 | 1.0 | 0.9 | 1% |
| Ra-226 | | 4 | | 1.0 | 1.1 | ND | ND | ND | 0.6 | 28% |
| Sum of ratios to BCGs | | | | 0.28 | 0.41 | 0.14 | 0.02 | 0.01 | 0.19 | - |

^a BCG = Biota Concentration Guide (DOE 2002)

^b The BCG for Cs-137 is a site-specific modified BCG from McNaughton (2005)

^c ND indicates no analytical laboratory detection in 2007



The highest concentrations of most radionuclides in sediment were obtained from one fine-grained sample from the Mortandad Canyon sediment traps, including the highest values for americium-241, cesium-137, plutonium-238, plutonium-239/240, and strontium-90. This sediment was deposited by a flood on August 25, 2006, which was the largest flood on record in that canyon since discharges of radioactive effluent began at the TA-50 RLWTF in 1963. These values are all less than previous results from the sediment traps (LANL 2006c) and are below recreational SALs. The highest concentrations of tritium were measured in drainages below MDA G at TA-54 and are also below recreational SALs. No results for uranium isotopes in sediment in 2007 are above background levels.

2. Metals in Surface Water and Sediment

a. Surface water

During 2007, analytical data on metals were obtained from 504 surface water sampling events at 169 locations on the Pajarito Plateau, each event consisting of the collection of one or more samples from a specific location. The monitoring included 105 site-specific (mesa top or hillside) sites (SMAs) and 64 canyon bottom sites. These data were compared to screening levels which vary across the Laboratory depending on the designated uses for a particular stream segment, as discussed in Section C.1. Some screening levels are for dissolved constituents, which are compared to filtered sample results, and some are for totals, which are compared to non-filtered sample results. Results for filtered samples were also compared to drinking water and groundwater standards as screening levels because of the possibility for infiltration from streams to impact underlying groundwater. In addition, under the Clean Water Act §303(d) list, the NMWQCC has listed parts of one or more canyons within or near LANL as impaired for nine metals: aluminum, arsenic, cadmium, copper, lead, mercury, selenium, vanadium, and zinc (NMWQCC 2006). The 2007 results for these metals are discussed below, along with other selected metals that have results greater than screening levels or are otherwise of concern at LANL. As mentioned previously in Section C.4, hardness-dependent aquatic life criteria are calculated using a water hardness value of 100 mg CaCO₃/L (EPA 2006).

The screening levels for aluminum are based on aluminum dissolved in the water column. In 2007, 33% of filtered surface water samples collected on the Pajarito Plateau contained concentrations of aluminum higher than the screening levels of 750 µg/L for ephemeral or intermittent surface water, although most or all of this aluminum may be naturally occurring. For example, 42% of the filtered surface water samples collected from locations upstream of LANL or in canyons not affected by Laboratory activities also had aluminum >750 µg/L. Other samples from locations with perennial water also exceed the screening levels of 87 µg/L for perennial surface water, including non-LANL affected areas such as Frijoles Canyon in Bandelier National Monument. Aluminum is a natural component of soil and is not known to be derived from Laboratory operations in any significant quantity. In the slightly alkaline waters at Los Alamos, aluminum rarely occurs in solution in natural water at concentrations greater than a few tens to hundreds of micrograms per liter (Hem 1986). Consequently, a large majority of the results greater than the screening levels are probably due to the presence of particulate aluminum (colloids) passing through the filter, rather than aluminum dissolved in the water column.

In 2007, 3% of the filtered surface water samples collected on the Pajarito Plateau contained detected concentrations of arsenic higher than the screening level of 9 µg/L for surface water. These samples are scattered among multiple watersheds (Cañon de Valle and DP, Los Alamos, Pajarito, Potrillo, Pueblo, Sandia, Ten Site, and Threemile Canyons). The highest concentrations and the highest frequency of results >9 µg/L occur in storm water samples from the Ten Site Canyon watershed, associated with samples from near the top of the watershed below MDA C. Downstream surface water sample locations in Ten Site and Mortandad Canyons all had arsenic <9 µg/L in 2007. The source of the arsenic in storm water samples on the Pajarito Plateau is not certain, and may include both natural and anthropogenic sources. For example, prior sediment data have indicated small releases of arsenic from some LANL TAs (LANL 2004a; LANL 2006c), although soils at LANL have high background levels of arsenic (Longmire et al. 1995; Rytí et al. 1998) and most of the arsenic in these watersheds may be naturally occurring. The Laboratory is continuing to evaluate potential sources of arsenic in the affected watersheds.

For cadmium, no filtered surface water sample had a detected result greater than the screening level of 2 µg/L for ephemeral or intermittent streams, and no filtered surface water sample from a designated perennial stream segment had a detected result greater than the applicable screening level of 0.25 µg/L. Although Water Canyon had previously been listed as impaired for cadmium by the NMWQCC, the 2007 surface water data did not indicate any concerns with cadmium in this canyon.

For copper, no filtered surface water sample from a designated perennial stream segment on the Pajarito Plateau had a detected result greater than the applicable screening level of 9.4 µg/L, although 10% of all filtered surface water samples had results greater than the applicable screening level of 14 µg/L for ephemeral and intermittent streams. These results are scattered among multiple watersheds, including Ancho, Chaquehui, DP, Los Alamos, Mortandad, Pajarito, Potrillo, Pueblo, Sandia, Twomile, Threemile, and Water Canyons; Cañada del Buey; and Cañon de Valle. The highest value of 356 µg/L was obtained from a monitoring station near the head of the Potrillo Canyon watershed in TA-15 (PT-SMA-1), and all samples from this station had results for copper greater than 14 µg/L. Flow in this watershed is entirely ephemeral and rarely crosses NM 4, instead infiltrating into the alluvium upcanyon. Copper concentrations greater than 100 µg/L were also measured in the Pajarito, Threemile, Twomile, and Water Canyon watersheds, all at site monitoring stations or in small tributary drainages. Downstream samples from the major stream channels in these canyons all had copper less than 14 µg/L. The sources of copper in these watersheds have not been thoroughly evaluated, but its spatial distribution indicates copper is at least partly derived from firing sites.

For lead, no samples of filtered surface water had concentrations greater than the screening level of 81.7 µg/L for ephemeral and intermittent streams, and no filtered surface water sample from a designated perennial stream segment had a detected result greater than the applicable screening level of 3.2 µg/L. However, two samples of filtered surface water had concentrations greater than the EPA MCL of 15 µg/L for drinking water (screening level), one each from the Threemile Canyon and Water Canyon watersheds, constituting <0.5% of all samples from the Pajarito Plateau. These samples were both from ephemeral storm water at SMA stations (3M-SMA-06 and W-SMA-10), and all other samples from these stations and also from the major stream channels downstream had lead concentrations below the MCL.



For mercury, no filtered surface water samples had concentrations greater than the screening level of 0.77 µg/L. However, 4% of the non-filtered samples had detected results greater than 0.77 µg/L. These samples are scattered among multiple watersheds (Acid, Los Alamos, Mortandad, Pajarito, Pueblo, Rendija, Sandia, and Ten Site Canyons). The highest concentrations were in the Sandia Canyon watershed, particularly at the S-SMA-6 monitoring station in TA-72 and along the main stream channel immediately east of the Sandia Canyon wetland (gaging station E123). The highest frequency of detects >0.77 µg/L was in a tributary to Rendija Canyon adjacent to the Guaje Pines Cemetery and below a residential area. Mercury is also above background levels in sediment samples from these areas (LANL 2007d; LANL 2007f). The spatial distribution of mercury in these canyons and other canyons indicates both LANL and non-LANL sources, and the Laboratory is continuing to evaluate potential sources of mercury in the affected watersheds.

For selenium, only two non-filtered surface water samples of the total number of samples from the Pajarito Plateau had detected results greater than the screening level of 5 µg/L, or <0.5%. Both samples were from the Sandia Canyon watershed, from monitoring station S-SMA-6 and from the south fork of Sandia Canyon (gaging station E121). Notably, no canyons at LANL listed as impaired for selenium by the NMWQCC (Cañon de Valle and Los Alamos, Mortandad, Pajarito, Pueblo, and Water Canyons) had any detected results greater than 5 µg/L, indicating that selenium may no longer be of concern in these canyons.

For vanadium, no filtered surface water sample had a detected result greater than the screening level of 100 µg/L. Although Water Canyon had previously been listed as impaired for vanadium by the NMWQCC, the 2007 surface water data did not indicate any concerns with vanadium in this canyon.

For zinc, 2% of the filtered surface water samples collected had detected results greater than the screening level of 120 µg/L. These included locations in the watersheds of DP, Mortandad, Sandia, Twomile, and Water Canyons. The highest concentrations were from a short tributary to Twomile Canyon at TA-3 below large paved areas. Although the main channel of Water Canyon had previously been listed as impaired for zinc by the NMWQCC, the 2007 surface water data did not indicate any concerns with zinc along the main stream in this canyon.

In addition to the metals discussed above, several other metals have some results exceeding screening levels.

For antimony, 5% of the filtered surface water samples from the Pajarito Plateau had concentrations greater than the EPA MCL for drinking water of 6 µg/L. These results were found in several watersheds (Acid, Los Alamos, Mortandad, Pajarito, Sandia, and Twomile Canyons). The highest concentrations were obtained from storm water samples from a short tributary drainage at TA-3 in the Twomile Canyon watershed that receives runoff from a developed area, and the highest frequency of antimony results above the MCL were also from the Twomile Canyon watershed. These samples were all from ephemeral storm water draining TA-3, and all samples downstream along the main Twomile Canyon channel were below the MCL.

For barium, 2% of the filtered surface water samples from the Pajarito Plateau had concentrations greater than the NMWQCC groundwater standard of 1000 µg/L (used as a screening level). All of these results were measured in the Cañon de Valle watershed except one, from a SMA station in the Pajarito Canyon watershed (PJ-SMA-10). Cañon de Valle has been the subject of focused investigations to address barium and HE contamination in surface water and groundwater (LANL 2004b; LANL 2006b), and a corrective measures investigation is planned (LANL 2007a).

For iron, 9% of the filtered surface water samples from the Pajarito Plateau had concentrations greater than the NMWQCC groundwater standard of 1000 µg/L. These results were measured in many watersheds, specifically Acid, DP, Mortandad, Pajarito, Potrillo, Pueblo, Sandia, Ten Site, Threemile, Twomile, and Water Canyons; Cañada del Buey; and Cañon de Valle. Sample locations include site monitoring stations and stream channels in both small and large canyons. Similar to aluminum, the widespread occurrence of elevated iron concentrations suggests that naturally occurring iron dominates these results. The Laboratory is continuing to evaluate the sources of iron in affected watersheds.

For manganese, 14% of the filtered surface water samples from the Pajarito Plateau had concentrations greater than the New Mexico groundwater standard of 200 µg/L. These results were measured in many watersheds, specifically Acid, DP, Mortandad, Los Alamos, Pajarito, Potrillo, Pueblo, Sandia, Threemile, Twomile, and Water Canyons; Cañada del Buey; and Cañon de Valle. Sample locations include site monitoring stations and stream channels in both small and large canyons. As with aluminum and iron, the widespread occurrence of elevated manganese concentrations suggests that naturally occurring manganese dominates these results. The Laboratory is continuing to evaluate the sources of manganese in affected watersheds.

For molybdenum, a single result from filtered storm water at a SMA location in the Mortandad Canyon watershed (M-SMA-1) was greater than the EPA Region 6 tap water screening level of 180 µg/L (EPA 2007), at 268 µg/L, but below the NMWQCC groundwater standard of 1000 µg/L. Three other samples from this SMA and all downstream samples in 2007 were below 180 µg/L. This isolated occurrence indicates that molybdenum is not a significant problem in surface water at LANL.

For silver, 1% of the filtered surface water samples from the Pajarito Plateau had concentrations greater than the screening level of 3.8 µg/L. All of these results were measured from storm water at a site monitoring station in the Cañon de Valle watershed below a former photo-processing facility, CDV-SMA-1.5, indicating localized silver contamination.

One additional metal of concern at LANL is chromium, which is the focus of ongoing investigation because of impacts to groundwater (LANL 2006a; LANL 2007b). Although chromium has been detected at concentrations greater than the EPA MCL for drinking water of 100 µg/L in groundwater beneath the Laboratory, no filtered surface water samples from the Pajarito Plateau in 2007 had chromium results greater than the MCL or the NMWQCC groundwater standard of 50 µg/L.

b. Sediment

During 2007, analytical data on metals in sediment were obtained from 53 samples as part of the annual surveillance program, including 45 samples from the Pajarito Plateau, 2 samples from banks along the Rio Grande, and 6 samples from upriver (Abiquiu) or downriver (Cochiti) reservoirs. The Pajarito Plateau samples included 36 active channel locations typically dominated by coarse-grained sediment and 9 locations where fine-grained sediment was deposited from large floods in 2006.

Twenty metals were detected in sediment at concentrations greater than the LANL background values, although all results are below recreational SSLs. Twelve of the maximum results for these metals were obtained from off-site samples collected from Abiquiu or Cochiti Reservoirs, and differing background conditions along the Rio Grande than on the Pajarito Plateau probably contribute to these elevated values. Five of the maximum concentrations (for barium, copper, lead, manganese, and zinc) were measured in a fine-grained sediment sample from Pajarito Canyon above NM 4. The sediment at this location was primarily deposited in 2000 or 2001 by floods from the Cerro Grande burn area and contains abundant reworked ash, which results in elevated concentrations for many metals (Katzman et al. 2001; LANL 2004a). Two of the maximum concentrations (for antimony and silver) were obtained from small drainages below MDA G at TA-54 within the Pajarito Canyon watershed, although results from samples collected downcanyon along the main stream channel were below the background values. The remaining metal detected above its background value, chromium, had a maximum concentration in upper Sandia Canyon below the wetland. Contaminants in sediment in the Pajarito and Sandia watersheds are currently the subject of more detailed investigations (LANL 2007e; LANL 2007f).



3. Organic Chemicals in Surface Water and Sediment

a. Surface water

During 2007, analytical data for organic chemicals were obtained from 356 surface water sampling events at 126 locations on the Pajarito Plateau, each event consisting of the collection of one or more samples from a specific location. The monitoring included 73 SMAs and 53 canyon bottom sites. The types of organic chemicals analyzed varied depending on the location and included the following suites: dioxins and furans, explosive compounds, herbicides, pesticides, polychlorinated biphenyls (PCBs), semi-volatile organic compounds (SVOCs), total petroleum hydrocarbons-diesel range organics (TPH-DRO), and volatile organic compounds (VOCs). These data were compared to screening levels which vary across the Laboratory depending on the designated uses for a particular stream segment, as discussed in Section C.1. Results were also compared to drinking water and groundwater standards as screening levels because of the potential for infiltration from streams to impact underlying groundwater. All analyses were on non-filtered samples, and comparisons to drinking water or groundwater standards and screening levels are therefore protective, as concentrations for most analytes in filtered samples would be lower. Under the federal Clean Water Act §303(d) list, the NMWQCC has listed parts of three canyons within LANL as impaired for PCBs in the water column: Los Alamos, Pueblo, and Sandia Canyons (NMWQCC 2006). These organic chemicals are discussed below along with other organic chemicals with results greater than screening levels.

Analyses for dioxins and furans were obtained from 49 non-filtered surface water samples collected at 19 canyon bottom locations on the Pajarito Plateau in 2007. One or more dioxin or furan congeners were detected in 18 samples from 9 locations in Los Alamos, Mortandad, Pajarito, Pueblo, Ten Site, and Twomile Canyons. The highest concentrations were measured at a station in lower Twomile Canyon (gaging station E244), which is downstream of locations where dioxins and furans have previously been detected in sediment samples (LANL 2007e); a former incinerator ash pond at TA-69 is a possible source for these chemicals (LANL 1998). Both detections for hexachlorodibenzodioxins, from two separate sampling events in lower Twomile Canyon, exceeded the EPA drinking water screening level of 1.1×10^{-5} µg/L (EPA 2007). However, all results from downstream stations were non-detects, and some of the dioxin and furan detections may represent false positives from the analytical laboratory, as found in groundwater samples from 2006 (Rogers and Vanden Plas 2007).

Analyses for explosive compounds were obtained from 148 non-filtered storm water samples collected at 60 locations on the Pajarito Plateau in 2007. A total of 15 different explosive compounds were detected, and one of these, RDX (“research department explosive”, or hexahydro-1,3,5-trinitro-1,3,5-triazine), had detected results in 10 samples greater than EPA Region 6 tap water screening level of 6.1 µg/L. All RDX results greater than the screening level were collected from the Cañon de Valle watershed, including both SMA stations and the main stream channel. Cañon de Valle is the subject of focused investigations to address barium and HE contamination in surface water and groundwater (LANL 2004b; LANL 2006a), and a corrective measures investigation is planned (LANL 2007a).

Analyses for herbicides were obtained from 22 non-filtered surface water samples collected at 21 canyon bottom locations on the Pajarito Plateau in 2007. No herbicides were detected in these samples.

Analyses for PCBs were obtained from 218 non-filtered surface water samples collected at 77 locations on the Pajarito Plateau in 2007, and 21% of the samples had detected PCBs. The most commonly detected PCBs were Aroclor-1254 and Aroclor-1260, which were detected in 15% and 19% of the samples, respectively. A single detected result was also obtained for Aroclor-1242. All samples with detected PCBs had concentrations above the screening level, including SMAs and canyon bottom locations in the watersheds of Los Alamos, Mortandad, Pajarito, Pueblo, Sandia, Ten Site, and Twomile Canyons. The highest concentrations were measured at SMAs in the Los Alamos, Pueblo, and Sandia Canyon watersheds, and along the stream channel in upper Sandia Canyon. Excavation of PCB-contaminated soil at a former transformer storage area in the Sandia Canyon watershed was conducted in 2001 (LANL 2001a), and an interim measure to address the transport of PCBs in storm water in Los Alamos and Pueblo Canyons was begun in 2008 (LANL 2008).

Analyses for pesticides were obtained from 69 non-filtered surface water samples collected at 35 canyon bottom locations on the Pajarito Plateau in 2007. Pesticides were rarely detected, with only four pesticides detected from four samples at three locations, although three detected results were above screening levels. Both of the detected results for chlordane, from Pueblo Canyon below the Los Alamos County WWTP (Pueblo 3 station), were above the screening level of 0.0081 µg/L. The single detected result for DDT, in lower Effluent Canyon (a tributary to Mortandad Canyon; E1E station), was above the screening level of 0.001 µg/L. However, there were some quality problems with pesticide analyses in water samples in 2007, as discussed in Section G of Chapter 5, and these detected results may in part represent false positives from the analytical laboratory.

Analyses for SVOCs were obtained from 115 non-filtered surface water samples collected at 52 locations on the Pajarito Plateau in 2007. Twenty-two SVOCs were detected in one or more samples from 24 locations. Two SVOCs, benzo(a)anthracene and benzo(b)fluoranthene, each have two results above the EPA Region 6 tap water screening values of 0.92 µg/L, from SMAs in the Pajarito Canyon and Sandia Canyon watersheds. These analytes are commonly detected below urban areas and other developed areas (LANL 2004a). Another SVOC, bis(2-ethylhexyl)phthalate, has three results above the EPA MCL of 6 µg/L. The highest result for bis(2-ethylhexyl)phthalate is from Mortandad Canyon at the Rio Grande, downstream from the community of White Rock and from a stream receiving treated sanitary wastewater from a Los Alamos County WWTP (Cañada del Buey). The second highest result is from a SMA location in the Water Canyon watershed, and the third is from Pueblo Canyon downstream from the other active Los Alamos County WWTP. The sources of the bis(2-ethylhexyl)phthalate are uncertain. All of the SVOCs are infrequently detected at any location, and there were also some quality problems with SVOC analyses in water samples in 2007, as discussed in Section G of Chapter 5, and the detected results may in part represent false positives from the analytical laboratory.

Analyses for TPH-DRO were obtained from 25 non-filtered storm water samples collected at 9 locations on the Pajarito Plateau in 2007. There are no TPH-DRO standards for surface water, but results from three locations are greater than the NMED screening guideline of 1720 µg/L for potable groundwater and below the screening guideline of 30,400 µg/L for inhalation of vapors from shallow groundwater (NMED 2006c). The highest concentration of TPH-DRO was measured at a site monitoring station in upper Sandia Canyon in TA-60 (S-SMA-3.6), and some results from two monitoring stations in the Mortandad Canyon watershed at TA-35 (M-SMA-10.3 and M-SMA-11) were also above the potable groundwater screening guideline. However, there were quality problems with TPH-DRO analyses in water samples in 2007, as discussed in Section G of Chapter 5, and many detected results represent false positives from the analytical laboratory.

Analyses for VOCs were obtained from 53 non-filtered surface water samples collected at 27 canyon bottom locations on the Pajarito Plateau in 2007. Ten VOCs were detected in one or more samples from 22 locations. None of these results exceed standards or screening levels.

b. Sediment

Analytical data on explosive compounds in sediment were obtained from 17 samples in 2007 as part of the annual surveillance program, including 9 samples from active channels on the Pajarito Plateau downgradient from firing sites, 2 samples from banks along the Rio Grande, and 3 samples each from upriver (Abiquiu) and downriver (Cochiti) reservoirs. There were no detected explosive compounds in these samples.

Analytical data on PCBs in sediment were obtained from 42 samples in 2007 as part of the annual surveillance program, including 34 samples from the Pajarito Plateau, 2 samples from banks along the Rio Grande, and 6 samples from Abiquiu and Cochiti Reservoirs. The Pajarito Plateau samples included 25 active channel locations that are typically dominated by coarse-grained sediment and 9 locations where fine-grained sediment was deposited from large floods in 2006. The PCB Aroclor-1242 was detected in 1 sample from the Pajarito Plateau, Aroclor-1254 was detected in 12 samples, and Aroclor-1260 was detected in 19 samples. In addition, Aroclor-1248 was detected in a Rio Grande bank sample near Otowi Bridge, upriver of LANL, and this sample had the highest detected PCB result in the 2007 samples, 0.355 mg/kg. None of the PCB results were greater than recreational or residential screening levels.

On the Pajarito Plateau, PCBs were detected in sediment in the watersheds of Los Alamos, Mortandad, Pajarito, Pueblo, Sandia, and Water Canyons. For total PCBs (the sum of all detected PCBs in each sample), the highest concentrations were measured in Los Alamos Canyon, followed by Pueblo and Mortandad Canyons. The fourth highest concentration was measured in Pueblo Canyon upstream of Acid Canyon, indicating a non-Laboratory source for some of the PCBs.

F. IMPACTS TO THE RIO GRANDE

Potential Laboratory impacts to the Rio Grande were assessed in 2007 by comparing data from sediment samples collected upriver and downriver of LANL. River sediment was collected from the banks of the Rio Grande at the Otowi gage (upriver of LANL) and at the confluence with Frijoles Canyon in Bandelier National Monument (downriver of LANL). Additionally, samples of bottom sediment were collected at three separate locations each in Abiquiu Reservoir (upriver) and in Cochiti Reservoir (downriver). All of these samples were analyzed for the same suite of radionuclides, metals, and organic chemicals.

All measurements of radionuclides in sediments from the Rio Grande and Cochiti Reservoir were orders of magnitude below recreational and residential SALs. In river sediment, no radionuclides were detected above background levels either above or below the Laboratory. Concentrations of one radionuclide from Cochiti Reservoir bottom sediment, plutonium-239/240, were above background levels in two samples. These concentrations were comparable to those measured in previous years after the Cerro Grande fire, slightly elevated above regional background levels resulting from atmospheric fallout (Figure 6-11).

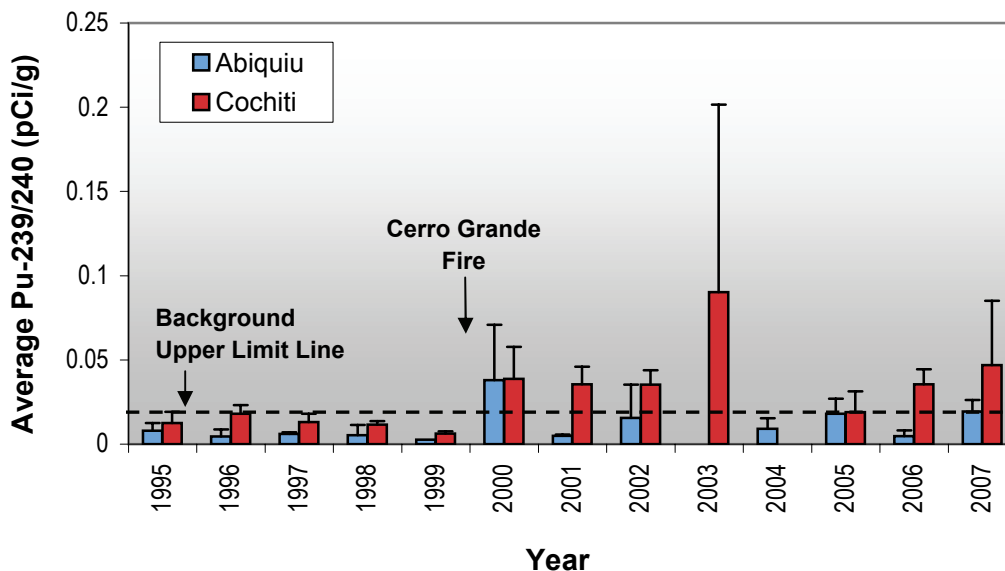


Figure 6-11. Plutonium-239/240 concentration (mean ± 1 standard deviation of results from 3 samples) in Abiquiu and Cochiti Reservoir bottom sediment, 1995-2007.

Concentrations of many metals are elevated in Rio Grande and Cochiti Reservoir bottom sediment relative to background levels in Pajarito Plateau sediment, but these may reflect different background conditions along the Rio Grande than on the plateau or upriver sources. For example, in 2007, the highest concentrations were obtained from Cochiti Reservoir for 11 metals (aluminum, arsenic, beryllium, cadmium, cobalt, iron, magnesium, nickel, potassium, selenium, and vanadium), but if the main source was the Pajarito Plateau, then concentrations should instead be higher on the plateau. Some metals that are elevated in Cochiti Reservoir sediments have similar concentrations in Abiquiu Reservoir sediments, indicating that there is no recognizable Laboratory contribution to the Rio Grande (barium, chromium, copper, nickel, and vanadium). The other metals

with concentrations above background levels in both Pajarito Plateau and Cochiti Reservoir sediment samples (lead, manganese, and zinc) have the highest concentration on the plateau in an ash-rich post-fire sediment sample from Pajarito Canyon; concentrations of many metals have been shown to be elevated in ash, not reflecting Laboratory contributions (Katzman et al. 2001; LANL 2004a).

No explosive compounds were detected in sediment samples from the Rio Grande or from Abiquiu or Cochiti Reservoirs in 2007. PCBs were detected only in a single sample from these sites, collected from the banks of the Rio Grande at Otowi, upriver of LANL. These results indicate that there is no recognizable Laboratory contribution to organic chemicals along the Rio Grande.

Natural stream flow and sediment loading in the Rio Grande are quite large compared to Los Alamos area streams. These factors reduce the possibility of identifying significant impacts from the Laboratory in the Rio Grande. A hydrographic comparison of 2007 flows in Los Alamos area canyons to flows in the Rio Grande is shown in Figure 6-12. Daily average flow in the Rio Grande at the Otowi gage ranged from about 400 to 3700 cfs. In contrast, combined flows from all the Los Alamos area canyons exceeded 5 cfs only on December 1, 2007, when the estimated average daily discharge was 22 cfs. Similarly, the average annual budgets of suspended sediment and bed sediment passing the Otowi gaging station has been calculated to be 1,000 and 100 times, respectively, more than those contributed by Los Alamos Canyon (Graf 1994).

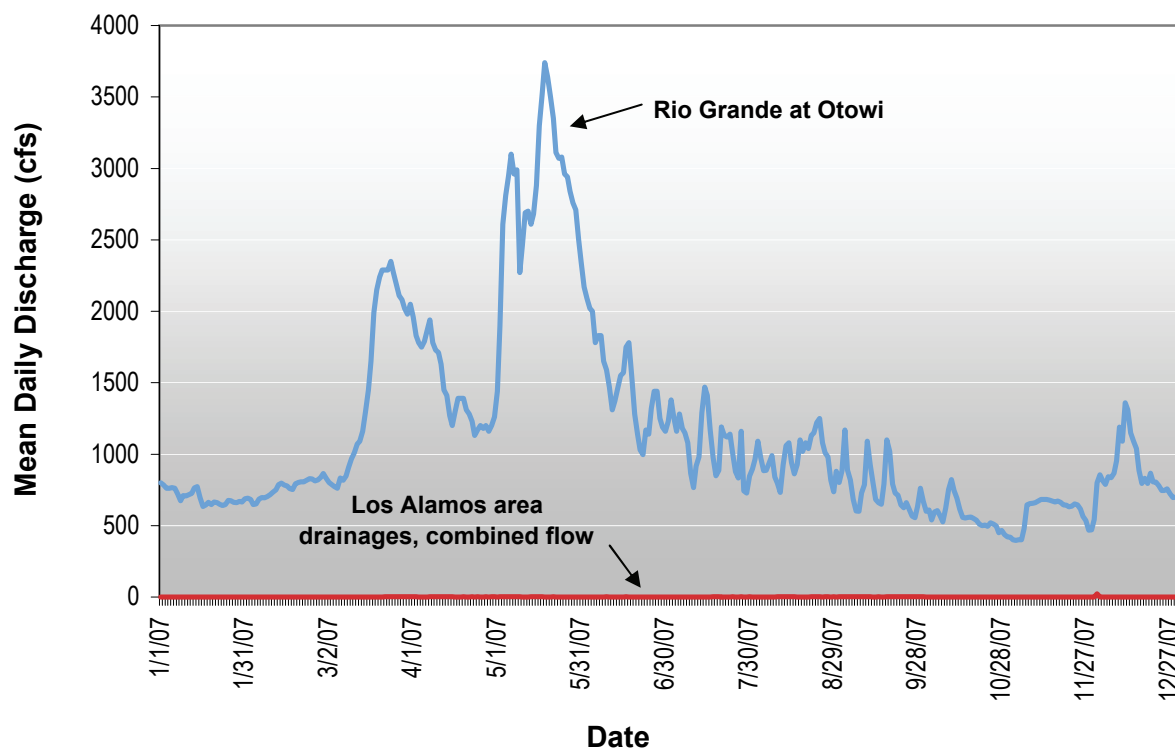


Figure 6-12. Discharge from Los Alamos drainages in 2007 in comparison to discharge in the Rio Grande at Otowi gaging station.

Surface water samples were collected from two locations along the Rio Grande downriver from Los Alamos Canyon in September 2007 for analysis of radionuclides, metals, and organic chemicals. These locations are at a proposed surface water diversion-site for Santa Fe at Buckman (at the mouth of Cañada Ancha), and at the mouth of Frijoles Canyon in Bandelier National Monument. No upriver samples were collected, which prevents a complete evaluation of potential Laboratory impacts, but these data provide an indication of water quality in the Rio Grande near Los Alamos.

The non-filtered surface water sample from Buckman had gross alpha radiation greater than the NMWQCC livestock watering standard of 15 pCi/L, but the downriver station at Frijoles Canyon had gross alpha radiation below the standard. The result from Buckman, 23.5 pCi/L, was less than many samples from canyons on the Pajarito Plateau that are unaffected by Laboratory operations, which range up to 200 pCi/L. Neither sample from the Rio Grande had radionuclide concentrations greater than DOE BCGs.

The surface water samples from the Rio Grande had no concentrations of metals in filtered water above drinking water MCLs, and no concentrations of metals in non-filtered water above screening levels. No explosive compounds, PCBs, or pesticides were detected in these samples. The SVOC bis(2-ethylhexyl)phthalate was detected in non-filtered water from the Frijoles Canyon location, and the VOC methylene chloride was detected in non-filtered water from the Buckman location, but both results were below screening levels.

G. CANYON-SPECIFIC RESULTS

a. Guaje Canyon (includes Barrancas and Rendija Canyons)

Guaje Canyon is a major tributary of Los Alamos Canyon that heads in the Sierra de los Valles and lies north of Laboratory land. The total drainage area above Los Alamos Canyon is about 33 mi² (85 km²), and the stream channel has a length of about 16 mi (25 km). Guaje Canyon and its tributaries have not received any effluents from LANL activities, but contained some firing sites and other locations with potential Laboratory contaminants (LANL 2001b). In 2007, a storm water sample from a gaging station in lower Guaje Canyon (E099) had measured gross alpha radiation of 209 pCi/L, well above the NMWQCC livestock watering standard of 15 pCi/L. This result indicates the pervasive nature of gross alpha radiation above the standard in storm water on the Pajarito Plateau due to the presence of naturally occurring radionuclides. Concentrations of metals in Guaje Canyon storm water in 2007 were below applicable screening levels except for aluminum, which was greater than the screening level of 750 µg/L in a filtered sample. Aluminum results above the screening level are also widespread on the Pajarito Plateau. Mercury was detected above the screening level of 0.77 µg/L at a site-monitoring area in Rendija Canyon adjacent to the Guaje Pines Cemetery and below residential areas. Mercury has also been detected above background levels in sediment samples from this area (LANL 2007d). The source of this mercury is uncertain, and is under continued evaluation. No PCBs or pesticides were detected in Guaje Canyon storm water samples in 2007.

b. Los Alamos Canyon (includes Acid, Bayo, DP, and Pueblo Canyons)

Los Alamos Canyon has a large drainage area that heads in the Sierra de los Valles. Excluding Guaje Canyon and its tributaries, the drainage area is about 28 mi² (72 km²), and the stream channel has a length of about 17 mi (27 km). The Laboratory has used land in the Los Alamos Canyon watershed continuously since the early 1940s with operations conducted at some time in the watersheds of several tributary canyons (Acid, Bayo, DP, and Pueblo Canyons). Several of the canyons within the watershed also receive urban runoff from the Los Alamos town site, and lower Pueblo Canyon receives treated sanitary municipal wastewater from the Los Alamos County WWTP.

Historical releases of radioactive liquid effluents into Acid, DP, and Los Alamos Canyons have introduced americium-241, cesium-137, plutonium-238, plutonium-239/240, strontium-90, and tritium, among other radionuclides, into the canyon bottoms. Most of these radionuclides bind to stream sediment and persist at concentrations well above atmospheric fallout levels. Cesium-137 and plutonium-239/240 are the most important radionuclides in the Los Alamos Canyon watershed from the perspective of potential human health risk, although concentrations are low enough that they do not pose an unacceptable risk to recreational users of the canyons (LANL 2004a; LANL 2005b). Discharges into DP Canyon from a treatment facility at TA-21 between 1952 and 1986 were the main source for cesium-137. Discharges between 1945 and 1964 into Acid Canyon from former TA-1 and former TA-45, located within the current Los Alamos town site, were

the main source for plutonium-239/240. These radionuclides and other contaminants have been transported by floods down these canyons, off-site across Pueblo de San Ildefonso land, and to the Rio Grande near Otowi Bridge (Graf 1994, 1996; Reneau et al., 1998; LANL 2004a). Plutonium-239/240 from historical Acid Canyon discharges has been traced in sediment more than 55 km to lower Cochiti Reservoir (Gallaher and Efurud 2002). A major contaminated sediment removal effort was conducted in Acid Canyon in 2001 to reduce concentrations of plutonium-239/240 in the canyon bottom (Reneau et al. 2002). In 2005, additional stabilization of sediment was performed in Pueblo Canyon to reduce downstream transport of plutonium-contaminated sediment. The installation of 3,000 linear feet of jute matting along channel banks with elevated radionuclide concentrations, and the planting of 3,000 willow stems to provide additional stream bank support, was completed in 2005 (PPWP 2005). Additional actions to reduce the transport of contaminated sediment in the Los Alamos Canyon watershed began in 2008 (LANL 2008).

The highest concentrations of cesium-137 measured in storm water in 2007 within the Los Alamos Canyon watershed were from Los Alamos Canyon above the low-head weir (gaging station E042, 31.4 pCi/L) and lower DP Canyon (gaging station E040, 18.6 pCi/L) (Figure 6-13). These values are well below the maximum measured in 2006, from Los Alamos Canyon below the low-head weir (E050, 87.7 pCi/L). The highest concentrations of plutonium-239/240 measured in storm water within the Los Alamos Canyon watershed were from lower Acid Canyon (gaging station E056, 34.7 pCi/L) and lower Pueblo Canyon (gaging station E060, 34.3 Ci/L) (Figure 6-14). These values are also well below the maximum concentration measured in 2006, from a hillside monitoring station in Los Alamos Canyon (LA-SMA-6.3, 117 pCi/L). Measured concentrations of both cesium-137 and plutonium-239/240 in 2007 were much lower in lower Los Alamos Canyon near the Rio Grande (gaging station E110) than upstream on LANL land. At E110, plutonium-239/240 was detected in one of two samples, at 1.13 pCi/L, and cesium-137 was not detected in either sample.

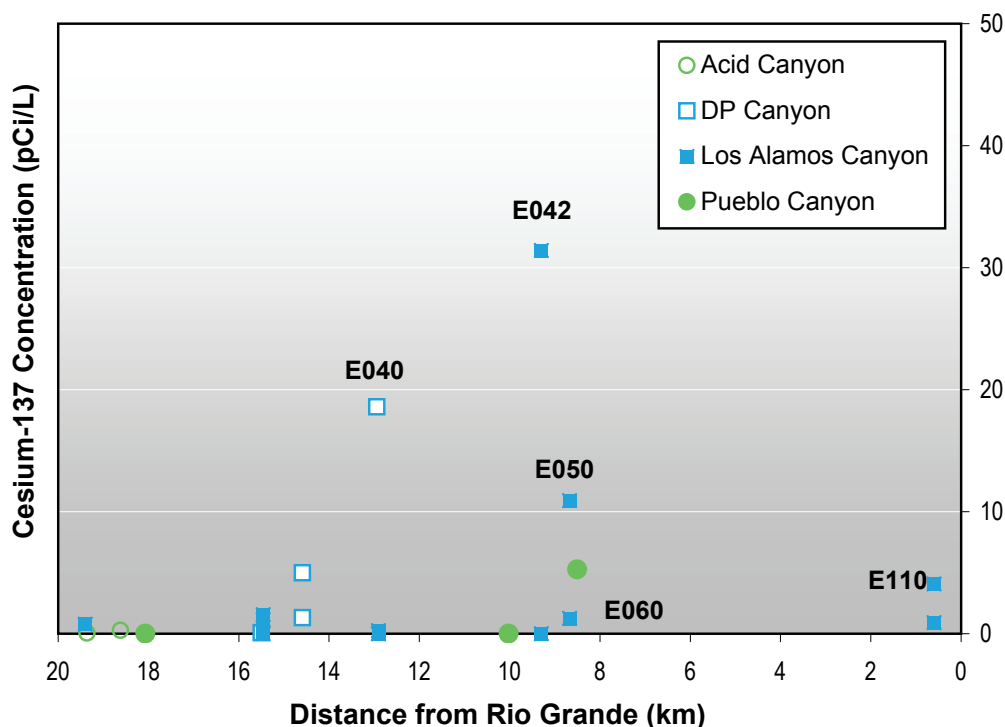


Figure 6-13. Spatial variations in cesium-137 concentration in non-filtered surface water samples from the Los Alamos Canyon watershed in 2007; values below 8 pCi/L are non-detects.

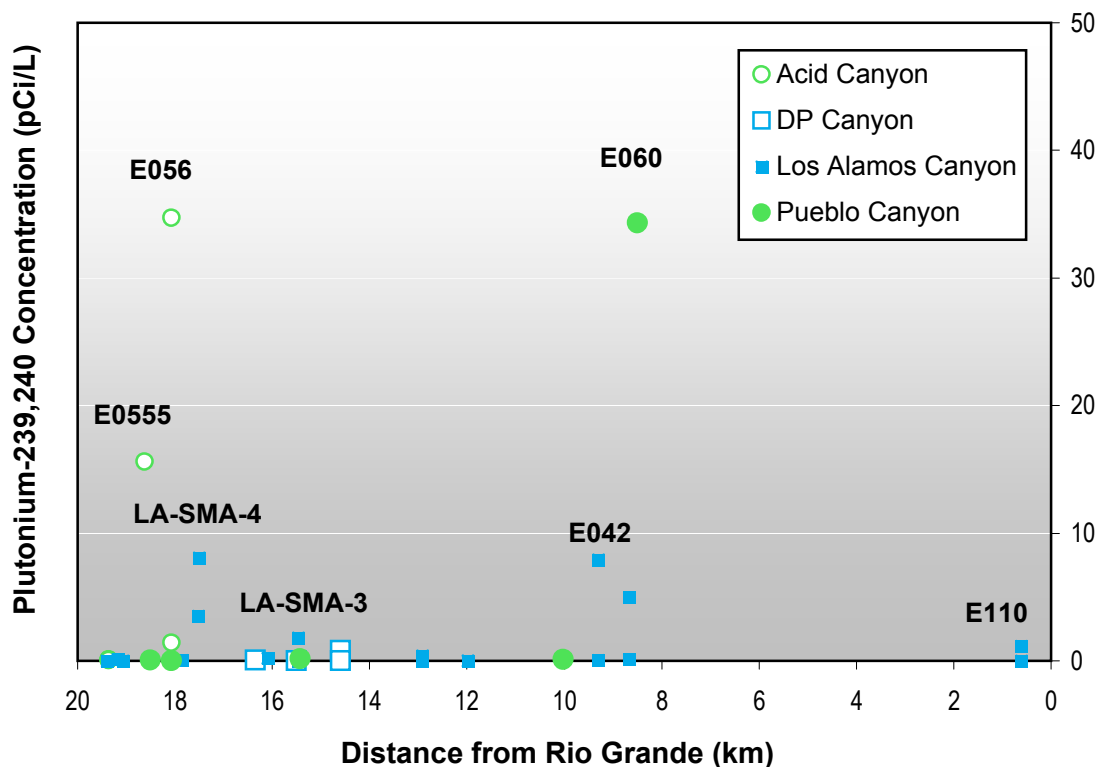


Figure 6-14. Spatial variations in plutonium-239/240 concentration in non-filtered surface water samples from the Los Alamos Canyon watershed in 2007; the average detection limit for these samples is about 0.03 pCi/L.

The annual time-weighted average concentrations of radionuclides are well below the BCGs in non-filtered surface water collected from Acid, DP, Los Alamos, and Pueblo Canyons (Table 6-2). When the mixture of radionuclides is considered (see discussion in D.4), surface water along the stream channels in these canyons ranged from 1% to 41% of the BCGs, with the highest percentage in lower Pueblo Canyon and the lowest in Los Alamos Canyon at the Rio Grande. The largest contribution to the value from lower Pueblo Canyon is radium-226, a naturally-occurring radionuclide.

The transport of PCBs in storm water is also of concern in the Los Alamos Canyon watershed, and an interim measure has been proposed to mitigate this transport (LANL 2008). In 2007, the highest concentrations of PCBs in storm water were detected at a hillside monitoring station in Los Alamos Canyon below former Manhattan Project facilities in what is now the Los Alamos town site (LA-SMA-2) (Figure 6-15). Concentrations at downstream gaging stations were much lower. The highest detected concentration of PCBs at LANL in the 2007 surveillance sediment samples were also in Los Alamos Canyon, from a fine-grained floodplain deposit above NM 4 resulting from the large flood of August 6, 2006. This result, 0.0362 mg/kg, is the sum of detected Aroclor-1254 and Aroclor-1260 concentrations; concentrations are well below recreational SSLs for these PCBs (6.65 and 10.5 mg/kg, respectively).

Plutonium-239/240 is the most important radionuclide in Pueblo Canyon from the perspective of potential human health risk (LANL 2004a), and plutonium-239/240 concentrations in sediment transported by floods today are much less than concentrations during the period of active releases of radioactive effluent into Acid Canyon from 1945 to 1964. Figure 6-16 shows variations in plutonium-239/240 concentration in active channel sediment in lower Pueblo Canyon between ca. 1950 and 2007, extending the record presented previously (LANL 2004a; Reneau et al. 2004) with data from more recent surveillance sediment samples. As shown in the previous studies, plutonium-239/240 concentrations were much higher prior to 1965, and since that time have shown no distinct trends. The year-to-year variations seen in these samples may be due at least in part to variability in silt and clay percentages, as there are strong relations between sediment particle size and contaminant concentration (LANL 2004a; Reneau et al. 2004).

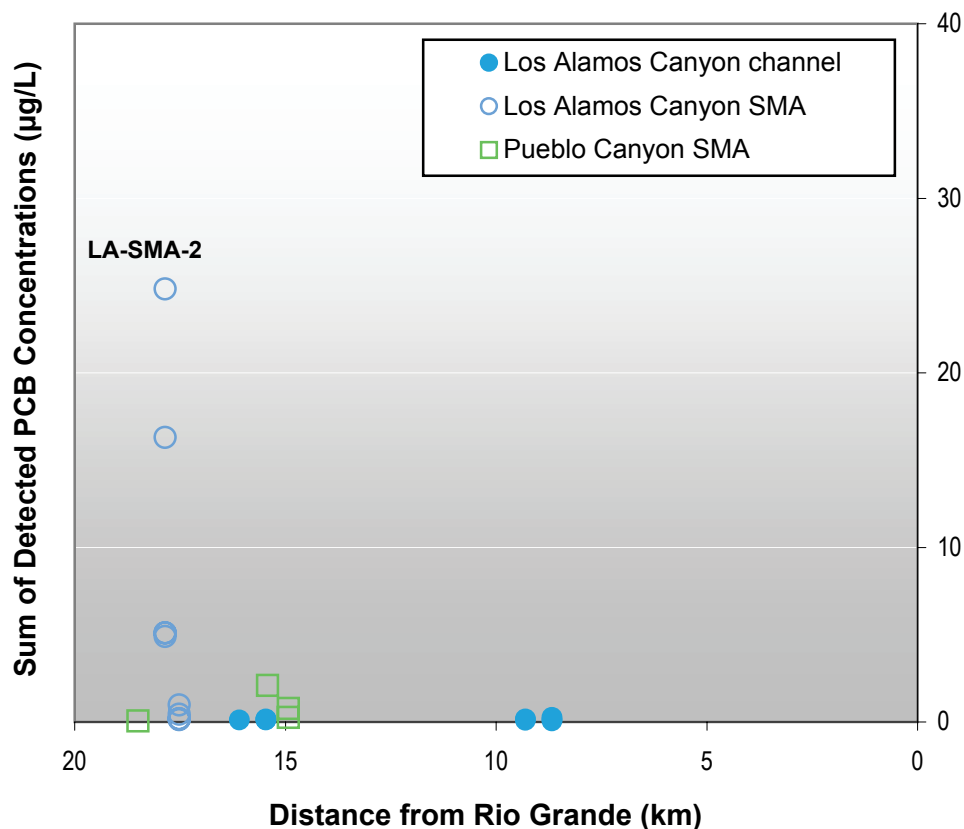


Figure 6-15. Spatial variations in detected PCB concentration in non-filtered surface water samples from the Los Alamos Canyon watershed in 2007.

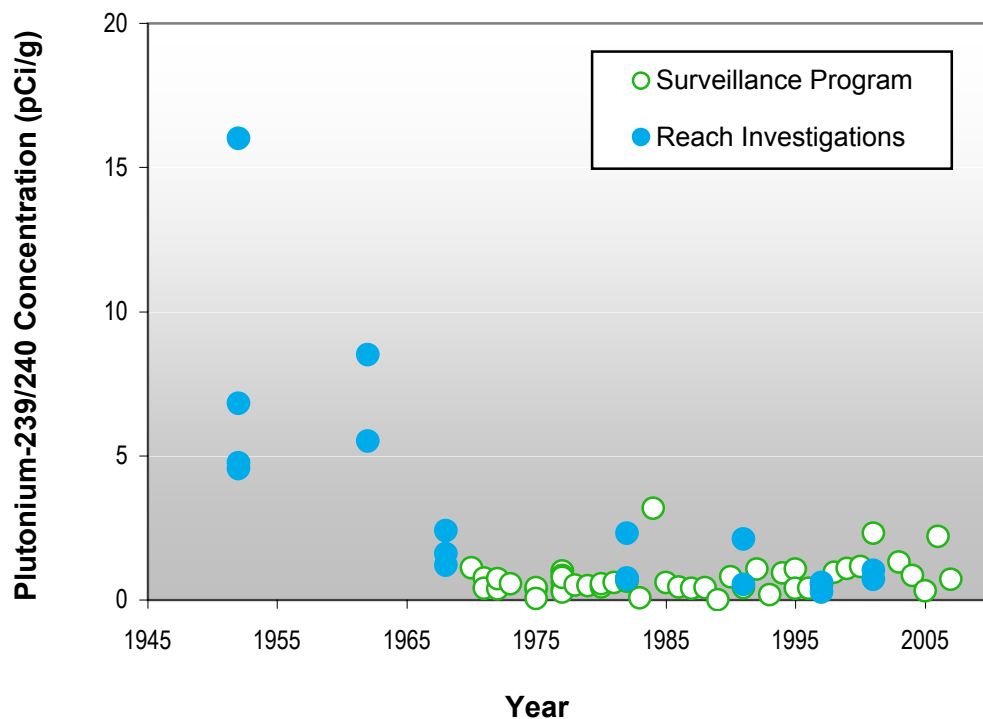


Figure 6-16. Variations in plutonium-239/240 concentration over time in active channel sediment in lower Pueblo Canyon; all results are detects and most are above the background value of 0.068 pCi/g.

In lower Acid Canyon, analyses of active channel sediment samples show an overall decrease in plutonium-239/240 concentrations between 1970 and 2007 (Figure 6-17, modified from LANL 2004a and Reneau et al. 2004), with inter-year and intra-year variability also seen. Downstream in lower Los Alamos Canyon, analyses of active channel sediment samples indicate no trends in plutonium-239/240 concentrations between 1977 and 2007, although inter-year and intra-year variability is also seen here (Figure 6-18). The variability between samples in these figures may also be due in part to differences in silt and clay content between samples. All concentrations in these figures are less than the recreational and residential SALs of 300 and 33 pCi/g, respectively.

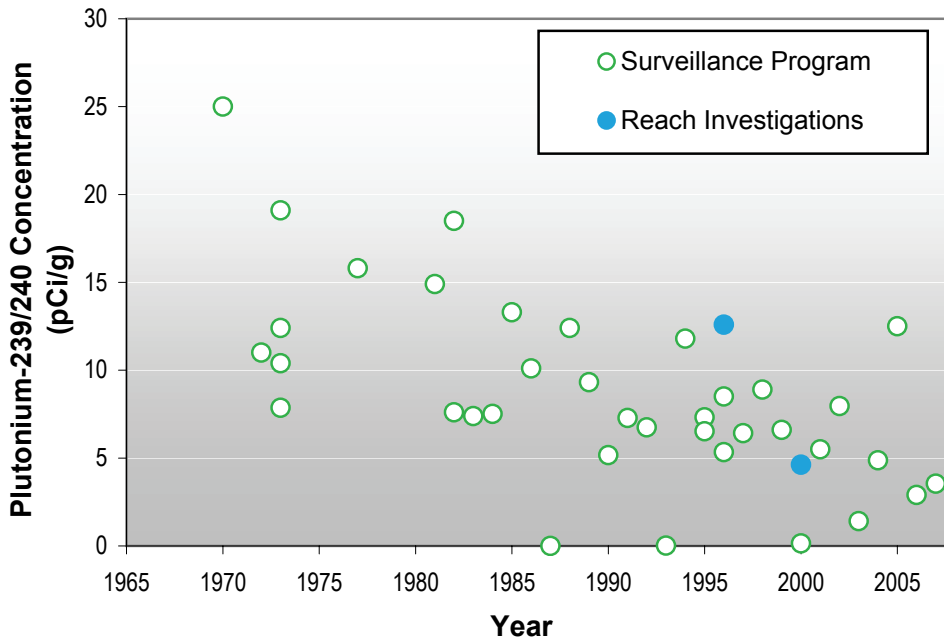


Figure 6-17. Variations in plutonium-239/240 concentration over time in active channel sediment in lower Acid Canyon; most values are detects and are above the background value of 0.068 pCi/g.

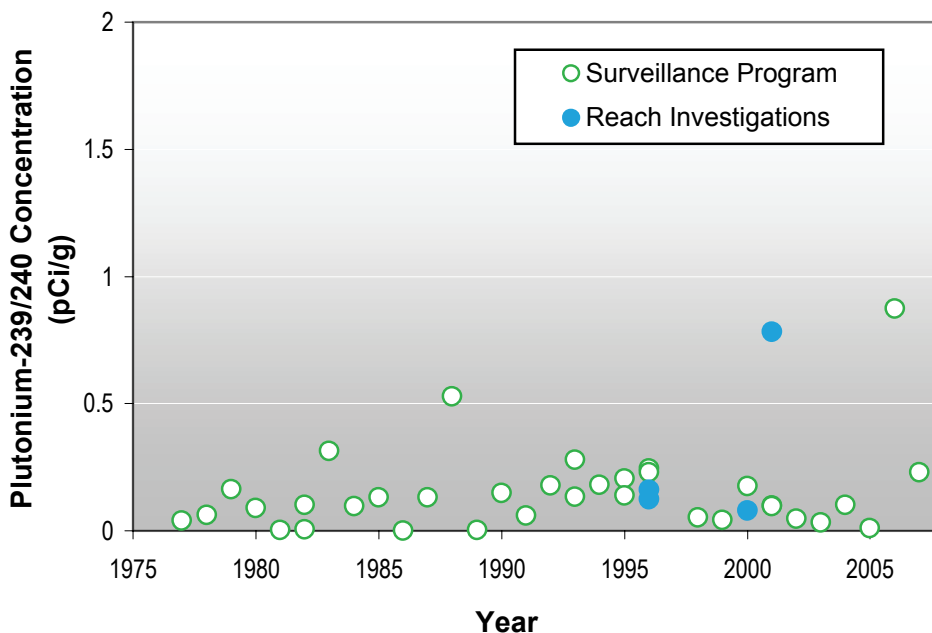


Figure 6-18. Variations in plutonium-239/240 concentration over time in active channel sediment in lower Los Alamos Canyon near the Rio Grande; most values are detects and are above the background value of 0.068 pCi/g.

Two samples of fine-grained sediment deposited on the lower Pueblo Canyon floodplain by the record flood of August 8, 2006, were collected to evaluate how plutonium-239/240 concentrations in floodplain sediment resulting from this flood compared to the active channel sediment and to older floodplain deposits. These samples, with 61% and 85% silt plus clay, contained roughly twice as much plutonium-239/240 as the active channel sample with 24% silt plus clay (1.3-1.6 pCi/g vs. 0.7 pCi/g). In comparison, fine-grained sediment deposited on the active floodplain of lower Pueblo Canyon between roughly 1945 and 1964 averaged about 35 pCi/g plutonium-239/240, and between roughly 1965 and 1985 averaged about 6.6 pCi/g (Reneau et al. 2004). Concentrations of plutonium-239/240 in sediment transported in suspension by floods in lower Pueblo Canyon are therefore decreasing over time. Plutonium-239/240 concentrations in fine-grained sediment sampled in 2007 also decrease downstream, as found in previous years (LANL 2004a), averaging about 0.36 pCi/g in lower Los Alamos Canyon near the Rio Grande.

Cesium-137 is the most important radionuclide in Los Alamos Canyon from the perspective of potential human health risk (LANL 2004a). Cesium-137 concentrations in sediment transported by recent floods are much less than concentrations measured during the period of active releases of radioactive effluent into DP Canyon from 1952 to 1986. Figure 6-19 plots cesium-137 concentrations in samples from the active channel of lower DP Canyon since 1971, and shows that concentrations have been relatively low and constant since about 1989. Figure 6-20 plots cesium-137 concentrations in samples from the active channel of Los Alamos Canyon above NM 4 since 1968, and shows that concentrations have been relatively low and constant since about 1993. Downstream, all samples from the active stream channel in Los Alamos near the Rio Grande have had cesium-137 concentrations below the background value of 0.9 pCi/g since 2001.

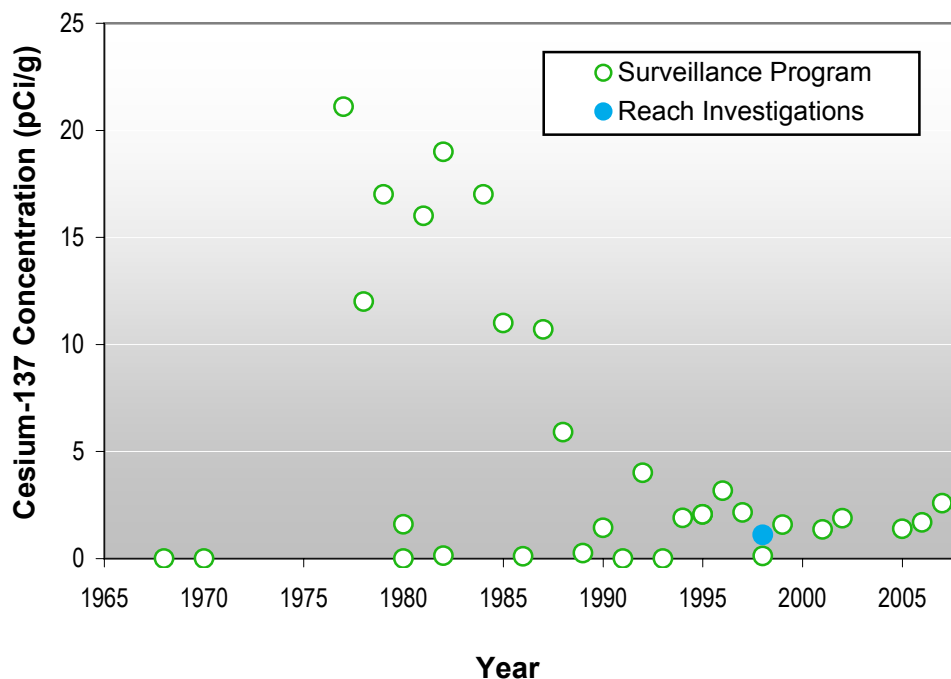


Figure 6-19. Variations in cesium-137 concentration over time in active channel sediment in lower DP Canyon; most values are detects and are above the background value of 0.9 pCi/g.

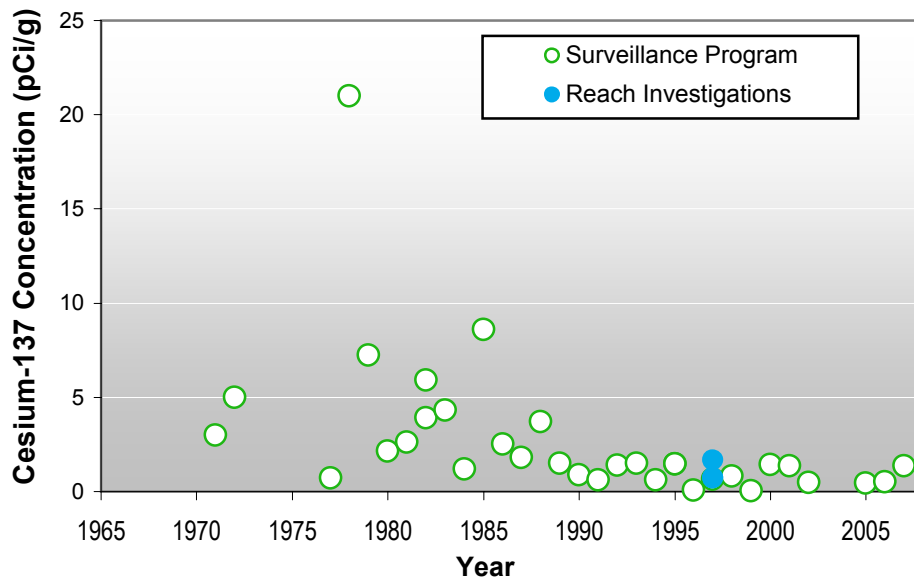


Figure 6-20. Variations in cesium-137 concentration over time in active channel sediment in Los Alamos Canyon above NM 4; all values are detects and most are above the background value of 0.9 pCi/g.

c. Sandia Canyon

Sandia Canyon heads on the Pajarito Plateau within the Laboratory's TA-3 and has a total drainage area of about 5.5 mi² (14 km²) and a channel length of about 11 mi (18 km). This relatively small drainage extends eastward across the central part of the Laboratory and crosses Bandelier National Monument and Pueblo de San Ildefonso land before ending at the Rio Grande. Effluent discharges from a sanitary wastewater treatment plant, supplemented by releases from a steam plant, create perennial flow conditions along a two-mile reach below TA-3. Surface flow rarely extends past the Laboratory boundary, and no runoff event was recorded at the E125 gaging station above NM 4 in 2007. Two contaminants that have been of concern in Sandia Canyon are chromium and PCBs. Chromium was discharged in water from the TA-3 power plant from 1956 to 1972, and is the focus of extensive ongoing investigations related to groundwater contamination (LANL 2006a; LANL 2007b). PCBs were released from a former transformer storage area at TA-3, and were the target of remediation activities involving excavation of soil near the source (LANL 2001a). Contaminant concentrations in sediment deposits decrease downstream from TA-3, and relatively low levels of contaminants are present above NM 4, adjacent to the eastern Laboratory boundary (LANL 2007f).

Chromium concentrations in Sandia Canyon storm water are much higher in non-filtered samples than filtered samples, indicating that it is largely associated with suspended sediment particles. Relatively high chromium concentrations were measured in 2007 at two gaging stations along the main stream channel, E123 and E124, and higher concentrations were measured in one sample from a SMA adjacent to the firing range in TA-72 (S-SMA-6; Figure 6-21). No samples were collected farther downstream because all flow completely infiltrated into the alluvium before the next downstream gaging station above NM 4 (E125). All filtered surface water samples from the Sandia Canyon watershed in 2007 had chromium concentrations below the EPA MCL 100 µg/L and below the NMWQCC groundwater standard of 50 µg/L.

The concentrations of detected PCBs in Sandia Canyon storm water are highest at the upstream gaging stations E123 and E121, below and above the wetland, respectively. PCBs are also relatively high at one downcanyon SMA monitoring area in TA-72 (S-SMA-6), as also seen for chromium (Figure 6-22). As with chromium, no samples were collected farther downstream because flow had completely infiltrated into the alluvium before the next downstream gaging station above NM 4 (E125).

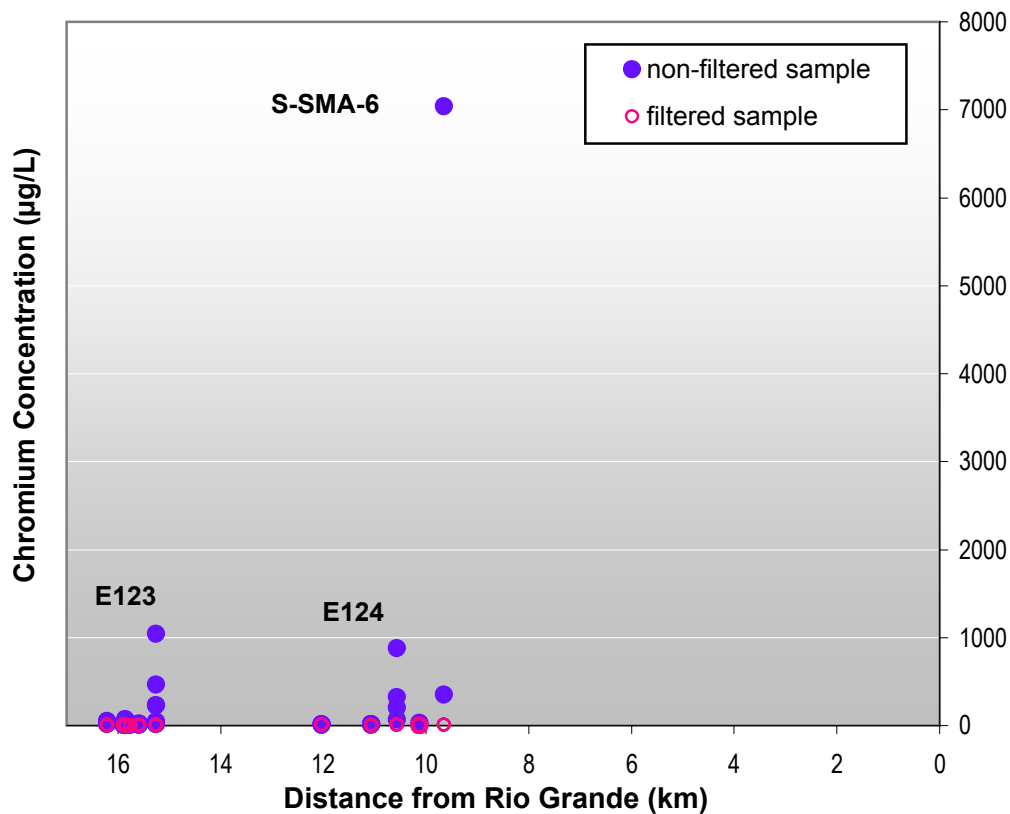


Figure 6-21. Spatial variations in chromium concentration in surface water samples from the Sandia Canyon watershed in 2007; all values above 10 µg/L are detects.

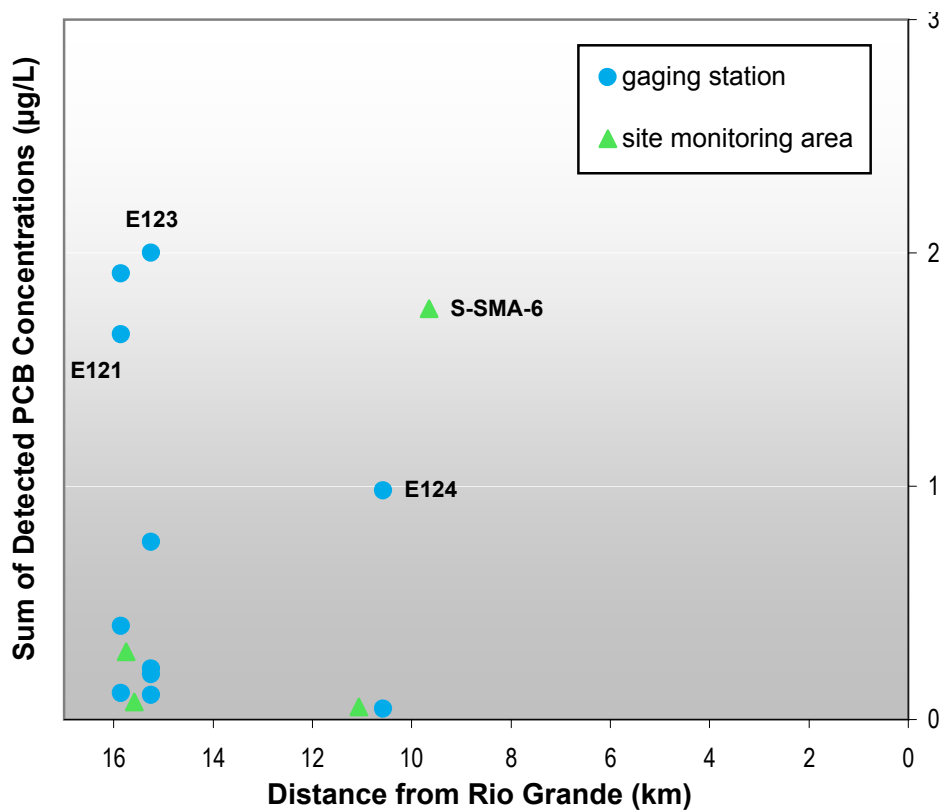


Figure 6-22. Spatial variations in total detected PCB concentration in surface water samples from the Sandia Canyon watershed in 2007.

The highest concentrations of mercury and selenium measured in non-filtered storm water at the Laboratory in 2007 were in samples collected from the Sandia Canyon watershed. Mercury results above the screening level of $0.77 \mu\text{g/L}$ were measured at two gaging stations along the main stream channel (E123 and E124), and at the same SMA where elevated values of chromium and PCBs were measured (S-SMA-6; Figure 6-23). Mercury is also elevated in the north fork of Sandia Canyon (gaging station E121), but below the screening level. Selenium results above the screening level of $5 \mu\text{g/L}$ were measured in one sample each from S-SMA-6 and gaging station E122 in the south fork of Sandia Canyon.

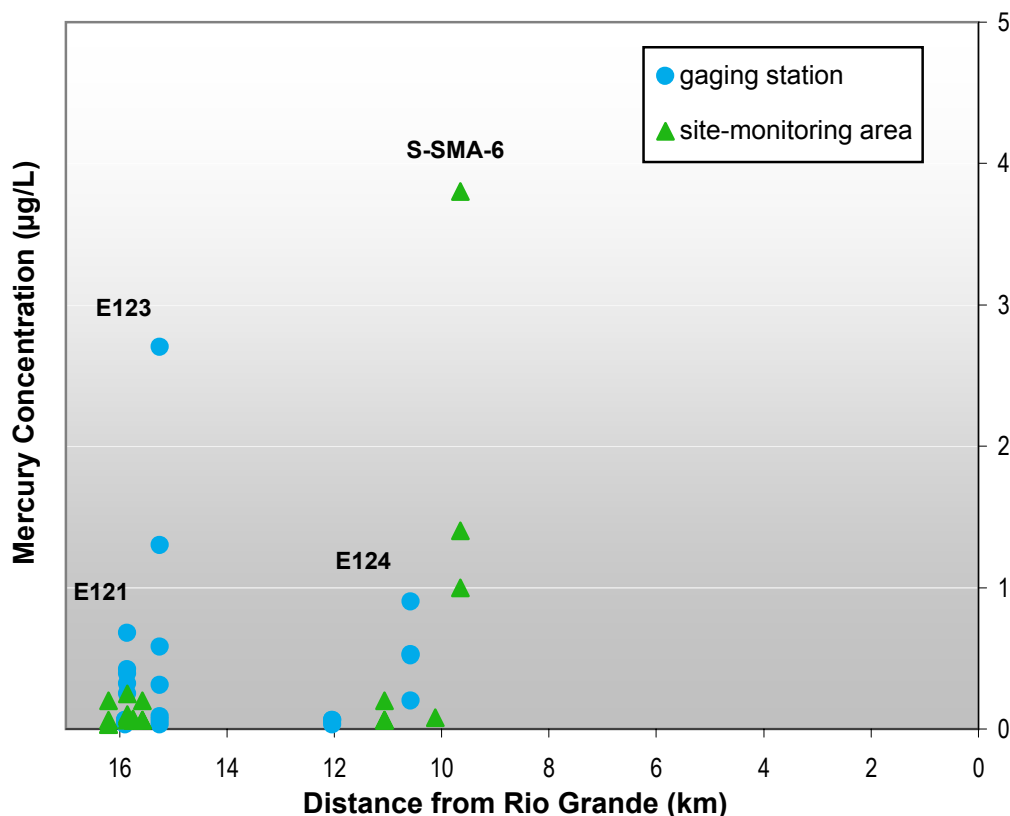


Figure 6-23. Spatial variations in mercury concentration in non-filtered surface water samples from the Sandia Canyon watershed in 2007; all values above $0.2 \mu\text{g/L}$ are detects.

Active channel sediment collected in the upper portion of Sandia Canyon below the wetland contained chromium above background levels (19.4 mg/kg vs. 10.5 mg/kg for the upper level of background), but downstream samples from the Laboratory boundary and the Rio Grande had chromium within background ranges. Low concentrations of PCBs were detected in the active channel below the wetland (0.0070 mg/kg) and at the Laboratory boundary (0.0023 mg/kg), but PCBs were not detected from the Sandia Canyon channel at the Rio Grande. These concentrations of chromium and PCBs are well below recreational SALs.

d. Mortandad Canyon (includes Cañada del Buey and Effluent, Pratt, and Ten Site Canyons)

Mortandad Canyon heads on the Pajarito Plateau in the main Laboratory complex at TA-3, and crosses Pueblo de San Ildefonso land before reaching the confluence with the Rio Grande. It has a total drainage area of about 10 mi^2 (27 km^2) and a main channel length of about 10 mi (16 km). Mortandad Canyon receives treated water discharged into Effluent Canyon from the TA-50 RLWTF. No runoff events have crossed the Laboratory boundary in Mortandad Canyon proper since a stream gage was installed in 1993, and the only reported event that crossed the boundary occurred in 1952 (LANL 2006c). The Mortandad Canyon sediment traps are located approximately two miles upstream of the Laboratory's eastern boundary, and in most years, including 2007, runoff events have not extended past here.

Cañada del Buey is a major tributary that heads in TA-63 and passes through the community of White Rock and Pueblo de San Ildefonso land before reaching the confluence with Mortandad Canyon near the Rio Grande. It has a drainage area of about 4 mi² (11 km²) and a main channel length of about 8 mi (13 km). Runoff events have crossed the Laboratory boundary in Cañada del Buey every year since a gaging station (E230) was established above NM 4 in 1994, although in most years flow has not been recorded at the next upstream station (E225), indicating that the runoff originates in the lower part of the watershed.

The highest concentrations of several radionuclides in surface water samples collected at the Laboratory in 2007 were measured in the Mortandad Canyon watershed, including americium-241, cesium-137, plutonium-238, plutonium-239/240, and tritium. The highest concentrations for all these radionuclides were along the stream channel downstream from the TA-50 RLWTF outfall, between Effluent Canyon and the sediment traps. As an example, the spatial distribution of plutonium-239/240 results in the Mortandad Canyon watershed is shown in Figure 6-24. The annual time-weighted average concentrations of radionuclides are well below the BCGs in non-filtered surface water collected from Mortandad Canyon below Effluent Canyon (Table 6-2). When the mixture of radionuclides is considered (see discussion in D.4), the surface water here was at 19% of the BCGs.

Stream sediment in Mortandad Canyon downstream of Effluent Canyon to near regional well R-28 (1 km above the LANL boundary) contains above-background concentrations of radionuclides, with concentrations decreasing to at or near background levels at the Laboratory boundary (LANL 2006c). Mortandad Canyon had the highest concentrations at the Laboratory of five radionuclides in the sediment samples collected in 2007: americium-241, cesium-137, plutonium-238, plutonium-239/240, and strontium-90. All of these concentrations were below the recreational SALs.

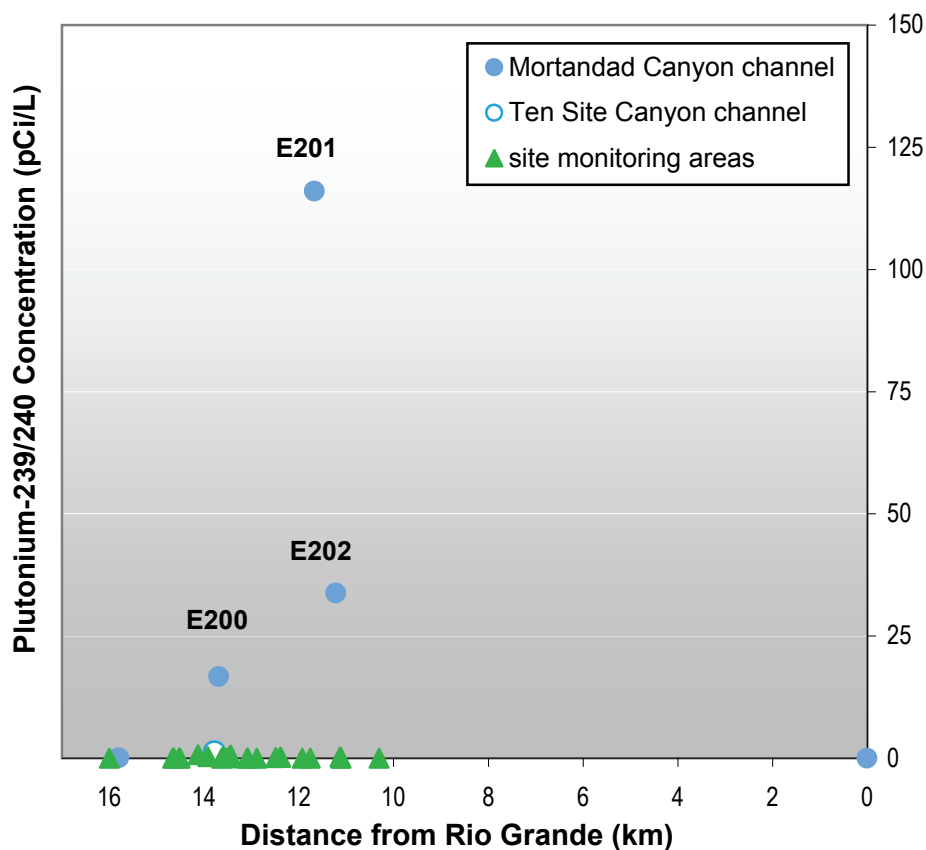


Figure 6-24. Spatial variations in plutonium-239/240 concentration in surface water samples from the Mortandad Canyon watershed in 2007; most values are detects.

Cesium-137 is the most important radionuclide in Mortandad Canyon from the perspective of potential human health risk (LANL 2006c). Cesium-137 concentrations in sediment transported by recent floods are much less than concentrations measured during the period of peak releases of radioactive effluent from the RLWTF into Effluent Canyon prior to 1980. Figure 6-25 plots cesium-137 concentrations in samples from the active channel of Mortandad Canyon below Effluent Canyon since 1972 (updated from LANL 2006c), and shows that concentrations have been relatively low and constant since about 1983, below the recreational SAL of 210 pCi/g. Similar trends are present for other radionuclides in Mortandad Canyon (LANL 2006c).

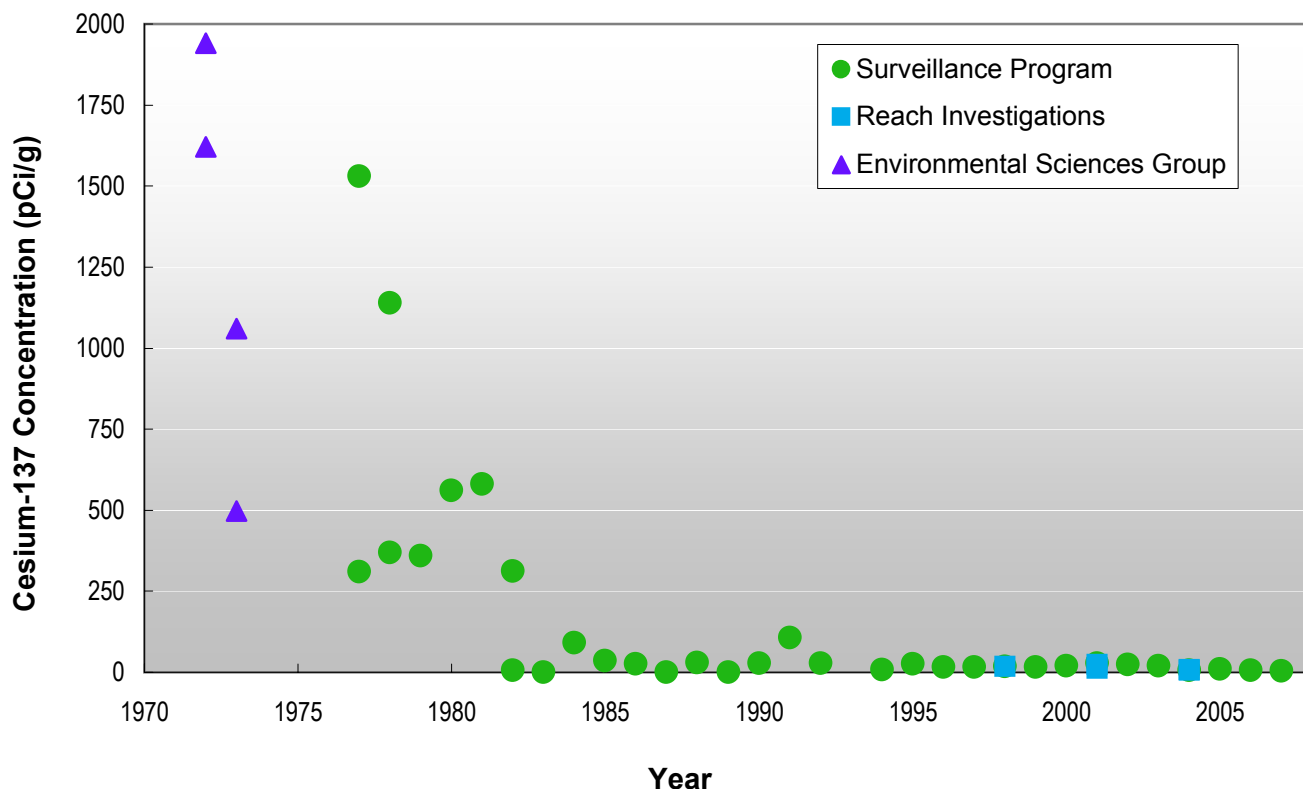


Figure 6-25. Variations in cesium-137 concentration over time in active channel sediment in Mortandad Canyon below Effluent Canyon; most values are detects and are above the background value of 0.9 pCi/g.

Concentrations of radionuclides are higher in fine-grained sediment transported in suspension in floods than in coarse-grained sediment transported along the stream bed. Fine-grained sediment deposited in the Mortandad Canyon sediment traps during the record flood of August 25, 2006, was sampled to help evaluate changes in radionuclide concentration over time. Figures 6-26 to 6-28 show estimated average concentrations of five radionuclides over time in fine-grained sediment deposits in Mortandad Canyon near the confluence with Ten Site Canyon, including the area of the sediment traps, extending the record presented in a previous study (LANL 2006c; each value on these plots is the average of multiple individual samples). For cesium-137 and strontium-90, radionuclides with relatively short half-lives, concentrations are shown adjusted for radioactive decay both for 2008 (the year of this report) and for the time of deposition. All five radionuclides show similar trends, with the highest concentrations between the late 1960s and the mid-1980s, much lower and gradually decreasing concentrations since about 1987, and the lowest concentrations in the August 2006 flood deposits. Figures 6-27 and 6-28 show the significant decreases in the concentrations of cesium-137 and strontium-90 that have occurred over time due to radioactive decay.

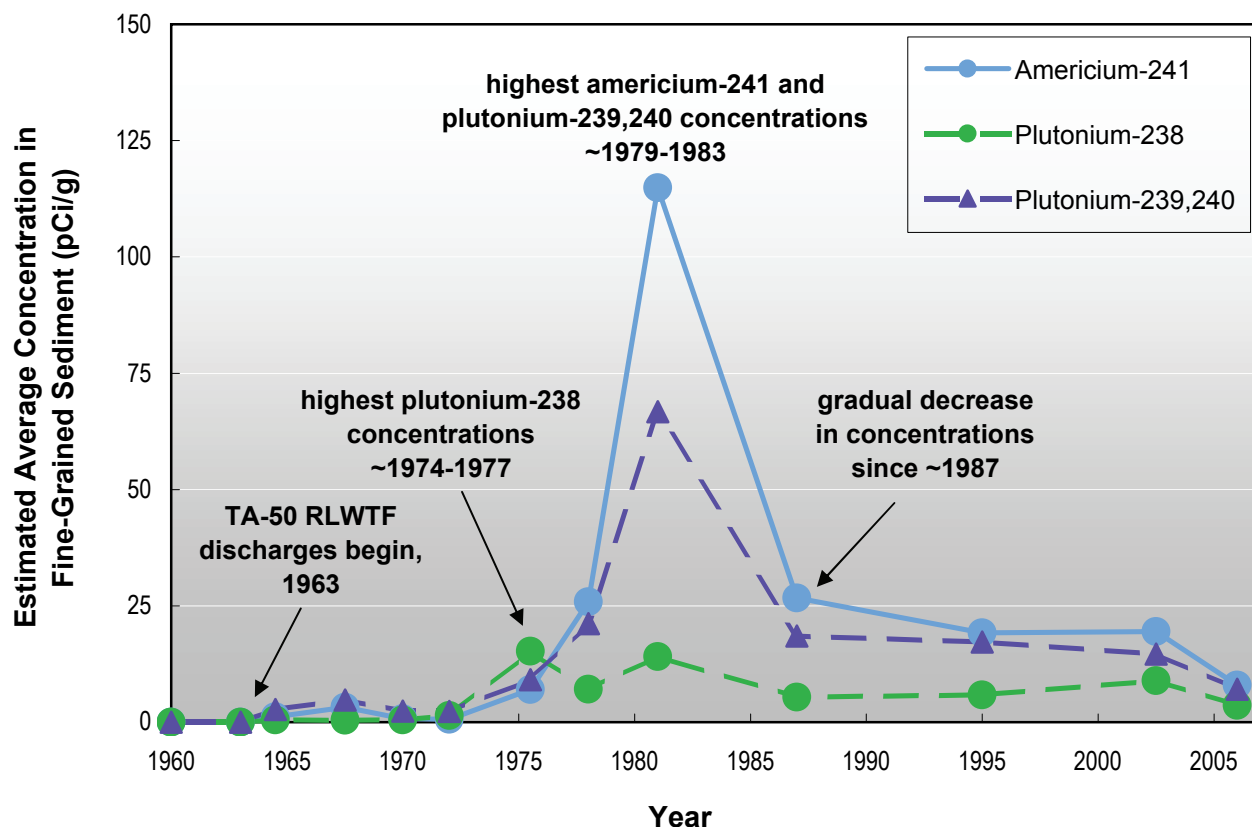


Figure 6-26. Variations in the concentrations of americium-241, plutonium-238, and plutonium-239/240 in fine-grained sediment in Mortandad Canyon near the confluence with Ten Site Canyon, plotted against year.

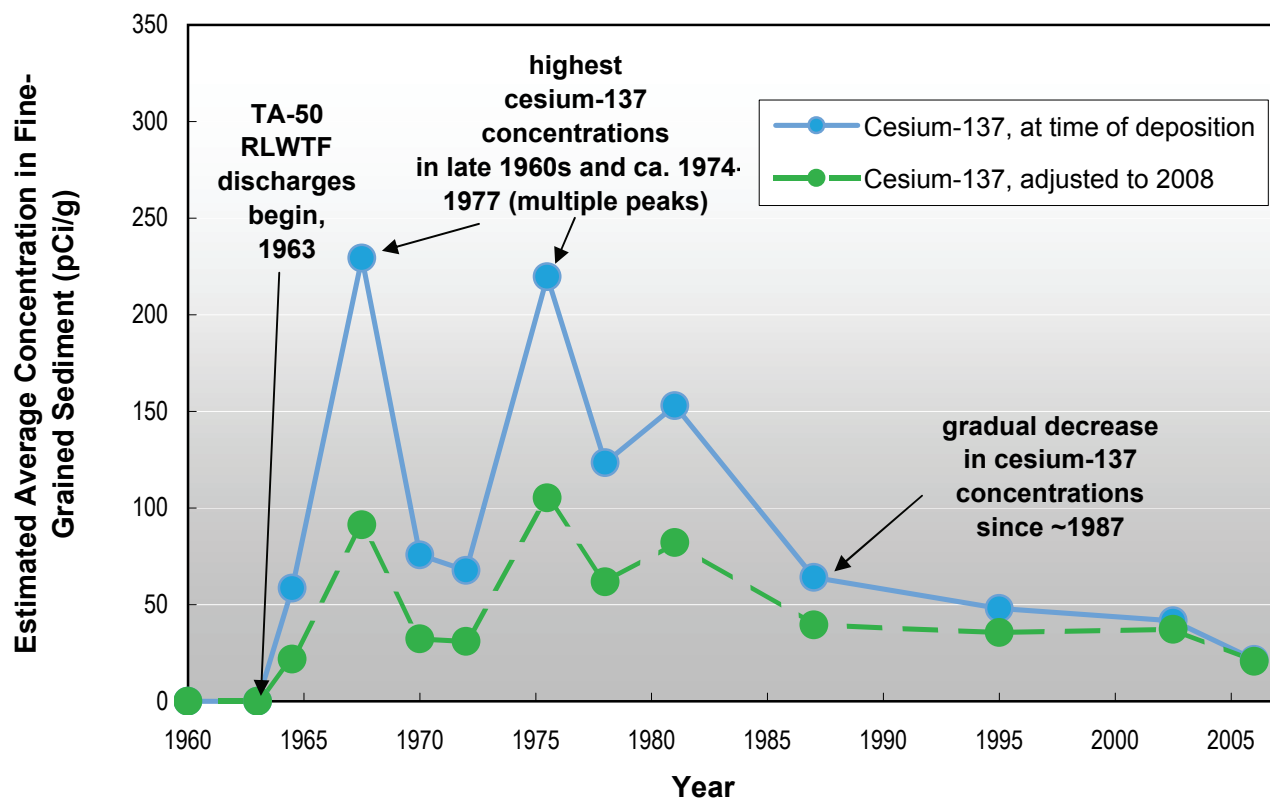


Figure 6-27. Variations through time in the concentrations of cesium-137 in fine-grained sediment in Mortandad Canyon near the confluence with Ten Site Canyon.

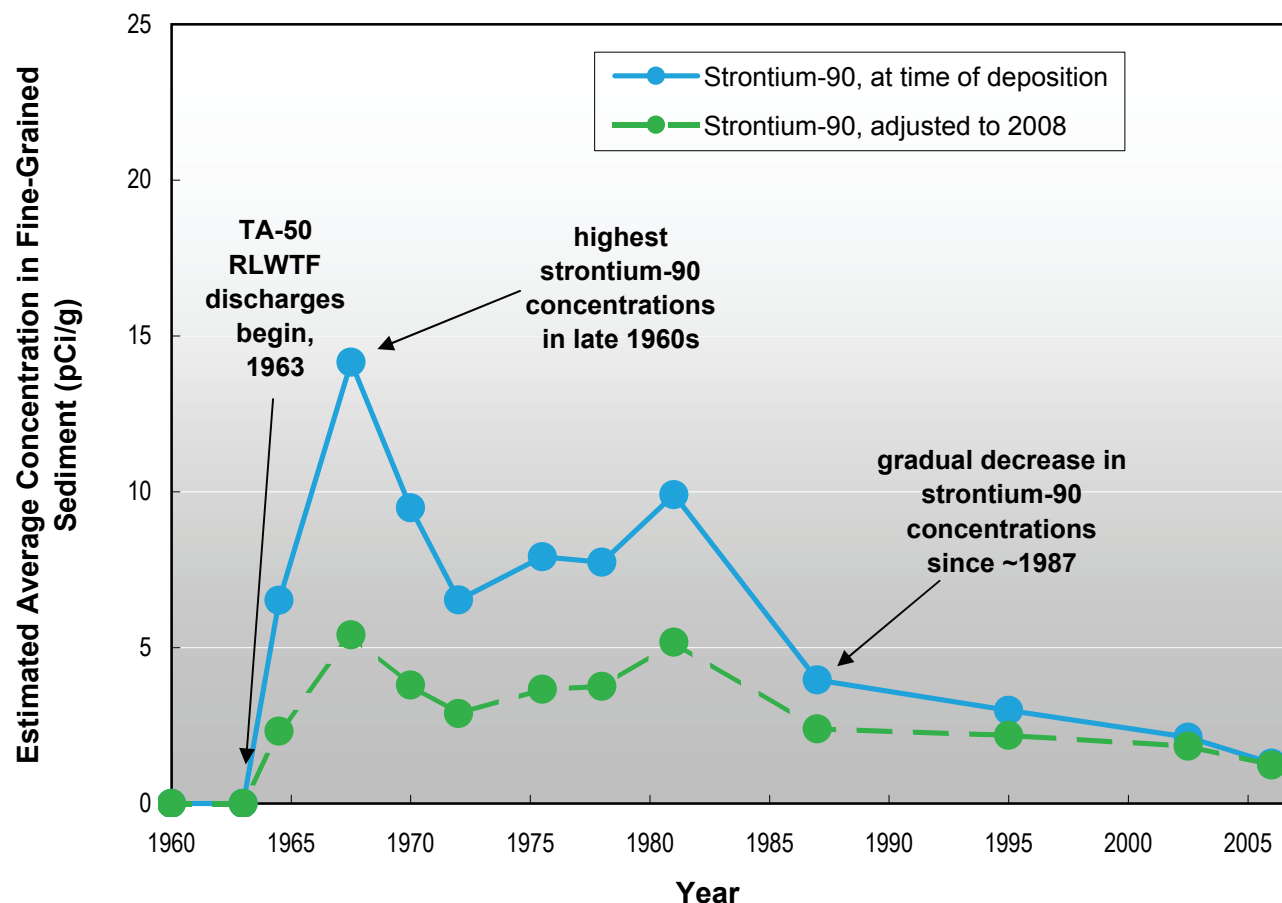


Figure 6-28. Variations through time in the concentrations of strontium-90 in fine-grained sediment in Mortandad Canyon near the confluence with Ten Site Canyon.

The highest concentrations of arsenic measured in filtered surface water at the Laboratory in 2007 were in samples collected from the head of Ten Site Canyon below MDA C, in TA-50. Arsenic concentrations at this location were above the screening level of 9 $\mu\text{g/L}$ in three out of four samples, with a maximum sample result of 20.3 $\mu\text{g/L}$. However, all concentrations measured downstream were below 9 $\mu\text{g/L}$, indicating little chance for impacts to groundwater.

Several radionuclides were measured at low concentrations above background levels in sediment in small drainages below MDA G in the Cañada del Buey watershed, specifically americium-241, plutonium-238, and plutonium-239/240. Concentrations for these radionuclides in 2007 were all less than 2 pCi/g, which is consistent with previous years. All results are well below the recreational and residential SALs. None of these radionuclides were detected above background levels downstream in the active channel of Cañada del Buey.

e. Pajarito Canyon (includes Twomile and Threemile Canyons)

Pajarito Canyon heads in the Sierra de los Valles in the Santa Fe National Forest, and crosses the central part of the Laboratory before passing through the community of White Rock east of NM 4. It has a total drainage area of about 13 mi² (33 km²) and a main channel length of about 15 mi (24 km). Major tributary canyons include Twomile Canyon, which also heads in the Sierra de los Valles, and Threemile Canyon, which heads on the Pajarito Plateau. The Pajarito Canyon watershed includes a variety of active and inactive Laboratory sites, which are discussed in an earlier report (LANL 1998).

Uranium-238 was measured at concentrations above the DOE BCG of 200 pCi/L in two storm water samples from a site monitoring location in the Threemile Canyon watershed in 2007 (3M-SMA-0.6), located at a firing site in TA-15 (Figure 6-29). Except for this one SMA, all other locations in the Pajarito Canyon watershed had low levels of uranium-238 and other uranium isotopes in surface water, including stations downstream of this SMA.

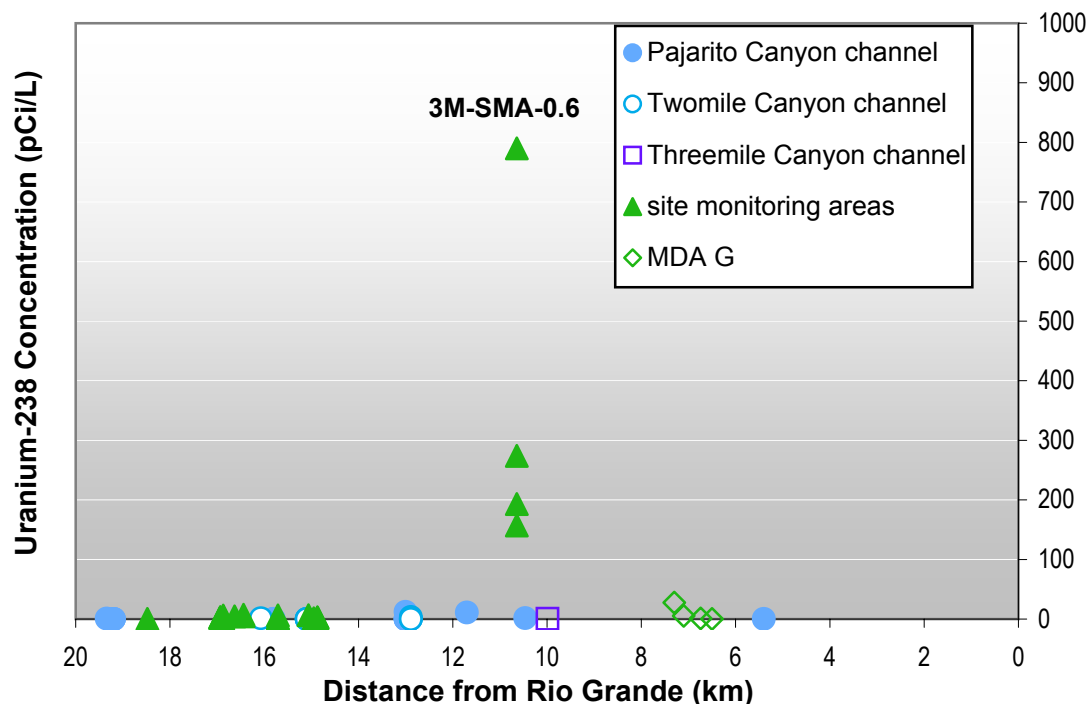


Figure 6-29. Spatial variations in uranium-238 concentration in surface water samples from the Pajarito Canyon watershed in 2007; most values are detects.

Copper was measured at concentrations greater than the screening level of 14 $\mu\text{g/L}$ in filtered surface water collected from the Pajarito, Threemile, and Twomile Canyon watersheds in 2007, consistent with results from previous years (Gallaher 2007). The highest concentrations were measured from SMAs in TA-22 (PJ-SMA-5), TA-40 (PJ-SMA-10), and TA-15 (3M-SMA-0.6), and in a tributary channel to Twomile Canyon at TA-3 (E243.5) (Figure 6-30). Concentrations east of the confluence of Pajarito and Threemile Canyons were all less than the screening level.

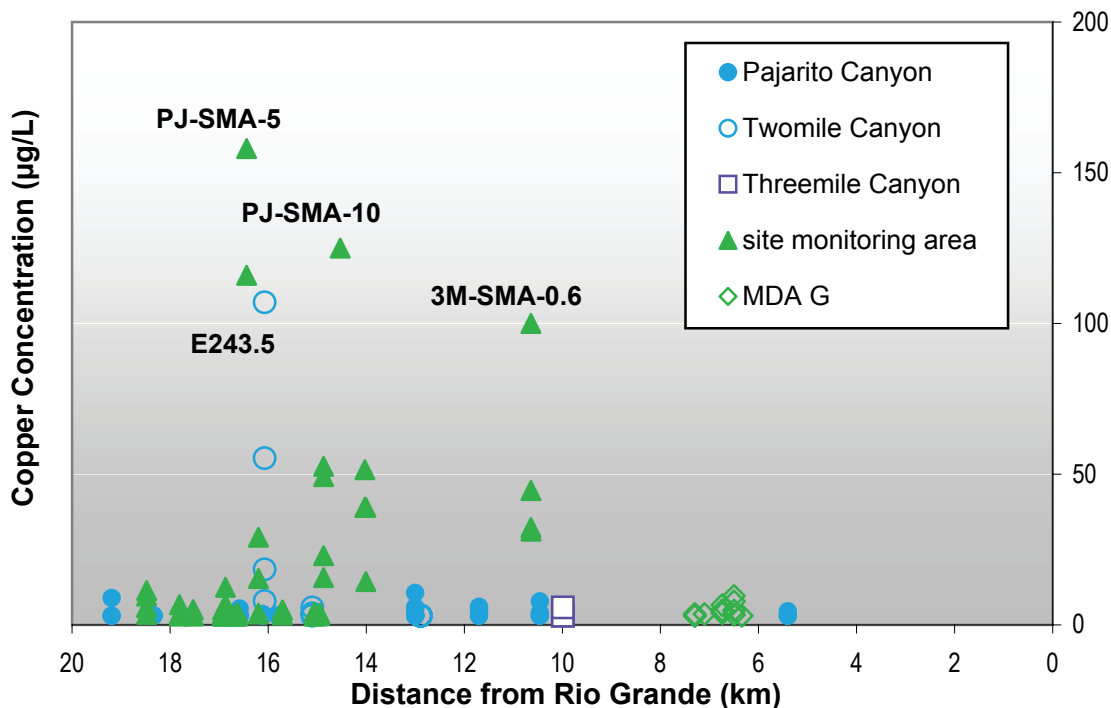


Figure 6-30. Spatial variations in copper concentration in surface water samples from the Pajarito Canyon watershed in 2007; all values above 3 $\mu\text{g/L}$ are detects.

One sample from 3M-SMA-0.6 had the highest lead concentration measured in filtered surface water at the Laboratory in 2007, 26.3 µg/L, which is above the EPA MCL for drinking water of 15 µg/L. Three other samples from this location in 2007 had lead concentrations below the MCL. All flow at this location is ephemeral, and all samples from downcanyon locations had lead below the MCL, indicating little chance for impacts to groundwater. Samples from another of these locations, E243.5, had the highest antimony concentration measured in filtered surface water at the Laboratory in 2007, 104 µg/L, also greater than the EPA MCL for drinking water of 6 µg/L. Three other samples from this location in 2007 also had antimony concentrations above the MCL. However, all flow at this location is ephemeral, and all samples from downcanyon locations had antimony less than the MCL, indicating little chance for impacts to groundwater.

The highest concentrations of dioxins and furans in storm water measured at the Laboratory in 2007 were in samples from lower Twomile Canyon above Pajarito Canyon, at gaging station E244. Dioxins and furans had previously been measured in sediment deposits farther west in Twomile Canyon (LANL 2007e), and a possible source is a former incinerator ash pond at TA-69 (LANL 1998). Concentrations measured downstream in Pajarito Canyon above NM 4 were less than 1/10th those measured in Twomile Canyon.

Consistent with past years, americium-241, plutonium-238, plutonium-239/240, and tritium concentrations were measured above background levels in sediment samples from channels in the Pajarito Canyon watershed draining MDA G at TA-54. Americium-241, cesium-137, and plutonium-239/240 were also detected above background levels downstream in Pajarito Canyon above NM 4, but this was from an ash-rich sample deposited soon after the Cerro Grande fire; concentrations of fallout radionuclides are elevated in ash from the Cerro Grande burn area (Katzman et al. 2001; LANL 2004a), and these results therefore do not necessarily indicate Laboratory impacts. All of the radionuclides were at concentrations below recreational and residential SALs.

The highest concentrations of antimony and silver in the 2007 surveillance sediment samples were measured in drainages below MDA G at TA-54 in the Pajarito Canyon watershed. Antimony was above the background value of 0.83 mg/kg in 2007 in the MDA G-7 drainage (1.95 mg/kg), but was within the background range in 2006 at this location. Silver was above the background value of 1 mg/kg in 2007 in the MDA G-6 retention pond, and was also elevated here in 2006. Silver concentrations were somewhat less in 2007 (2.02 vs. 3.39 mg/kg). These concentrations are all below recreational and residential SSLs.

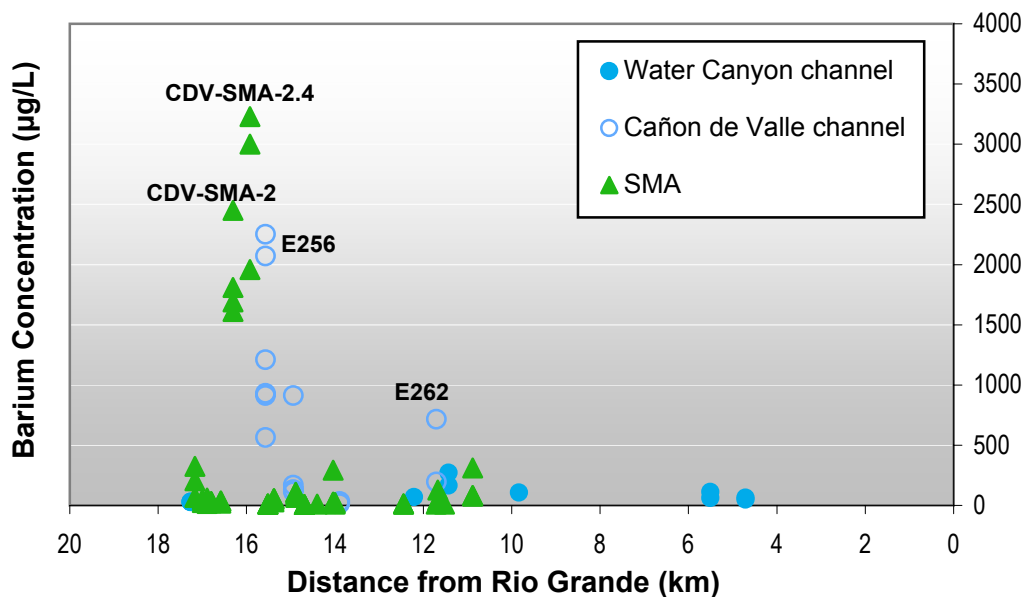
f. Water Canyon (includes Cañon de Valle and Fence, Indio, and Potrillo Canyons)

Water Canyon heads in the Sierra de los Valles in the Santa Fe National Forest and extends across the southern portion of the Laboratory to the Rio Grande. It has a total drainage area of about 19 mi² (49 km²) and a main channel length of about 14 mi (23 km). Cañon de Valle is a major tributary that also heads in the Sierra de los Valles. The Water Canyon watershed also includes the shorter canyons of Fence, Indio, and Potrillo Canyons that head on the Pajarito Plateau within LANL. Explosives development and testing and other activities take place in this part of the Laboratory, and elevated concentrations of uranium isotopes, barium, silver, the HE compounds HMX and RDX, along with other analytes, have previously been measured in sediment and surface water in the watershed (LANL 2006d). Cañon de Valle has been the subject of focused investigations to address barium and HE contamination in surface water and groundwater (LANL 2004b; LANL 2006a), and a corrective measures investigation is planned (LANL 2007a).

The highest concentrations of RDX in surface water at the Laboratory in 2007 were measured in non-filtered samples at two SMAs in the Cañon de Valle watershed in TA-16 (CDV-SMA-2 and CDV-SMA-2.4), in an area where development of explosive compounds has occurred (Figure 6-31). Concentrations are lower downstream along the Cañon de Valle stream channel, and RDX was not detected farther downstream in Water Canyon, which is consistent with analyses from previous years (Gallaher 2007).



Figure 6-32. Spatial variations in barium concentration in filtered surface water samples from the Water Canyon watershed in 2007; all values are detects.



Copper was measured at concentrations above the screening level of 14 $\mu\text{g/L}$ in filtered surface water samples collected from SMAs in the watersheds of Potrillo and Water Canyons and Cañon de Valle in 2007. The highest concentrations of copper in filtered surface water from the Laboratory in 2007 were measured at an SMA at a firing site in the Potrillo Canyon watershed at TA-15 (PT SMA 1) (Figure 6-33). Copper concentrations were also above the screening level at a SMA in the Water Canyon watershed at TA-16 (W-SMA-5). Concentrations in the main stream channels were all less than the screening level.

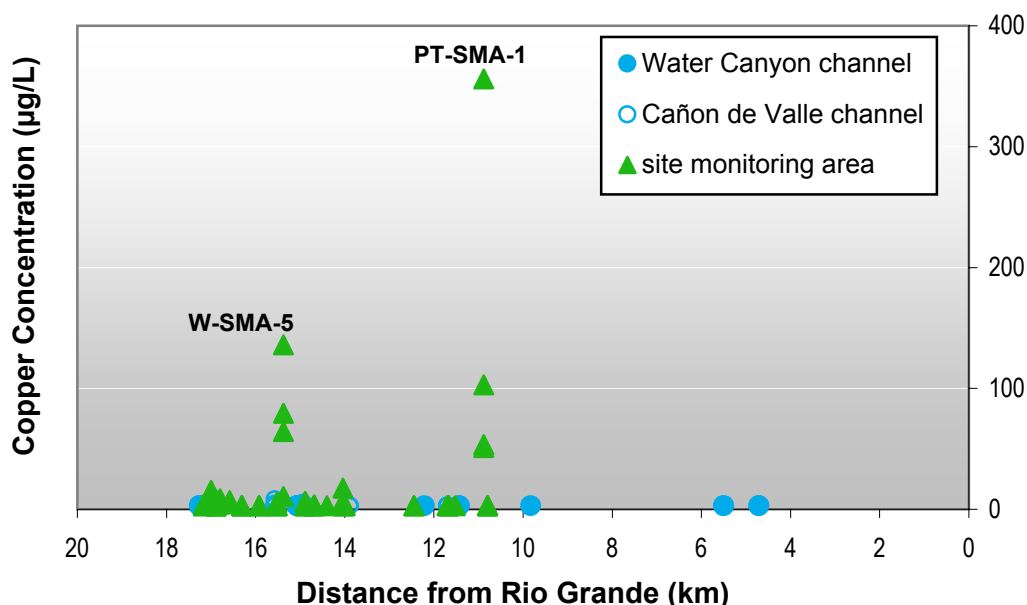


Figure 6-33. Spatial variations in copper concentration in filtered surface water samples from the Water Canyon watershed in 2007; all values above 3 $\mu\text{g/L}$ are detects.

The highest concentrations of silver in filtered surface water from the Laboratory in 2007 were measured at an SMA in the Cañon de Valle watershed at TA-16 (CDV-SMA-1.5), below a former photo-processing facility. Three of the four silver results from this location, 4.6-12.2 $\mu\text{g/L}$, are higher than the screening level of 3.8 $\mu\text{g/L}$. However, surface water here is ephemeral, and silver was not detected in filtered surface water samples downstream along the main channels of Cañon de Valle or Water Canyon.

The highest concentrations of uranium-234 and uranium-238 in surface water from the Laboratory in 2007 were measured at a site monitoring location in the Potrillo Canyon watershed at a TA-15 firing site (PT-SMA-1, 545 and 945 pCi/L, respectively, in the same sample), and were above the DOE BCGs of 200 pCi/L. Surface water is ephemeral here and downstream in Potrillo Canyon, and there is little opportunity for biological exposure from this water. All other uranium concentrations from the Water Canyon watershed in 2007 were less than the BCGs.

Within the Water Canyon watershed, the metals barium and cobalt were detected above background levels in a single surveillance sediment sample in 2007, from Fence Canyon above NM 4. Selenium was also detected above background in this sample and in three other samples from Potrillo and Water Canyons. All of these concentrations are below recreational and residential SSLs. The PCB Aroclor-1260 was detected in one surveillance sediment sample from the Water Canyon watershed in 2007, from the main stream channel of Water Canyon below NM 4, at a concentration below the recreational and residential SSL. No radionuclides were detected at concentrations above background levels in these sediment samples.

g. Ancho Canyon

Ancho Canyon heads on the Pajarito Plateau in TA-49 and extends across the Laboratory to the Rio Grande. It has a total drainage area of about 7 mi² (17 km²) and a main channel length of about 7 mi (12 km). Potential Laboratory sources of contamination in the Ancho Canyon watershed include MDA AB in TA-49, the site of underground testing from 1959 to 1961, and firing sites in the north fork of Ancho Canyon in TA-39 (LANL 2006d). The only analyte of note in surface water samples from this watershed is copper, which was detected above the screening level of 14 µg/L in one filtered storm water sample from a site monitoring location (18.8 µg/L, at A-SMA-2). No metal or radionuclide was detected above background levels in sediment samples from active stream channels in the Ancho Canyon watershed and no explosive compounds were detected.

h. Chaquehui Canyon

Chaquehui Canyon heads on the Pajarito Plateau near the Bandelier National Monument entrance station and extends across the Laboratory to the Rio Grande. It is the smallest of the primary watersheds at LANL, with a total drainage area of about 1.6 mi² (4 km²) and a main channel length of about 3 mi (5 km). Potential Laboratory sources of contamination in the Chaquehui Canyon watershed are located at TA-33, and include firing sites and outfalls (LANL 2006d). The only analyte of note in surface water samples from this watershed is copper, which was detected in three filtered storm water samples from one site monitoring location (CHQ-SMA-6) above the screening level of 14 µg/L (at 46.5 to 59.9 µg/L). The metals nickel and selenium were detected above background levels but below recreational and residential SSLs in a sediment sample from the active stream channel of Chaquehui Canyon. No radionuclide was detected above background levels in this sediment sample and no explosive compounds were detected.

H. QUALITY ASSURANCE

To process watershed samples, the same quality assurance (QA) protocols and analytical laboratories described in Chapter 5 were used. QA performance for the year is also described in Chapter 5.

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7. Soil Monitoring



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A. INTRODUCTION

A soil sampling and analysis program offers the most direct means of determining the concentrations (activities), distribution, and long-term trends of radionuclides and chemicals around nuclear facilities (DOE 1991). Soil provides an integrating medium that can account for contaminants released to the atmosphere, either directly in gaseous emissions or indirectly from re-suspension of on-site contamination, or through liquid effluents released to a stream that is subsequently used for irrigation on farm lands. Consequently, soil contaminant data may provide information about potential pathways (e.g., soil ingestion, food ingestion, re-suspension into the air, and groundwater contamination) that may deliver radioactive materials or chemicals to humans.

The overall soil surveillance program at Los Alamos National Laboratory (LANL or the Laboratory) consists of

1. An institutional component that monitors soil within and around the perimeter of LANL in accordance with US Department of Energy (DOE) Orders 450.1 (DOE 2003) and 5400.5 (DOE 1993); and
2. A facility component that monitors soil (and sediment) within and around the perimeter of two Laboratory sites:
 - ▣ principal radioactive waste disposal area (Area G) in accordance with DOE Orders 435.1 (DOE 1999a) and M 435.1-1 (DOE 1999b), and
 - ▣ principal explosive test facility (Dual Axis Radiographic Hydrodynamic Test [DARHT]) in accordance with the Mitigation Action Plan (DOE 1996).

The objectives of LANL's soil surveillance program are to determine

1. Radionuclide and chemical (inorganic and organic chemicals) concentrations in soil collected from potentially impacted areas (institution-wide and facility-specific) and compare them to the appropriate soil standards (e.g., regional background levels, screening levels, and DOE standards);
2. Trends over time (i.e., whether radionuclide and chemical concentrations are increasing or decreasing); and
3. The committed effective dose equivalent potentially received by surrounding area residents (see Chapter 3 for the potential radiation doses that individuals may receive from exposure to soil).

B. SOIL COMPARISON LEVELS

To evaluate Laboratory impacts from radionuclides and chemicals in soil, we first compare the analytical results of samples collected from the Laboratory's on-site and perimeter areas with regional background levels. Where the results exceed these background levels, we then compare the concentrations with screening levels (SLs) and, finally, if needed, with the appropriate standard. Descriptions of the levels and/or the standard used to evaluate the results of radionuclides and chemicals in soil are as follows and an overall summary can be found in Table 7-1.

- Regional Statistical Reference Levels: RSRLs are the upper-level background concentration (mean plus three standard deviations = 99% confidence level) for radionuclides and chemicals calculated from soil data collected from regional locations away from the influence of the Laboratory over at least the last five sampling periods. RSRLs, which represent natural and fallout sources, are calculated as data become available and can be found in the supplemental data tables of this report.
- Screening Levels: SLs for radionuclides are set below the DOE single-pathway dose limit of 25 mrem/yr (DOE 1993, DOE 1999c) so that potential concerns may be identified in advance, i.e., a "yellow flag." If a radionuclide exceeds the SL, we investigate the basis for the exceedance. LANL developed SLs to identify radionuclides of potential concern on the basis of a 15-mrem/yr protective dose limit for several scenarios (LANL 2005) using the residual radioactive (RESRAD) computer model (Yu et al. 1995). We compare chemicals to the New Mexico Environment Department (NMED) SLs that are set at a 10^{-5} risk level for carcinogens and a hazard quotient (HQ) of 1 for non-carcinogens (NMED 2006). To evaluate these constituents in the most conservative manner, the values from perimeter and on-site areas are compared to SLs based on a residential scenario.
- Standard: If an SL for a radionuclide is exceeded, then a dose to a person is calculated using RESRAD and all of the measured radionuclide concentrations available from supplemental data Table S7-1. The calculated dose is based on a residential scenario with soil ingestion, inhalation of suspended dust, external irradiation, and ingestion of homegrown fruits and vegetables as the exposure pathways. Unit conversions, input parameters, model and parameter assumptions, and the uncertainty analysis we used are presented in Fresquez et al. 1996. This calculated dose is compared to the 25-mrem/yr DOE dose constraint standard.

Table 7-1
Application of Soil Standards and Other Reference Levels to LANL Monitoring Data

| Constituent | Sample Location | Standard | Screening Level | Background Level |
|---------------|--------------------------------|------------|-------------------------------------|------------------------|
| Radionuclides | Perimeter, On-site, and Area G | 25 mrem/yr | 15 mrem/yr (resident) | RSRL |
| | DARHT | 25 mrem/yr | 15 mrem/yr (resident) | RSRL/BSRL ^a |
| Chemicals | Perimeter, On-site, Area G | | 10^{-5} risk (resident) or HQ = 1 | RSRL |
| | DARHT | | 10^{-5} risk (resident) or HQ = 1 | RSRL/BSRL ^a |

^a Baseline Statistical Reference Levels (BSRL); a discussion of these levels is provided in Section D.3.

C. INSTITUTIONAL MONITORING

1. Monitoring Network

Institutional surface soil samples are collected from 17 on-site, 11 perimeter, and six regional (background) locations on a triennial basis (every third year) (Figure 7-1). Our last soil survey, which included the analysis of radionuclides, target analyte list (TAL) inorganic elements, polychlorinated biphenyls (PCBs), semi-volatile organic compounds (SVOCs), and high explosives (HE), occurred in 2006 (Fresquez 2007a). The next planned full-scale institutional soil assessment will occur in 2009.

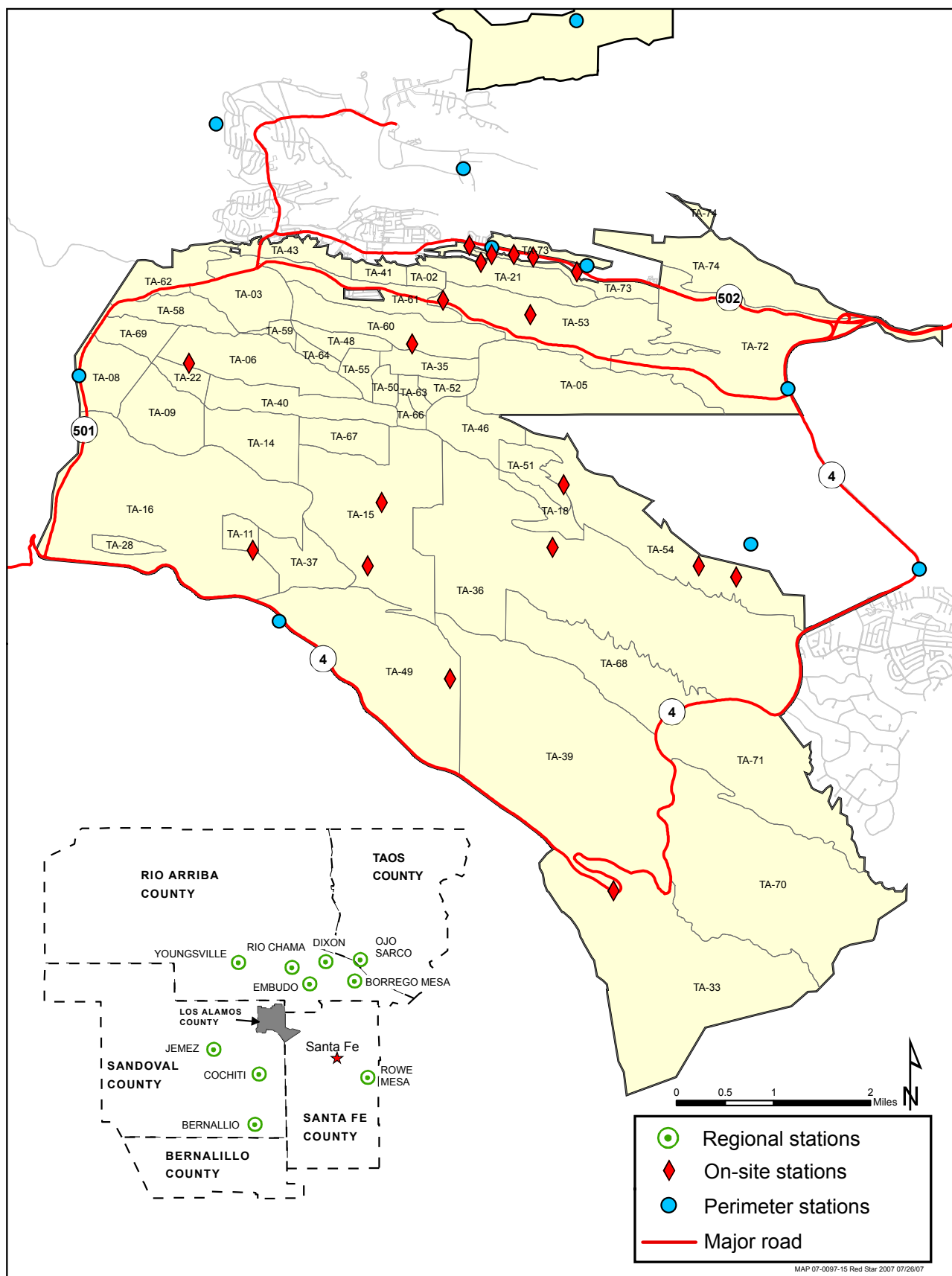


Figure 7-1. On-site Laboratory, perimeter, and off-site regional soil sampling locations. (The two perimeter soil samples collected in 2007 are north of TA-54.)

7. Soil Monitoring

Although the institutional soil-sampling program was changed to a three-year sampling cycle, the Pueblo de San Ildefonso requested that we annually collect two perimeter soil samples for radionuclides and TAL elements on their lands that are downwind of Area G, the Laboratory's principal radioactive waste disposal site. Area G, approximately 63 acres in size, is located in Technical Area (TA) 54 at the Laboratory's eastern boundary. Soil samples on Pueblo de San Ildefonso lands were collected from relatively level, open (unsheltered by trees or buildings), and rock-free areas. One sample, identified as "San Ildefonso," was collected across Mortandad Canyon about one-half mile northeast (and downwind) of Area G, and the other sample, identified as "Tsankawi/PM-1," was collected just a little over two miles north of Area G.

Soil samples from these two perimeter stations were compared with soil samples collected from regional areas in northern New Mexico that surround the Laboratory in all major directions and where radionuclides and chemicals are mostly from natural sources or worldwide fallout events. These areas are located near Ojo Sarco, Dixon, and Borrego Mesa (near Santa Cruz dam) to the northeast; Rowe Mesa (near Pecos) to the southeast; Youngsville to the northwest; and Jemez to the southwest. All locations are at similar elevations to LANL, are more than 20 mi away from the Laboratory, and are beyond the range of potential influence from normal Laboratory operations as required by the DOE (DOE 1991).

Samples were analyzed for tritium, plutonium-238, plutonium-239/240, strontium-90, americium-241, cesium-137, uranium-234, uranium-235, and uranium-238 by Paragon Analytics, Inc. The soil samples were also analyzed for 23 TAL elements (aluminum, barium, beryllium, calcium, chromium, cobalt, copper, iron, magnesium, manganese, nickel, potassium, sodium, vanadium, zinc, antimony, arsenic, cadmium, lead, selenium, silver, thallium, and mercury). The results from these sample analyses are presented in supplemental Table S7-1 and Table S7-2.

2. Radionuclide Analytical Results

All radionuclide (activity) concentrations in soil collected from both perimeter locations on Pueblo de San Ildefonso lands in 2007 were low (pCi range), and most were either not detected or detected below RSRLs (Table S7-1). A nondetected value is one in which the result is lower than three times the counting uncertainty and is not significantly ($\alpha = 0.01$, or 99% confidence level) different from zero (Keith 1991, Corely et al. 1981). The only radionuclides detected above the RSRLs were americium-241, uranium-234, and uranium-238 in the Tsankawi/PM-1 sample and plutonium-239/240 and americium-241 in the San Ildefonso sample.

Although these radionuclides were detected above the RSRLs, they are far below the SLs and thus do not pose a potential unacceptable dose to the public. Moreover, the uranium in the soil at the Tsankawi/PM-1 site was naturally occurring as the distribution of uranium-234 and uranium-238 was at equilibrium. These levels are very similar to past years and not increasing over time (Fresquez 2007a).

3. Chemical Analytical Results: Trace and Abundant Elements

Table S7-2 shows the results of the inorganic chemical analyses in surface soil collected from two perimeter sites located on Pueblo de San Ildefonso lands in 2007. All inorganic chemical concentrations from these two areas, with the exception of sodium, were detected below RSRLs. Sodium is a natural and essential element in soil and the difference between the concentration in the Tsankawi/PM-1 sample and the RSRL is small. There are no SLs for sodium in soils.



D. FACILITY MONITORING

1. Monitoring Network for Area G at TA-54

The Laboratory conducts facility-specific soil monitoring on an annual basis at Area G (Lopez 2002). Area G is a 63-acre radioactive waste processing area located on the east end of Mesa del Buey at TA-54 (Figure 7-1). Established in 1957, Area G is (as noted above) the Laboratory's primary radioactive solid waste burial and storage site (Hansen et al. 1980, Sohlt 1990). Tritium, plutonium, americium, uranium, and a variety of fission and activation products are the main radionuclides in waste materials disposed at Area G (DOE 1979). Facility monitoring at Area G includes sample collection and analysis of air, sediment, surface water runoff, soil, vegetation, and small mammals for contaminants. Section D.2, below, reports on the 30 soil surface samples collected in 2007 at designated locations around the perimeter of Area G and one soil surface sample (T-3) collected at the LANL/Pueblo de San Ildefonso boundary line approximately 800 ft northeast of Area G (Figure 7-2).

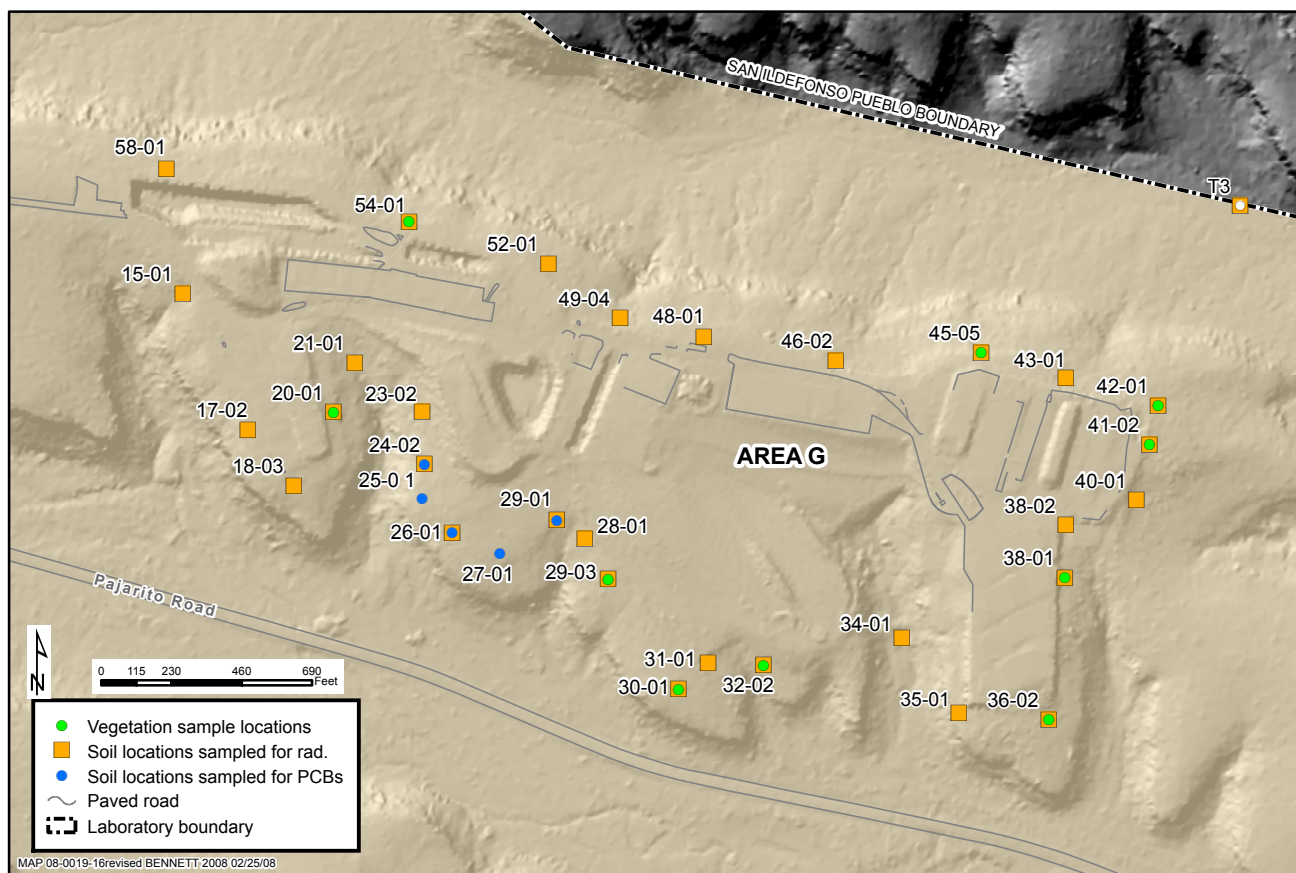


Figure 7-2. Locations of soil and vegetation samples collected at Area G in 2007.

Samples for analysis of radionuclides (tritium, plutonium-238, plutonium-239,240, americium-241, uranium-234, uranium-235, and uranium-238) were collected. In addition, five soil samples for polychlorinated biphenyl (PCB) analysis were collected from the southwestern side of Area G where traces of PCBs were detected in 2006 (location #26-01). All samples were analyzed by Paragon Analytics, Inc. The results from these samples are presented in supplemental [Table S7-3](#) and [Table S7-4](#). (Note: We report on the analyses of vegetation collected at Area G in Chapter 8, Section 4.a.)

2. Radionuclide and Nonradionuclide Analytical Results for Area G

a. Perimeter Results

Tritium, americium-241, plutonium-238, and plutonium-239/240 were detected at concentrations above the RSRLs in many of the 30 soil samples collected around the perimeter of Area G in 2007 (Table S7-3). Specifically, tritium was detected above the RSRL (0.86 pCi/mL) in 9 of the 30 samples with the majority of the concentrations above the RSRL reported in the southern portion of Area G where the tritium shafts are located. Although these data are within the range of concentrations detected in past years (Fresquez et al. 2004a, Fresquez and Lopez 2004, Fresquez et al. 2005, Fresquez 2006) they are variable from year to year (Figure 7-3). Nonetheless, with the exception of two years (2002 and 2003), the concentrations of tritium in soil at Area G have been below the SL of 5,400 pCi/mL, and the migration of tritium from the Area G boundary, at least at surface and subsurface depths, is not extensive. In a recent study involving the measurement of tritium in trees starting from the perimeter fence line outward (approximately 33, 165, 330, 490, and 660 ft), the concentrations of tritium decreased greatly with distance; at about 330 ft away, they were similar to the RSRL (Fresquez et al. 2003).

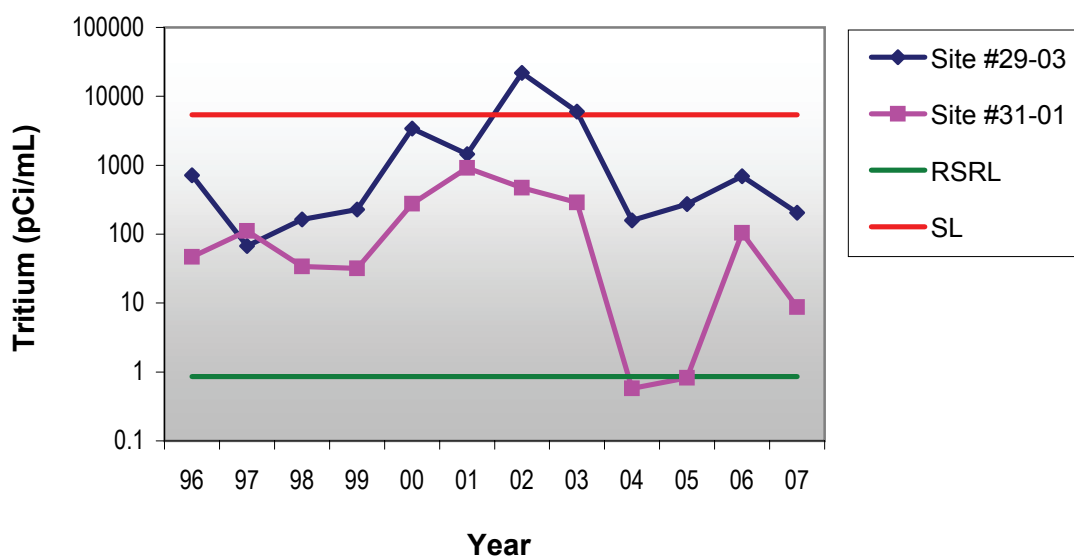


Figure 7-3. Tritium in surface soils collected from the southern portions of Area G at TA-54 from 1996 to 2007 as compared with the regional statistical reference level (RSRL) and the residential screening level (SL).

With respect to the concentrations of americium-241, plutonium-238, and plutonium-239/240 in soil at Area G, most samples showed higher amounts than the RSRLs, particularly around the perimeter of the northern, northeastern, and eastern sections (Table S7-3). Americium-241 was higher than the RSRL in 17 of 30 samples, plutonium-238 was higher in 18 of 30 samples, and plutonium-239/240 was higher in 19 of 30 samples. The highest concentrations (americium-241 = 2.4 pCi/g dry; plutonium-238 = 1.1 pCi/g dry; and plutonium-239/240 = 14 pCi/g dry) were detected in soil samples located on the perimeter of the eastern side of Area G near the Transuranic Waste Inspection Project (TWISP) domes. Plutonium-239/240, in particular, has doubled in concentration on the eastern part (location #38-01) over the past two years (Figure 7-4). Concentrations of plutonium-239/240 in other sections of Area G that have historically high levels (locations #41-02 and 43-01) have not generally increased over the years. However, all radionuclide concentrations, including plutonium-239/240, were below SLs.

No TAL elements were tested in 2007, but in 2006 most elements (478 out of 483 measurements) were at background levels (Fresquez 2007a), and the few detected above RSRLs were far below the SLs.

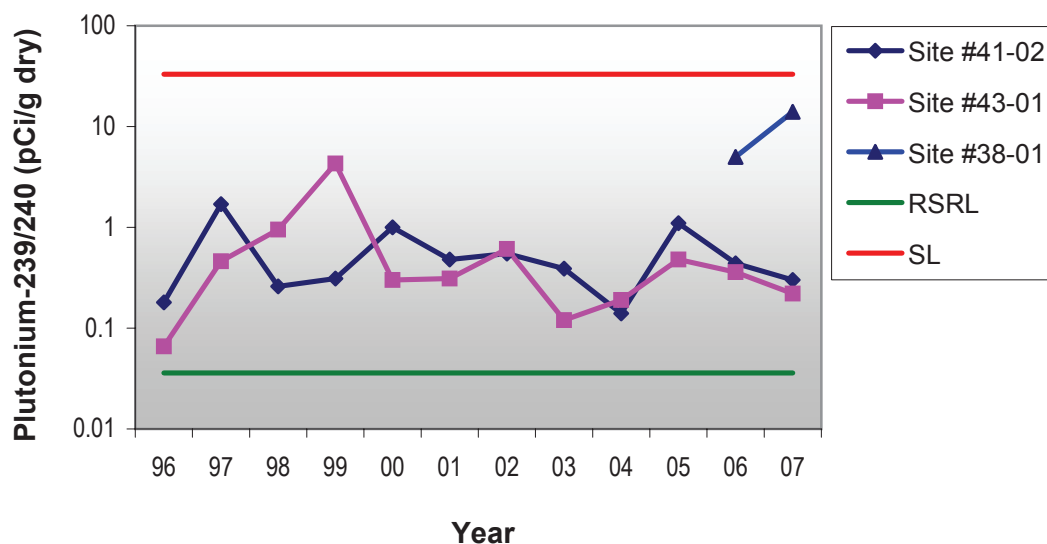


Figure 7-4. Plutonium-239/240 in surface soils collected from the northeastern and eastern portions of Area G at TA-54 from 1996 to 2007 as compared with the regional statistical reference level (RSRL) and the residential screening level (SL).

Last year, one soil sample out of 21 collected contained PCBs—namely at location #26-01 (Figure 7-2), which is on the southwest side of Area G. Aroclor-1254 and Aroclor-1260 (these are PCB commercial mixtures) concentrations in this one soil sample were reported at 0.067 and 0.094 mg/kg dry, respectively. Although the concentrations are two orders of magnitude below the residential SL of 1.1 mg/kg dry, we re-sampled this same location and collected two more samples on each side of the target area. No PCBs were detected above reporting limits in any of the five soil samples in 2007, including site #26-01 (Table S7-4). The results in 2006, therefore, may have been false positives.

b. Results at the Pueblo de San Ildefonso Boundary

Americium-241 and plutonium-239/240 in a soil sample collected at the LANL/Pueblo de San Ildefonso boundary northeast of Area G were detected at concentrations above the RSRLs (Table S7-3). The level of americium-241 in 2007 was similar to the level in 2006, but the concentration of plutonium-239/240 in 2007 was about four times higher than in the previous year (Figure 7-5). Although the plutonium-239/240 concentration in a soil sample collected at the LANL/Pueblo de San Ildefonso boundary was higher than the RSRL, the amounts are still far below the SLs. Moreover, the concentrations of plutonium-239/240 on Pueblo de San Ildefonso decrease to RSRLs within a relatively short distance from the San Ildefonso/Laboratory fence line. For example, most (nine out of 12) soil samples collected as part of the institutional monitoring program about 800 ft northeast of the fence line on the mesa top (the “San Ildefonso” site) from 1996 through 2007 showed plutonium-239/240 concentrations below the RSRL (Figure 7-6).



3. Monitoring Network for DARHT at TA-15

The Laboratory conducts facility-specific soil and sediment monitoring on an annual basis at DARHT (Nyhan et al. 2001). Approximately 20 acres in size, DARHT is located at R-Site (TA-15) at the Laboratory's southwestern end. Activities at DARHT include the utilization of very intense X-rays to radiograph a full-scale non-nuclear mock-up of a nuclear weapon's primary during the late stages of the explosively driven implosion of the device (DOE 1995). Open-air detonations occurred from 2000 to 2006, foam mitigation was used from 2002 to 2006, and closed steel containment vessels were used starting in 2007. Since May 2007, four hydrodynamic test shots at DARHT have been conducted within steel containment vessels. Potential contaminants include radionuclides, beryllium, heavy metals, and possibly organic chemicals like PCBs, high explosives (HE), and semi-volatile organic compounds (SVOCs).

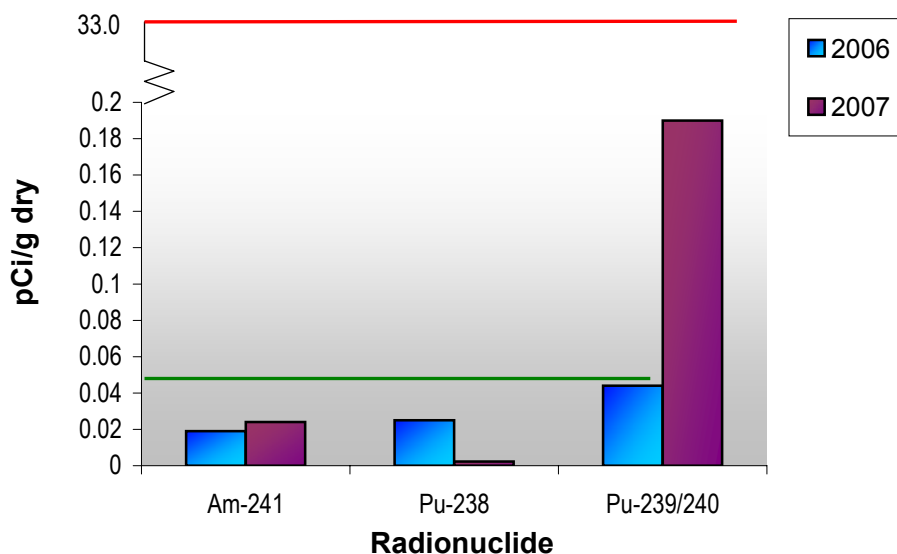


Figure 7-5. Transuranic radionuclides in surface soil collected from the LANL/Pueblo de San Ildefonso boundary northeast of Area G at TA-54 in 2006 and 2007. The regional statistical reference level (green line) and the residential screening level (red line) are shown with respect to plutonium-239/240 levels.

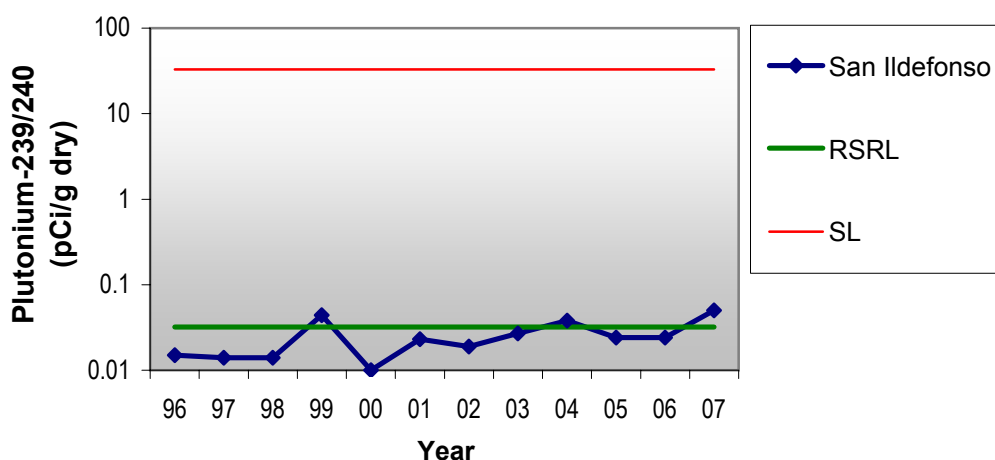


Figure 7-6. Plutonium-239/240 concentrations in soil samples collected from Pueblo de San Ildefonso lands approximately one-half mile northeast of Area G from 1996 through 2007 as compared with the regional statistical reference level (RSRL) and the residential screening level (SL).

Soil samples analyzed for radionuclides and inorganic chemicals are collected around the perimeter of the DARHT facility on the north, east, south, and west sides (Figure 7-7). An additional soil sample is collected on the north side near the firing point. Sediment samples were collected on the north, east, south, and southwest sides. All samples were analyzed for tritium; plutonium-238; plutonium-239/240; strontium-90; americium-241; cesium-137; uranium-234; uranium-235; uranium-238; and TAL elements. This year in addition to inorganic chemicals, we sampled and analyzed the same soil and sediment locations for PCBs, HEs, and SVOCs.

(Note: We report on the analyses of vegetation, small mammals, and birds collected around the DARHT facility in Chapter 8, Section 4.b.)

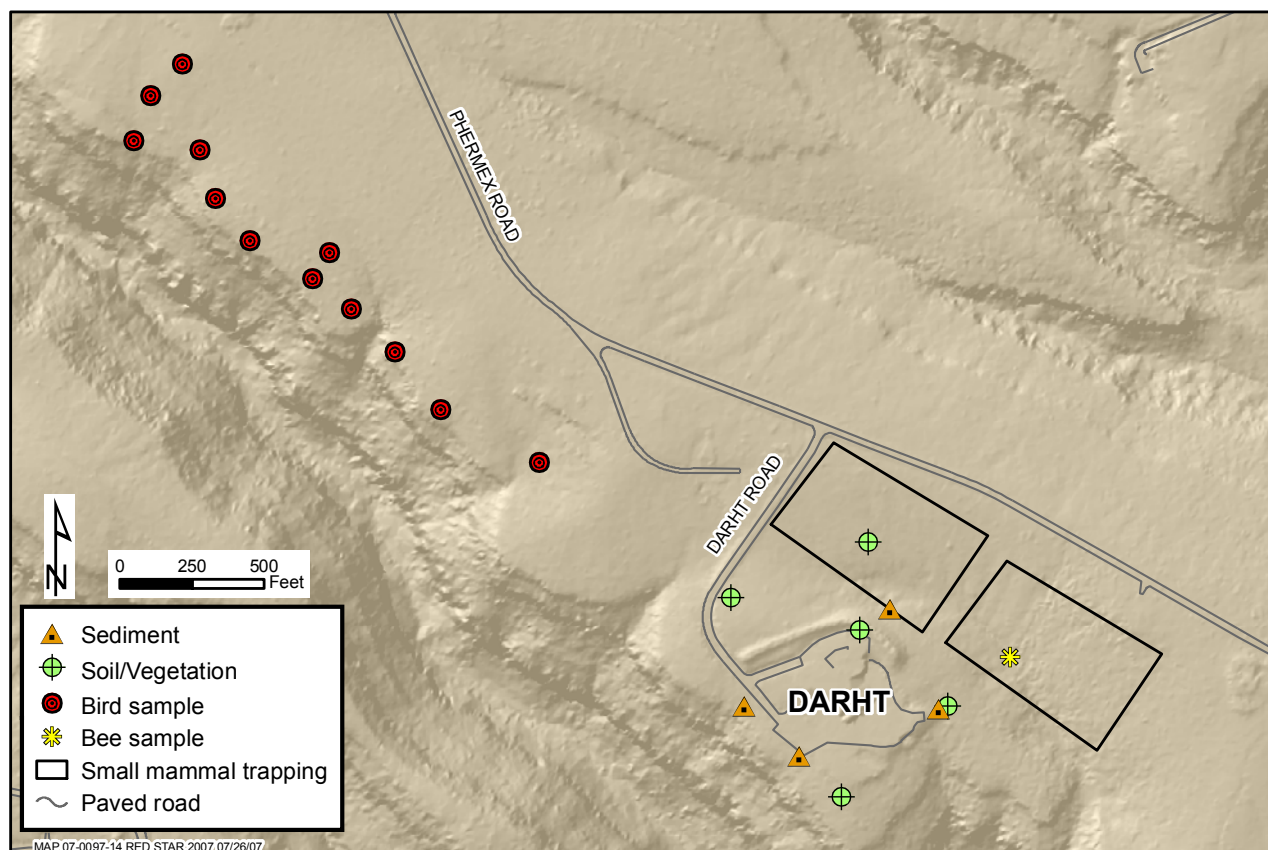


Figure 7-7. Sample locations of soil, sediment, and biota at DARHT in 2007.

We compared the radionuclide and chemical results in soil and sediment from the DARHT sampling to both RSRLs and baseline statistical reference levels (BSRLs). BSRLs are the concentrations of radionuclides and chemicals (mean plus three standard deviations) in soil and sediment collected from around the DARHT facility from 1996 through 1999 before the start-up of operations (Fresquez et al. 2001), per the DARHT Mitigation Action Plan (DOE 1996). Both reference levels are employed because the BSRLs for some elements may be biased as a result of changes in pre- and post- sampling locations and a change in analytical techniques. A comparison of BSRLs with RSRLs, for example, shows some baseline radionuclide concentrations, like cesium-137, may be biased low and some baseline inorganic chemical concentrations, like silver, may be biased high irrespective of DARHT activities. Moreover, some TAL metals analyzed recently have no baselines at all. To accommodate parking spaces and storage areas within the DARHT complex after operations began, soil sampling locations had to be moved from within the fenced perimeter boundary (<100 ft. from the facility) to sites located outside the perimeter fence boundary (>300 ft. from the facility). This may have affected the concentrations of some radionuclides, particularly cesium-137, because the pre-operation samples were collected in mostly disturbed soil and the post-operation samples were collected in mostly undisturbed soil.

Higher amounts of fallout radionuclides would be expected in the undisturbed soil rather than the disturbed soil because of the mixing associated with disturbed soil. Moreover, the change in analytical techniques may have improved detection capabilities for some metals. The use of inductively coupled plasma mass spectrometry instrumentation to analyze post-operation samples, for example, substantially decreased the detection limits of silver, from 2 to 0.2 mg/kg.

4. Radionuclide and Nonradionuclide Analytical Results for DARHT

Soil from the firing site area was not sampled this year because of scheduling conflicts associated with entrance requirements within the control area at DARHT. Last year, only uranium-238 and beryllium were detected above the statistical reference levels in the soil sample collected nearest the firing point. While the beryllium concentration was slightly above the BSRL (Figure 7-8), the concentration of uranium-238 was approximately an order of magnitude above the BSRL and appears to be increasing over time through 2006 (Figure 7-9). Although the concentrations of uranium-238 and beryllium in the soil sample collected near the firing point were above BSRLs, the levels were still far below SLs.

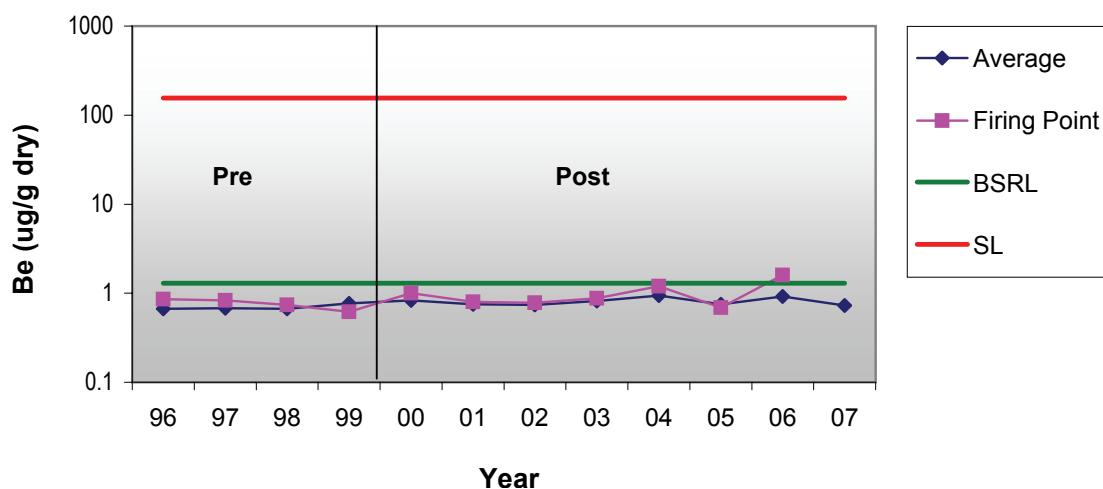


Figure 7-8. Beryllium concentrations in soil collected within (near the firing point) and around ($n = 4$) the DARHT facility at TA-15 from 1996-1999 (pre-operation) to 2000-2007 (post-operation) as compared with the baseline statistical reference level (BSRL) and the residential screening level (SL).

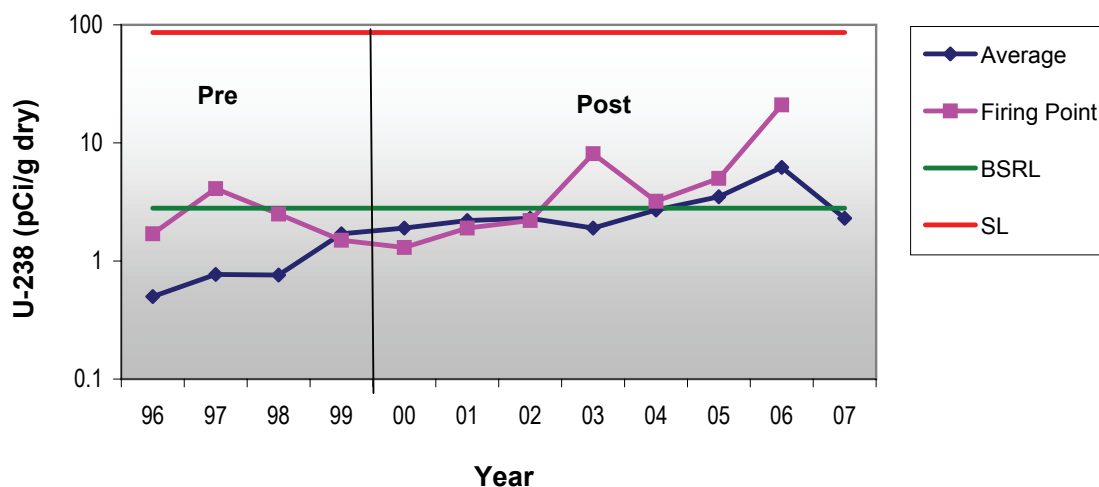


Figure 7-9. Uranium-238 concentrations in soil collected within (near the firing point) and around ($n = 4$) the DARHT facility at TA-15 from 1996-1999 (pre-operation) to 2000-2007 (post-operation) as compared with the regional statistical reference level (BSRL) and the residential screening level (SL).

This year, almost all the soil and sediment collected from around the perimeter of the DARHT facility contained concentrations of radionuclides and chemicals that were either not detected or below the statistical reference levels ([Table S7-5](#) and [Table S7-6](#)). The amounts of beryllium and uranium-238, in particular, decreased from the years prior to 2006, a difference that may be associated with the change from foam to steel vessels for containment mitigation. The only radionuclide that was above the

BSRLs was uranium-235 in soil samples collected on the north and east sides of DARHT. These amounts, however, were just above the BSRL (0.14 versus 0.13 pCi/g dry) and far below the SL.

Analyses of PCBs, HE, and SVOCs in soil and sediment samples collected around the perimeter of the DARHT facility resulted in no detections in any of the constituents above the reporting limits ([Table S7-7](#)).

E. SPECIAL MONITORING STUDIES

1. Los Alamos Canyon Weir and Pajarito Flood Control Structure: Third Year Results

Special monitoring studies of sediment (and biota) were conducted at the Los Alamos Canyon Weir (LACW) and the Pajarito Canyon Flood Control Structure (PCFCS); this is the third year of study. The LACW is located at the northeastern boundary of LANL within TA-72 near the junction of NM State Road 4 and NM State Road 502. The PCFCS is located downstream of the confluence of Two-Mile and Pajarito Canyons at TA-18. Sediment samples along with vegetation and small mammals were collected upgradient (upstream) of the structures to assess potential impacts to the biota as a result of potentially contaminated surface water runoff and sediment. Because sediment was collected and analyzed in support of the biota monitoring, the results are presented in Chapter 8, Section C.1 and C.2.

2. Results of the Analysis of High Explosives in Soil from LANL to the Valles Caldera

A request was made by the Pueblo of Jemez to collect soil samples and analyze the material for high-explosive residues at locations from Minnie Site, the main open-air detonation point for disposal shots at LANL, to the Valles Caldera. To this end, we collected soil samples from six areas along a western line starting at a point west of Minnie Site at TA-49. Samples were also collected at a point at TA-16 (S-Site) (collected in 2006 and reported in the Environmental Surveillance Report, LA-14341-ENV, [Table S7-3](#)), a point at the boundary of LANL near the SR501/SR4 intersection across from TA-16, and three points in the Vales Caldera identified by Jemez Pueblo environmental staff.

Fourteen types of high explosives were analyzed. There were no high-explosive residues above the reporting limits in any of the soil samples collected. All data are presented in Fresquez (2007b).



3. Baseline Radionuclide and Chemical Concentrations in Soils, Vegetation, and Small Mammals at the Proposed Expansion Area at TA-54 Area G

Area G is a low-level radioactive solid waste processing and disposal area located on the east end of Mesa del Buey at TA-54. This disposal area has been in existence since 1957 and is expected to be filled by the year 2015. A new area, adjacent to Area G on the west side, has been proposed for the expansion of disposal activities. Since 1994 to present, baseline levels of 20 radionuclides and 12 TAL elements have been collected in soils, vegetation, and small mammals (field mice and rock squirrels). These data will be used to assess potential impacts, if any, at the expanded site once operations begin. BSRLs (mean plus three standard deviations= 99% confidence level) of radionuclides and chemicals in these media were calculated and compared with RSRLs. RSRLs are calculated from regional areas away from the influence of the Laboratory and represent natural and worldwide fallout sources.

BSRLs in most media, with the exception of the field mice (mostly *Peromyscus spp.*), compare very well with RSRLs. Field mice do appear to be impacted by Area G operations, showing higher concentrations of tritium, plutonium-238, plutonium-239/240, and americium-241 as compared to RSRLs. This finding probably stems from the fact that field mice are highly mobile and likely to spend time within the active disposal area. Overall, however, the preoperational data from the other media show that the proposed expansion area has been impacted very little by Area G operations.

For a full description of years sampled, sampling sites, number of samples, media, and data, see Romero and Fresquez (2007).

F. QUALITY ASSURANCE FOR THE SOIL, FOODSTUFFS, & BIOTA MONITORING PROGRAM

1. Quality Assurance Program Development

The sampling team collects soil, foodstuffs, and biota (SFB) samples according to written, standard quality assurance and quality control procedures and protocols. These procedures and protocols are identified in the *LANL Quality Assurance Project Plan for the Soil, Foodstuffs, and Biota Monitoring Project* and in the following LANL standard operating procedures:

- Produce Sampling
- Fish Sampling
- Game Animal Sampling
- Processing and Submitting Samples
- Soil Sampling
- Chain-of-Custody
- Sampling Soil and Vegetation at Facility Sites
- Analytical Chemistry Data Management and Review for Soil, Foodstuffs and Biota

These procedures, which are available on the LANL public website (<http://www.lanl.gov/environment/all/qa.shtml>), ensure that the collection, processing, and chemical analysis of samples, the validation and verification of data, and the tabulation of analytical results are conducted in a manner consistent from year to year. Locations and samples have unique identifiers to provide chain-of-custody control from the time of collection through analysis and reporting.

2. Field Sampling Quality Assurance

Overall quality of field sampling is maintained through the rigorous use of the carefully documented procedures, listed above, which govern all aspects of the sample-collection program.

The team collects all samples under full chain-of-custody procedures, to minimize the chances of data transcription errors. Once collected, we hand-deliver the samples to the LANL Sample Management Office, which ships them via FedEx directly to an external analytical laboratory under full chain-of-custody control. The LANL project leader tracks all samples. Upon receipt of data back from the laboratory (electronically and in hard copy), a LANL chemist assesses the completeness of the field-sample process along with other variables. A quality assessment document is created, attached to the data packet, and provided to the LANL project leader.

3. Analytical Laboratory Quality Assessment

Specific statements of work are written to govern the acquisition and delivery of analytical services after the Data Quality Objective process has identified and quantified the program objectives. These statements of work are sent to potentially qualified analytical laboratories, which undergo a pre-award, on-site assessment by experienced and trained quality systems and chemistry laboratory assessors. Statement of work specifications, professional judgment, and quality-system performance at each laboratory (including recent past performance on nationally conducted performance-evaluation programs) are the primary criteria used to award contracts for specific types of radiochemical, inorganic chemical, and organic chemical analyses.

Each analytical laboratory conducts chain-of-custody and analytical processes under its own quality plans and analytical procedures. Each laboratory returns data by e-mail in an electronic-data deliverable with a specified format and content. The analytical laboratory also submits a full set of paper records that serves as the legal copy of the data. Each set of records contains all the internal quality control data the analytical laboratory generates during the analyses (including laboratory control standards, method blanks, matrix spikes, duplicates, and replicates, when applicable). The electronic data are uploaded into the database and immediately subjected to a variety of quality and consistency checks. Analytical completeness is determined, tracking and trending of all blank and control-sample data are performed, and all the data are included in the quality assessment memo mentioned in the field sampling section. We track all parts of the data-management process electronically and prepare periodic reports to management.



7. Soil Monitoring

4. Field Data Quality Assessment Results

Field data completeness for SFB in 2007 was greater than 95%.

5. Analytical Data Quality Assessment Results

Analytical data completeness for all SFB sampling programs was greater than 95% in 2007. We track, trend, and report all quality control data in specific quality evaluation memos which we submit to project staff along with each set of analytical data received from our chemistry laboratories. Overall results of the 2007 quality program indicate that all analytical laboratories maintained the same high level of control observed in the past several years.

6. Analytical Laboratory Assessments

During 2007, two external laboratories performed all chemical analyses reported for SFB samples:

- Paragon Analytics, Inc., Fort Collins, Colorado, provided radiological, TAL element, and organic chemical analysis of soil and sediment; radionuclide and TAL analysis of vegetation and small mammals; and processing of small mammals for PCB analysis.
- Alta Laboratories, California, provided PCB analysis from samples processed by Paragon.

We performed an assessment of Paragon Analytics, Inc., during 2004. The laboratory participated in national performance-evaluation studies during 2004 and 2005. Detailed results of these performance evaluations are included in the assessment report. Overall, the study sponsors judged the analytical laboratory to have acceptable performance for almost all analytes attempted in all matrices.

7. Program Audits

In 2005, we hosted a data quality assessment and evaluation to evaluate whether the procedures in various programs were being implemented as written. The auditors (Time Solutions 2) were professional external quality assurance experts (ISO 9000 and 14000 certified) and they examined all aspects of the SFB program procedures. While it was noted that improvements had been made to the SFB program since a previous audit (performed by auditors external to the sampling group but internal to LANL), several observations led to recommendations for improving processes for keeping procedures up to date and meeting internal commitments made in quality assurance plans. Since the data quality assessment, we have implemented all the recommendations.

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8. Foodstuffs and Biota Monitoring



contributing authors:

*Philip Fresquez, Chuck Hathcock, Dave Keller***To Read About****Turn to Page**

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A. FOODSTUFFS MONITORING**1. Introduction**

Foodstuffs within and around LANL may become contaminated through air (stack emissions and fugitive dust), soil (directly from the source), and water (storm water runoff and irrigation). The ingestion of these foods constitutes an important exposure pathway by which radionuclides (Whicker and Schultz 1982) and chemicals (inorganic and organic) (Gough et al. 1979) may be transferred to humans.

A wide variety of wild and domestic produce crops, including leafy vegetables, fruits, nuts, and grains are grown and harvested at many locations surrounding the Los Alamos National Laboratory (LANL or the Laboratory). Also, many food products from animals are available (e.g., milk, honey, and eggs), and fishing and hunting for small and big game animals (e.g., rabbits, deer and elk) on neighboring properties around LANL is a common occurrence. Elk and deer, for example, may graze through areas on LANL lands or drink from water catchments that may contain radioactive or chemical contamination. Fish could be exposed to potential contaminants entering the Rio Grande from runoff discharging from the canyons that cross Laboratory property.

The purpose of the foodstuff monitoring program is to determine whether Laboratory operations are impacting human health via the food chain. US Department of Energy (DOE) Orders 450.1 (DOE 2003) and 5400.5 (DOE 1993) mandate this monitoring program, and we accomplish this effort through the following tasks:

1. Measure radioactive and chemical concentrations in foodstuffs from neighboring communities and compare these results to regional (background), screening, and standard levels;
2. Determine concentration trends over time; and
3. Provide data used to estimate dose and risk from the consumption of the foodstuffs (see Chapter 3 for dose and risk estimates to individuals from the ingestion of foodstuffs).

In general, major foodstuffs like food crops and fish are collected every third year in a rotation with soil (and native vegetation). Other foods and wildlife are analyzed as they become available. We collected fish in 2005 (Fresquez et al. 2006) and soil and native vegetation in 2006 (Fresquez 2007). This year, we focused on the collection and analysis of radionuclides and other inorganic chemicals in domestic crop plants from neighboring communities surrounding the Laboratory. Also, we report on the analysis of wild edible plant foods collected downwind and down gradient of Area G, a low-level waste site, from within Cañada del Buey at the LANL/Pueblo de San Ildefonso boundary line, and on goat milk collected from the White Rock/Pajarito Acres area.

2. Foodstuffs Comparison Levels

To evaluate potential Laboratory impacts on foodstuffs in the neighboring communities from radionuclides and chemicals, we first compared the analytical results to regional statistical reference levels (RSRLs). RSRLs are the upper-level background concentration (mean plus three standard deviations = 99% confidence level) in foodstuffs collected from regional locations away from the influence of the Laboratory (> nine miles away) (DOE 1991) over at least the last five sampling periods. RSRLs represent natural and fallout sources, are calculated as data become available, and can be found in each of the supplemental data tables of this report.

If any radionuclide concentrations exceed RSRLs, we then compared the concentrations to screening levels (SLs). SLs are set below federal standards (= 1 mrem/yr, which is 4% of the 25 mrem/yr DOE single-pathway constraint) (DOE 1999) so that potential concerns may be identified in advance, i.e., a “yellow flag.” If a radionuclide exceeds an SL, the basis for that increase is investigated. For target analyte list (TAL) metals, we are not aware of any specific SLs for most inorganic elements in foodstuff plants (the exception is 1 part per million [ppm] of mercury in plants) (FDA 2000); however, we attempt to calculate and compare the highest result against the % daily value (%DV) recommended by the Food and Drug Administration (FDA 1994). DVs are reference numbers to help consumers determine how much of a specific nutrient a food contains.

In the event that a radionuclide in foodstuffs exceeds an SL, then, based on the concentrations of all radionuclides in that foodstuff, we would calculate a dose to a person (Chapter 3). This dose is compared with the 25-mrem/yr DOE single-pathway dose constraint (DOE 1999). There are no standards for inorganic chemicals in most foodstuffs.

A summary of the RSRLs, SLs and the standard used to evaluate the results of radionuclides and inorganic elements in foodstuffs is presented in Table 8-1.

Table 8-1
Standards and Other Reference Levels Applied to Foodstuffs

| Constituent | Sample Location | Media | Standard | Screening Level | Background Level |
|---------------------------|-----------------------|------------|------------|-----------------|------------------|
| Radionuclides | On-site and perimeter | Foodstuffs | 25 mrem/yr | 1.0 mrem/yr | RSRLs |
| Inorganic Elements | On-site and perimeter | Foodstuffs | NA | % DV | RSRLs |

NA = Not Available

3. Domestic Edible Plants

a. Monitoring Network

We collected 10 fruit and vegetable samples (apples, apricots, cherries, chile, corn, grapes, lettuce, peaches, squash, and tomatoes) from each of four communities surrounding the Laboratory in the summer/fall of 2007 (Figure 8-1). The four communities, their location with respect to the Laboratory, and the potential transport pathway(s) were as follows:

- Los Alamos, located north of LANL, air pathway;
- White Rock/Pajarito Acres, located southwest of LANL, air pathway;
- Pueblo de San Ildefonso/El Rancho, located northeast of LANL, air pathway; and
- Cochiti Pueblo/Sile/Pena Blanca, located south of LANL, water/irrigation pathway.

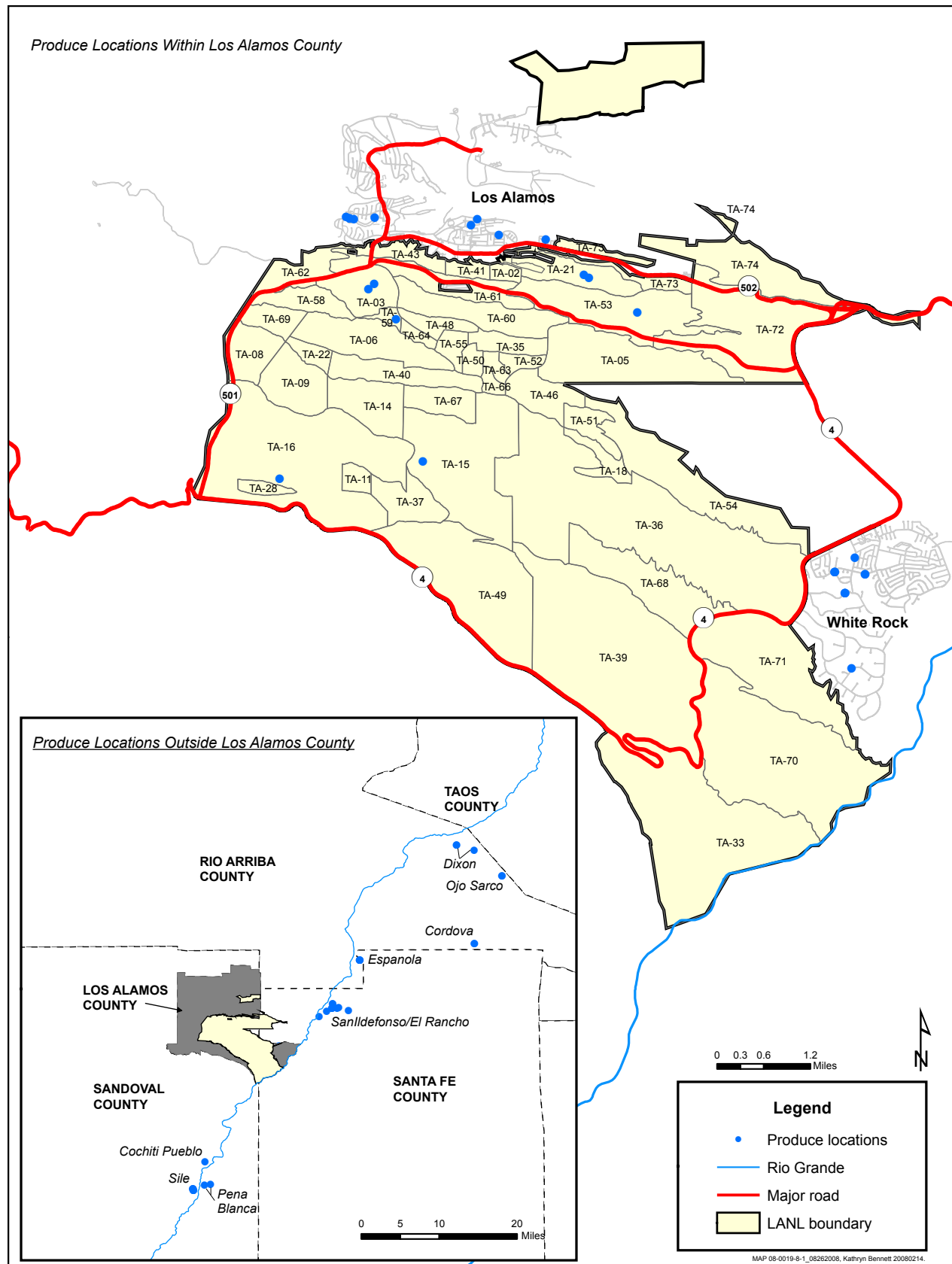


Figure 8-1. Locations of crops collected within and around LANL, 2007.

In addition, eight fruit samples (four apple, one apricot, one nectarine, and two peach) from six technical areas (TAs-3, 15, 16, 21, 53, and 59) within the Laboratory were collected. All samples were submitted to Paragon Analytical, Inc., where they were processed and analyzed for tritium, strontium-90, cesium-137, plutonium-238, plutonium-239/240, uranium-234, uranium-235, and uranium-238 and for 23 TAL inorganic elements (aluminum, barium, beryllium, calcium, chromium, cobalt, copper, iron, magnesium, manganese, nickel, potassium, sodium, vanadium, zinc, antimony, arsenic, cadmium, lead, selenium, silver, thallium, and mercury). Results for tritium are reported on a pCi/mL basis; results for the other radionuclides are reported on a pCi/g ash basis; and the results for the TAL elements are reported on an mg/kg dry basis.

The results from the on-site and perimeter area samples were compared to the results for the same types of fruits and vegetables collected from regional (background) areas away from the Laboratory. Radionuclides and TAL elements detected in produce from background areas are the result of worldwide fallout and naturally occurring sources. Regional sample areas included Cordova, Española, Dixon, and Ojo Sarco, New Mexico (Figure 8-1).

b. Radionuclide Analytical Results

Radionuclide (activity) concentrations in produce collected from on-site, perimeter, and regional (background) locations during the 2007 growing season are presented in Table S8-1. Most (99%) radionuclide concentrations in fruits and vegetables collected from on-site and perimeter areas were either not detected or detected below the RSRLs and are consistent with results from previous years (Fresquez et al. 2005). A nondetected result is one in which the result is lower than the minimum detectable amount and/or lower than three times the total propagated uncertainty (e.g., not significantly [$\alpha = 0.010$] different from zero [Keith 1991, Corely et al. 1981]).

The only radionuclides that were detected above RSRLs in 2007 were tritium in two fruit samples (apples and peaches) from the DP East facility at TA-21; a tritium research site (Figure 8-2) and uranium-234 and uranium-238 in a lettuce sample collected from the Los Alamos town site (Figure 8-3). (Note: The uranium in lettuce from Los Alamos was naturally occurring as the distribution of uranium-234 to uranium-238 was at 1:1). In both cases, the concentrations were similar or below levels from past years and far below SLs, and thus do not pose a potential unacceptable dose to humans who may ingest these fruits and vegetables.

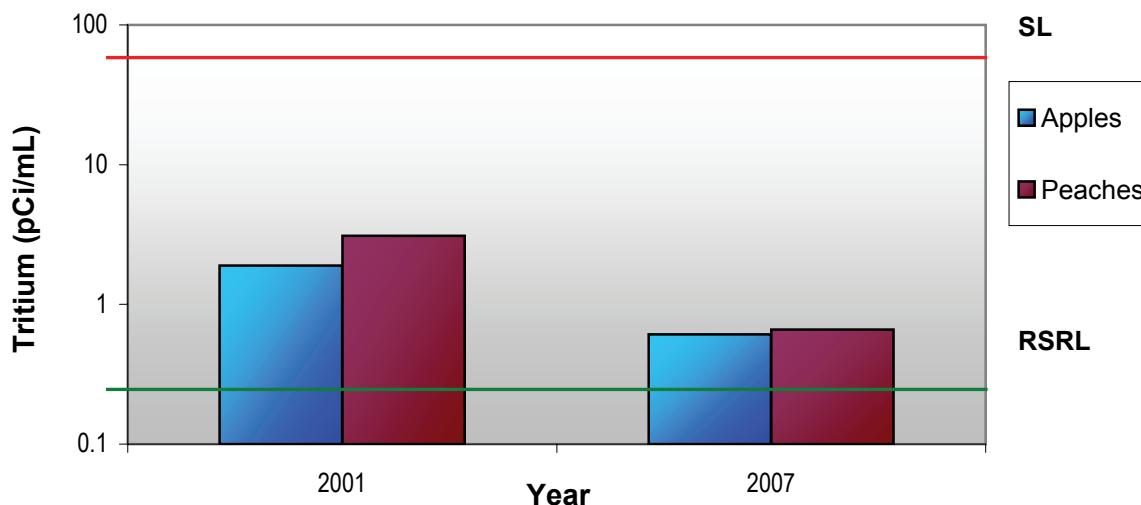


Figure 8-2. Concentrations of tritium in apples and peaches from DP East at TA-21 in 2001 and 2007 as compared with the regional statistical reference level (RSRL) and screening level (SL).

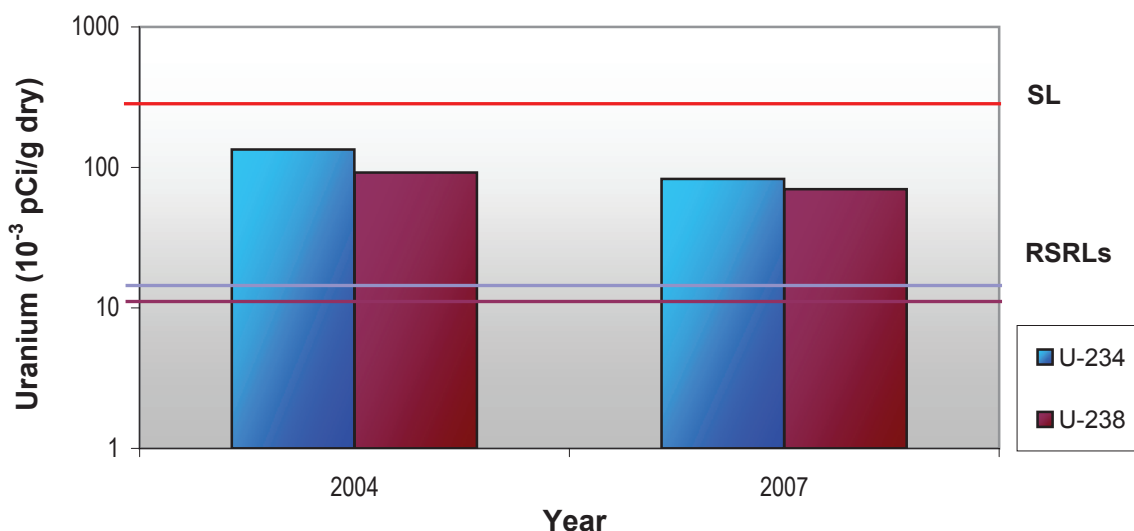


Figure 8-3. Concentrations of uranium-234 and uranium-238 in lettuce from the Los Alamos town site area in 2004 and 2007 as compared with the regional statistical reference levels (RSRLs) and screening level (SL).

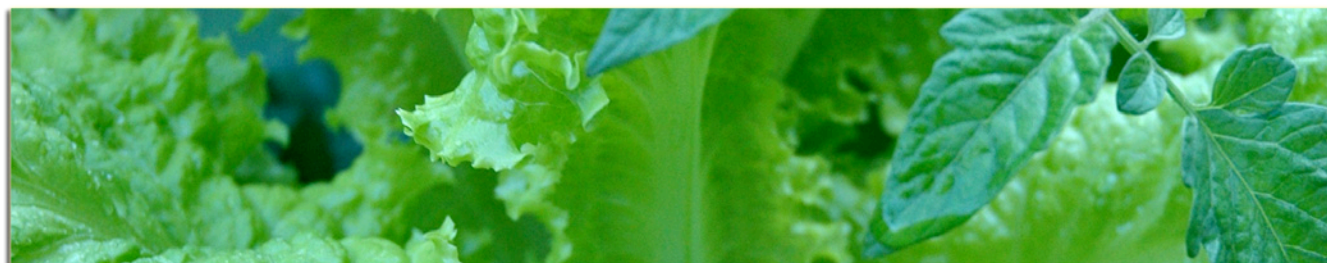
c. Chemical Analytical Results

Most (98%) TAL element concentrations in produce from on-site and perimeter areas were either not detected or were detected below the RSRLs (Table S8-2). The two elements in two or more produce samples from a community area that were above RSRLs included chromium (two samples from Cochiti/Sile/Pena Blanca) and selenium (two samples from White Rock/Pajarito Acres, four samples from Los Alamos townsite and two samples from Pueblo de San Ildefonso/El Rancho). The slightly higher concentrations of chromium and selenium in produce from perimeter areas as compared with RSRLs are more likely a result of (trace mineral) fertilizer additions by the small-scale farmer rather than from Laboratory operations since all of the sampled Laboratory fruit was at normal levels (<RSRLs).

Chromium and selenium are naturally occurring and widely distributed in the soil (Bowen 1979), with low concentrations in the diet being essential for good health (National Institute of Health 2004, 2005). A calculation, below, of the %DV using the highest amounts of chromium in lettuce and selenium in kale from the perimeter locations show that the contribution of these minerals to the recommended daily value required for good nutrition is still relatively low (FDA 1994).

Chromium in (green leaf) lettuce: $2.2 \mu\text{g/g dry} \times 0.092$ (dry to wet weight conversion ratio) = $0.20 \mu\text{g/g wet} \times 36 \text{ g}$ (one cup shredded) = $7.2 \mu\text{g} \div 120 \mu\text{g}$ (FDA daily value) = $0.060 \times 100 = 6\%$ (%DV).

Selenium in (raw) kale: $0.23 \mu\text{g/g dry} \times 0.12$ (dry to wet weight conversion ratio) = $0.028 \mu\text{g/g wet} \times 67 \text{ g}$ (one cup chopped) = $1.9 \mu\text{g} \div 70 \mu\text{g}$ (FDA daily value) = $0.027 \times 100 = 3\%$ (%DV).



4. Goat Milk

a. Monitoring Network

No commercial dairies operate in the general vicinity of LANL. However, there are a few residents of White Rock who raise goats for milk. The milk is for private use and is not sold commercially.

This year, one whole goat milk sample was collected from a farm located in the White Rock/Pajarito Acres area and compared with goat milk collected from three farms from regional locations (Pena Blanca, Penasco, and Lumberton, New Mexico). Radionuclides in milk from regional areas are due to worldwide fallout and to naturally occurring sources. The goat milk samples were collected directly by the farmer, placed into labeled 1L polyethylene bottles provided by the Laboratory, and submitted under chain of custody to Paragon Analytics, Inc., for the analysis of tritium, iodine-131, cesium-137, strontium-90, americium-241, uranium-234, uranium-235 and uranium-238. All results are reported on a pCi/L basis.

b. Radionuclide Analytical Results

All radionuclide concentrations in goat milk from White Rock/Pajarito Acres were either not detected or below RSRLs (Table S8-3). These data are very similar to past years and are not increasing over time (Fresquez 1998, Fresquez et al. 2004).

5. Wild Edible Plants

a. Monitoring Network

Over the past years, we have collected a variety of wild edible plants from the mesa top and canyon bottom areas within the Laboratory. Our most recent sampling of wild edible plants was within the ephemeral stream channels of Mortandad Canyon on the eastern side of LANL on Pueblo de San Ildefonso land. Results of common purslane, acorns, common lambsquarters (Fresquez et al. 2005b, 2006), and pigweed amaranth (Fresquez et al. 2007a) showed that there were no significant impacts from Laboratory operations on these wild food plants in those areas.

This year, we focused on collecting wild edible plants downwind (northeast) and down gradient of Area G, a low-level radioactive waste site, in Cañada del Buey at the LANL/Pueblo de San Ildefonso boundary. Samples of piñon pine (two samples), wax current (two samples), purslane (one sample), and common lambsquarters (two samples) were collected. Plants were processed and analyzed by Paragon Analytics, Inc., for tritium, plutonium-238, plutonium-239/240, strontium-90, americium-241, cesium-137, uranium-234, uranium-235, and uranium-238. Also, 23 TAL elements were analyzed. Results are reported on the same basis as the domestic crops.

b. Radionuclide Analytical Results

Most of the radionuclide results for the four species of wild edible plants collected from within Cañada del Buey at the LANL/Pueblo de San Ildefonso boundary northeast of Area G were either not detected or had concentrations below the RSRLs (Table S8-4). The only radionuclide that was detected above the RSRL was tritium in three of the seven wild food plant samples. Tritium is commonly detected in soil (see section Chapter 7 and section D.2.a for soil tritium results) and native vegetation (see Chapter 8, Section B.4.a.ii for native plant results) at Area G, but the amounts in these wild edible plants were still far below the SL (Figure 8-4) and do not pose a potential unacceptable dose to humans who may ingest them.

c. Chemical Analytical Results

Most (87%) TAL element concentrations in piñon, wax current, purslane, and common lambsquarters collected northeast of Area G from within Cañada del Buey at the LANL/Pueblo de San Ildefonso boundary were either not detected (below the reporting limits) or detected below the RSRLs (Table S8-5). The elements that were detected above the RSRLs in two or more samples included manganese, selenium, thallium, and mercury. All of

these elements in wild edible plants in Cañada del Buey were just above the RSRLs and do not pose a significant risk. Mercury was still far below the 1 mg/kg FDA screening level and a calculation of the %DV using the highest selenium and manganese levels (thallium is not considered a required nutrient and no data intakes were available) in lambsquarters shows that the nutrients are below or near the recommended percent daily intake.

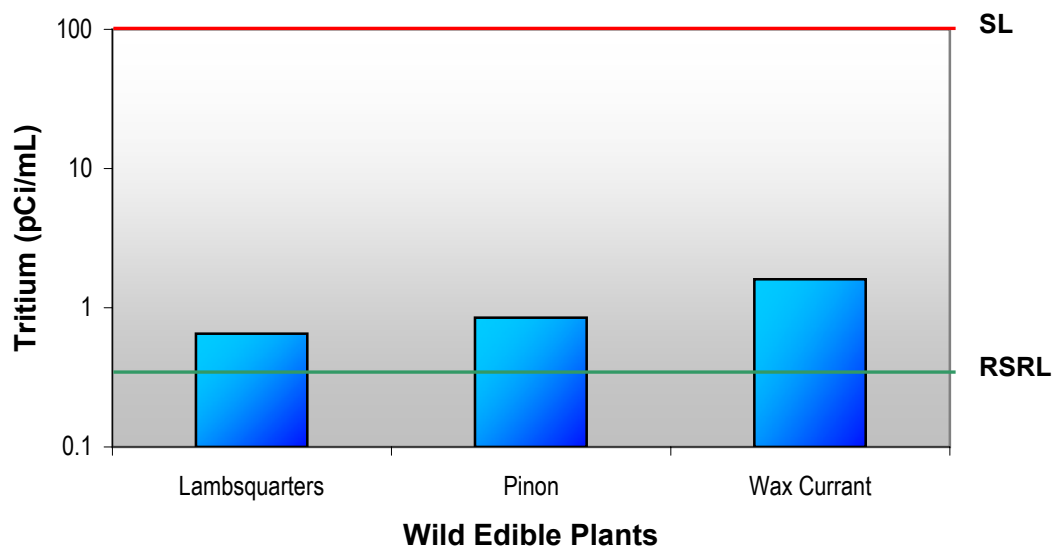


Figure 8-4. The highest concentrations of tritium in three wild food plants collected northeast of Area G at the bottom of Cañada del Buey on the LANL/ Pueblo de San Ildefonso boundary as compared with the regional statistical reference level (RSRL) and screening level (SL).

Selenium in wax current: $0.090 \mu\text{g/g dry} \times 0.19$ (dry to wet weight conversion ratio)
 $= 0.017 \mu\text{g/g wet} \times 112 \text{ g (one cup)} = 1.9 \mu\text{g} \div 70 \mu\text{g}$
 (FDA daily value) $= 0.027 \times 100 = 3\%$ (%DV).

Manganese in lambsquarters: $120 \mu\text{g/g dry} \times 0.17$ (dry to wet weight conversion ratio)
 $= 20 \mu\text{g/g wet} \times 180 \text{ g (one cup chopped)} = 3600 \mu\text{g} \div$
 $2000 \mu\text{g (FDA daily value)} = 1.8 \times 100 = 180\%$ (%DV).

(Note: The levels of manganese are still below the upper limit level for consumption (e.g. $<11,000 \mu\text{g}$ or 550% DV) (Nutrition ATC 2008) so the risk of toxicity to humans is small. Also, as a matter of comparison, the %DV of a background lambsquarter plant containing $55 \mu\text{g/g dry}$ of manganese (Fresquez et al. 2007b, Table S8-2) would be about 80%. So, the amounts of manganese in wild edible plants appear to be normally high.)

B. BIOTA MONITORING

1. Introduction

DOE Orders 450.1 (DOE 2003) and 5400.5 (DOE 1993) mandate the monitoring of biota (plants and animals not normally ingested by humans) for the protection of ecosystems. Monitoring of biota, mostly in the form of facility-specific or site-specific studies, began in the 1970s with the Environmental Surveillance Program, while site-wide native vegetation monitoring started in 1994. Presently, in addition to native vegetation, we also monitor small mammals, amphibians, reptiles, birds, and bees within and around LANL on a systematic basis or for special studies. Detection of contaminants in biota may indicate that these animals may be entering contaminated areas (e.g., burrowing in waste burial grounds) or that material is moving out of contaminated areas (e.g., blowing dust, transported soil/sediment via storm water, or food-chain transport).

The three objectives of the biota program are to determine the following:

1. Determine radionuclide and chemical concentrations in biota from on-site (LANL property) and perimeter areas and compare these results to regional (background) areas,
2. Determine concentration trends over time, and
3. Estimate potential dose to plants and animals.

Chapter 3 presents the results of the 2007 biota dose assessments at LANL.

2. Biota Comparison Levels

Like the foodstuffs biota data, Laboratory impacts from radionuclides and inorganic elements in biota were first compared to RSRLs. If the levels exceed RSRLs, we compared the concentrations with SLs, if available, and then to standards, if available. Comparison levels are summarized below and presented in Table 8-2:

- Regional background levels: RSRLs are the upper-level background concentrations (mean plus three standard deviations) for radionuclides and chemicals calculated from biota data collected from regional locations away from the influence of the Laboratory (>nine miles away) (DOE 1991) over the past five sampling periods. RSRLs represent natural and fallout sources, are calculated annually, and are presented in Table S8-3 through Table S8-25 of this report.
- Screening Levels: SLs are set below federal regulatory standards so that potential concerns may be identified in advance of potential ecological health problems—that is, they are a “yellow flag.” If a constituent exceeds an SL, then the reason for that exceedance is thoroughly investigated. For radionuclides in biota biota, SLs were set at 10% of the standard by the dose assessment team at the Laboratory to identify the potential contaminants of concern (McNaughton 2006). Chemicals are compared with toxicity values (TVs) obtained from the literature.
- Standards: Based on the concentrations of radionuclides in biota, we calculate a dose and compare it with the 1 rad/d DOE dose standard for terrestrial plants and aquatic biota and 0.1 rad/d for terrestrial animals (DOE 2002).

Table 8-2
Standards and Other Reference Levels Applied to Biota

| Constituent | Sample Location | Media | Standard | Screening Level | Background Level |
|----------------------|-----------------------|---------------------|-----------|-----------------|--------------------------|
| Radionuclides | On-site and perimeter | Terrestrial plants | 1 rad/d | 0.1 rad/d | RSRLs |
| | DARHT | Terrestrial plants | 1 rad/d | 0.1 rad/d | RSRLs/BSRLs ^a |
| | On-site and perimeter | Terrestrial animals | 0.1 rad/d | 0.01 rad/d | RSRLs |
| | DARHT | Terrestrial animals | 0.1 rad/d | 0.01 rad/d | BSRLs |
| Chemicals | On-site and perimeter | Biota | NA | TVs | RSRLs |
| | DARHT | Biota | NA | TVs | RSRLs/BSRLs |

^a Baseline Statistical Reference Levels (BSRL) and a discussion of these levels can be found in Section 4.b.i.

3. Institutional Monitoring

No institutional monitoring of native vegetation was performed in 2007. Native understory (grasses and forbs) and overstory (trees) vegetation is collected on a triennial basis at the same time and at the same locations as the soil monitoring program (17 on-site, 11 perimeter, and six regional locations) described in Chapter 7, Section C.1 (Figure 7-1). The next sampling period for the collection of native vegetation is in the year 2009. For a discussion of past results, see Gonzales et al. (2000) for 1998 sampling results, Fresquez and Gonzales (2004) for 2002 and 2003 sampling results, and Fresquez et al. (2007a) for a discussion of 2006 sampling results.

In general, all radionuclide and other inorganic chemical concentrations in native understory and overstory vegetation sampled from Laboratory and perimeter areas are very low and most are indistinguishable from regional background areas.

4. Facility Monitoring

a. Area G at TA-54

i. Monitoring Network

The Laboratory conducts facility-specific vegetation monitoring on an annual basis at Area G (Lopez 2002). A description of the area and the types of waste disposed of at Area G is presented in Chapter 7 Section D.1. This year, 10 locations at designated sites spaced equally around the perimeter of Area G were sampled for both understory and overstory vegetation (see Chapter 7, Figure 2, for sample locations). One set of samples was also collected at the LANL/Pueblo de San Ildefonso boundary downwind and northeast of Area G.

Historically, plants collected around the southern portions of Area G contain higher amounts of tritium than background and plants collected around the east and northeastern perimeter sections of Area G contain higher amounts of plutonium and americium than background (Fresquez and Lopez 2004, Fresquez et al. 2004, 2005a). Vegetation samples were processed and analyzed by Paragon Analytics, Inc., for tritium, cesium-137, strontium-90, americium-241, plutonium-238, plutonium-239/240, uranium-234, uranium-235, and uranium-238, and for 23 TAL elements. Results for tritium are reported on a pCi/mL basis; results for the other radionuclides are reported on a pCi/g ash basis; and the results for the TAL elements are reported on an mg/kg dry basis.

ii. Vegetation Results for Area G

Most radionuclides, with the exception of tritium, plutonium-238, and plutonium-239/240 in overstory vegetation (Table S8-6) and understory vegetation (Table S8-7) were not detected or were detected below RSRLs. The highest amounts of tritium were detected in understory (5750 pCi/mL compared with the RSRL of 0.56 pCi/mL) and overstory (1420 pCi/mL compared with the RSRL of 0.71 pCi/mL) plants on the southern portion of Area G near the tritium shafts (see Chapter 7, Figure 7-2, near location # 29-03). Concomitantly, the highest amounts of plutonium-238 and plutonium-239/240 were detected in understory vegetation collected on the northeastern and eastern side of Area G; the concentrations of plutonium-239/240 in understory vegetation at site # 38-01, in particular, were over four times higher than the RSRL (0.082 pCi/g ash compared with the RSRL of 0.017 pCi/g ash). Both tritium and plutonium-239/240 concentrations in understory and overstory vegetation correlate well with the soil data (Table S7-3). Also, concentrations of tritium and plutonium-239/240 are similar to previous years and although these radionuclides in vegetation at Area G are higher than the RSRLs, the amounts are still very far below the SLs (e.g., for tritium it is <345,000 pCi/mL and for plutonium it is <578 pCi/g ash) (Figures 8-5 and 8-6). Therefore these radionuclides do not pose a potential unacceptable dose to the vegetation growing around Area G.

With respect to the native understory and overstory plants collected at the LANL/Pueblo de San Ildefonso boundary in Cañada del Buey northeast of Area G, most of the radionuclides, with the exception of plutonium-238 in understory vegetation, were either not detected or were detected below RSRLs (Table S8-6 and S8-7). The differences between the reported value for plutonium-238 and the RSRL, however, were small and the amounts were far below the SL.

b. DARHT at TA-15

i. Monitoring Network

The Laboratory conducts facility-specific biota monitoring on an annual basis at DARHT (Nyhan et al. 2001) (DOE 1996). In 2007, the biota samples collected at DARHT included vegetation, small mammals, bees, and birds (see Chapter 7, Figure 7-7). Open air detonations occurred from 2000-2006; foam mitigation was used from 2002-2006; and closed steel containment vessels were used starting in 2007. Since May 2007, four hydrodynamic test shots at DARHT were accomplished within steel containment vessels.

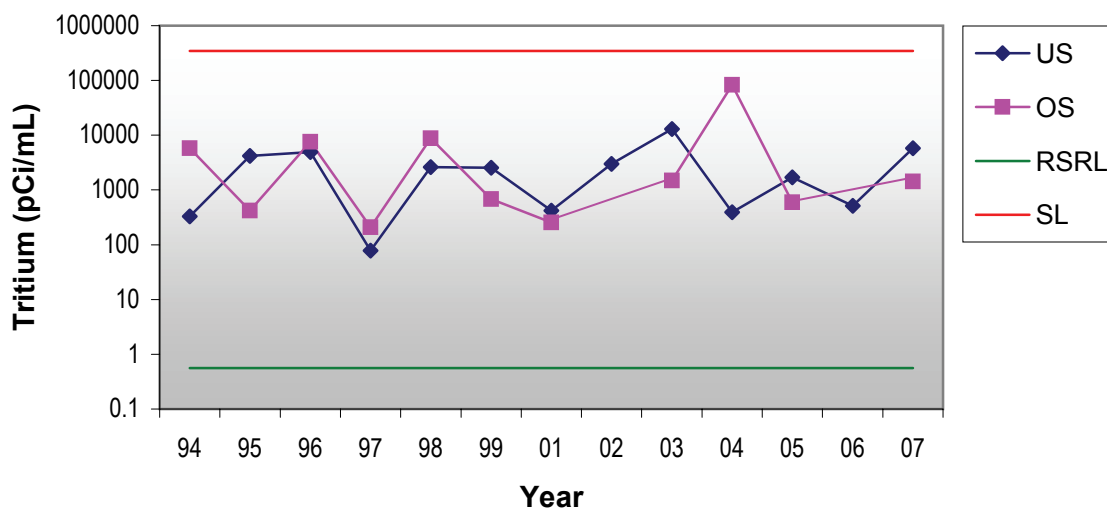


Figure 8-5. Tritium in understory (US) and overstory (OS) vegetation collected from the south side (see Chapter 7, Figure 7-4 for location information associated with site[s] near #29-03) of Area G at TA-54 from 1994 through 2007 compared with the regional statistical reference level (RSRL) and the screening level (SL). Note the logarithmic scale on the vertical axis.

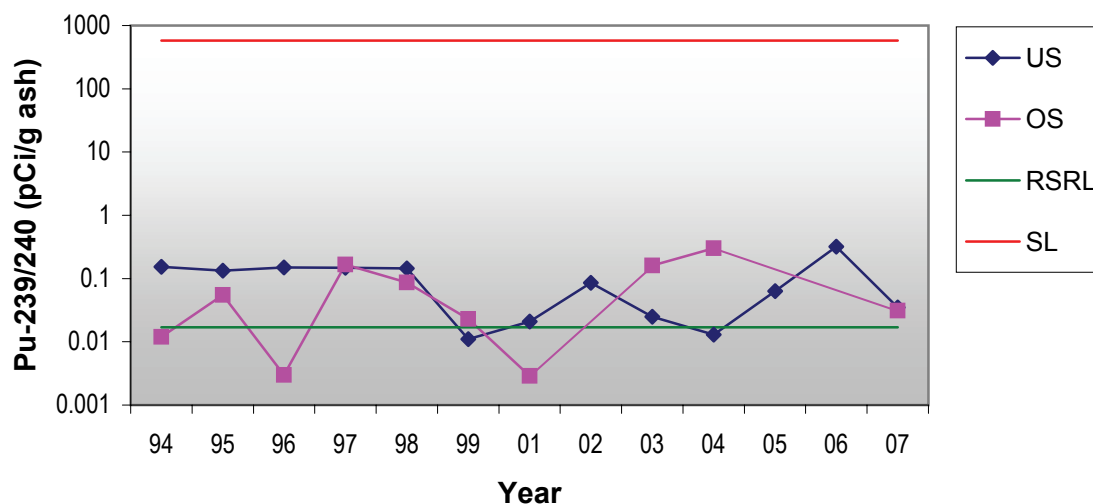


Figure 8-6. Plutonium-239,240 in understory (US) and overstory (OS) vegetation collected from the northeast side (see Chapter 7, Figure 7-4 for location information associated with site[s] near #41-02) of Area G at TA-54 from 1994 through 2007 compared with the regional statistical reference level (RSRL) and the screening level (SL). Note the logarithmic scale on the vertical axis.

Overstory and understory vegetation samples are collected on the north, south, west, and east sides of the complex. Small mammals, mostly deer mice (*Peromyscus* spp.), are collected using traps from two sample grids located on the north and northeast side of the DARHT facility. Bird samples were collected using 12 mist capture net traps spaced about 200 ft to 1,600 ft outward from the west side of the DARHT facility. Spacing of the nets was about 150 ft from one another. Finally, we collected honey bees from four hives located just northeast of the DARHT facility.

All biota samples were submitted to Paragon Analytics, Inc., where they were processed and analyzed for concentrations of tritium, plutonium-238, plutonium-239/240, strontium-90, americium-241, cesium-137, uranium-234, uranium-235, uranium-238, and TAL inorganic chemicals. Results for tritium are reported on a pCi/mL basis; results for the other radionuclides are reported on a pCi/g ash basis; and the results for the TAL elements in vegetation are reported on an mg/kg dry basis whereas the TAL elements in field mice, bees and birds are reported on an mg/kg wet basis.

Results of the vegetation, small mammals, bees, and bird samples were compared with either RSRLs or baseline statistical reference levels (BSRLs). BSRLs are the upper-limit baseline data established over a four-year period (1996–1999) prior to the start-up of DARHT operations in 2000. The BSRLs, at the three sigma level, are based on data from Fresquez et al. (2001a) for vegetation, Haarmann (2001) for bees, and Bennett et al. (2001) for small mammals. The bird samples collected from DARHT were compared with bird samples collected from regional background locations and the RSRLs can be found in the present data. Also, RSRLs were used in other media where BSRLs were not available.

i. Vegetation Results at DARHT

Most of the understory vegetation results for radionuclides, with the exception of tritium, were lost in analysis (i.e., inadvertently destroyed by the analytical laboratory) (Table S8-8). However, no significant detections of radionuclides above RSRLs in understory vegetation at DARHT have been found in the past, and the concentrations of radionuclides are usually higher in overstory vegetation than in understory vegetation (Fresquez et al. 2007c; Figure 8-6). (Note: A possible explanation for this observation is that after a DARHT shot, the dust may become elevated and is probably caught on the sticky sap of the tree shoots.)

With respect to overstory vegetation, all radionuclide concentrations, with the exception of uranium-238, were either not detected or were detected below BSRLs. The highest concentrations of uranium-238 were detected in overstory vegetation collected from the north, east, and west sides of the DARHT perimeter, and the isotopic distribution of uranium-234 to uranium-238 indicates that the uranium in vegetation was made up of depleted uranium. Depleted uranium, which is used as a substitute for enriched uranium in weapon components tested at LANL, has also been detected in soil (Fresquez 2004), bees (Hathcock and Haarmann 2004), small mammals (Fresquez 2005), and birds (Fresquez et al. 2007a) at DARHT in previous years.

Although concentrations of uranium-238 appear to be increasing over time up to 2006, particularly on the north and east sides (principal wind directions), the 2007 results show a slight downward turn (Figure 8-7). These results correlate well with the soil data (Table S7-5) and may be associated with the change in contaminant mitigation from foam to the use of steel containment vessels during 2007. Nevertheless, all concentrations of uranium-238 in overstory vegetation at DARHT were still far below the SL (<889 pCi/g ash) and do not pose a potential unacceptable dose to the plants.

The results for the 23 TAL elements in both understory and overstory vegetation collected from around the DARHT facility is summarized in Table S8-9. All of the elements were either below the detection limits or detected below the BSRLs (or below the RSRLs when BSRL data were not available).

Last year, arsenic was detected in an overstory sample collected on the south side of the DARHT facility that measured 2.3 mg/kg; this was over six times the BSRL and above the SL of 2.1 mg/kg. This year, an analysis of the same trees showed normal concentrations of arsenic (<0.34 mg/kg). Since there is no history of arsenic contamination in soil, sediment, vegetation, or small mammals from within or around the DARHT facility, the abnormally high arsenic level in an overstory plant sample from the south side in 2006 may have been due to an analytical error. Nonetheless, we will continue to monitor.

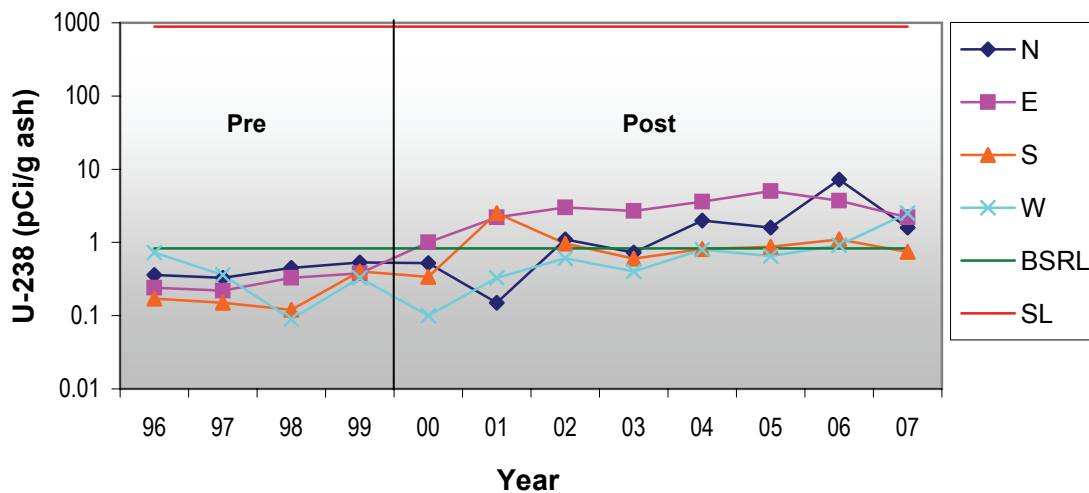


Figure 8-7. Uranium-238 in overstory vegetation collected from the north (N), east (E), south (S), and west (W) side of the DARHT facility at TA-15 from 1996 (pre-operation) through 2007 (during operations) compared with the baseline statistical reference level (BSRL) and the screening level (SL). Note the logarithmic scale on the vertical axis.

ii. Small Mammal Results at DARHT

All radionuclides were either not detected or below the BSRLs (Table S8-10), with the exception of uranium-238 in a composite mouse sample (five mice per sample) that was collected on the north side of the DARHT facility. Similarly, there were no other TAL inorganic chemicals in field mice that were higher than the RSRLs (Table S8-11).

The highest level of uranium-238 (2.4 pCi/g compared with the BSRL of 0.75 pCi/g ash) was far below the SL (<46 pCi/g ash) and does not pose a potential unacceptable dose to the mice. Like the soil and vegetation collected around certain sections of DARHT, the uranium in field mice was depleted uranium and uranium-238 concentrations appear to be increasing over time from preoperational levels (Figure 8-8).

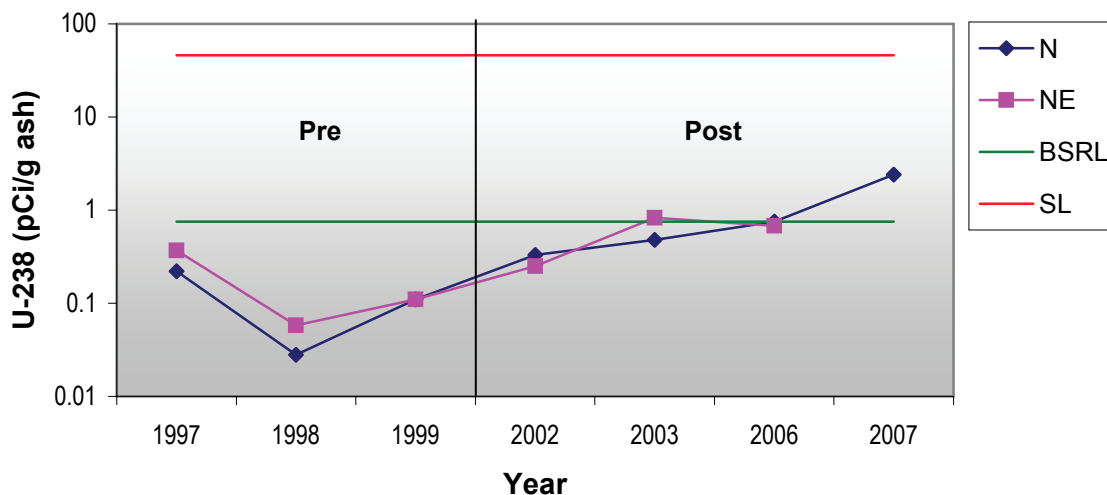


Figure 8-8. Uranium-238 in concentrations in (whole body) mice collected from the north (N) and northeast (NE) side of the DARHT facility at TA-15 from 1997 (pre-operation) through 2007 (during operations) compared with the baseline statistical reference level (BSRL) and the screening level (SL). Note the logarithmic scale on the vertical axis.

iii. Bird Results at DARHT

The work associated with bird sampling at DARHT during 2007 consisted of the following: (1) the analysis of three spotted towhee birds for TAL elements and (2) the comparison of species abundance and composition and trace element concentrations in birds (including the three birds collected in 2007) collected before (1999) and during operations (2002 through 2007) (Fresquez et al. 2007c).

Abundance and composition results show that the number and diversity of bird species generally increased over pre-operational levels with the greatest number of birds (412) and species (46) occurring in 2005. The most common bird species collected regardless of time periods were the chipping sparrow (*Spizella passerina*), the Virginia's warbler (*Vermivora virginiae*), the western bluebird (*Sialia mexicana*), the broad-tailed hummingbird (*Selasphorus platycercus*), the sage sparrow (*Amphispiza belli*), and the western tanager (*Piranga ludoviciana*).

Most radionuclides, with the exception of uranium-234 and uranium-238, in (whole body) birds collected after operations began were either not detected or were detected below RSRLs. Uranium-234 and uranium-238 concentrations (depleted uranium) in a few samples were far below screening levels and do not pose a potential unacceptable dose to the birds.

Many inorganic chemicals, particularly arsenic and silver, in birds collected before and after operations began were found in higher concentrations than RSRLs. Because birds (skin plus feathers) collected in the years before operations began contained higher levels of arsenic and silver than RSRLs and because there was no evidence of these metals in soil and sediment directly around the DARHT facility, the elevated levels of these metals in birds during early operations are probably not related to DARHT operations. Mean arsenic and silver concentrations in birds, however, have decreased over time to RSRLs in 2007 (Figure 8-9).

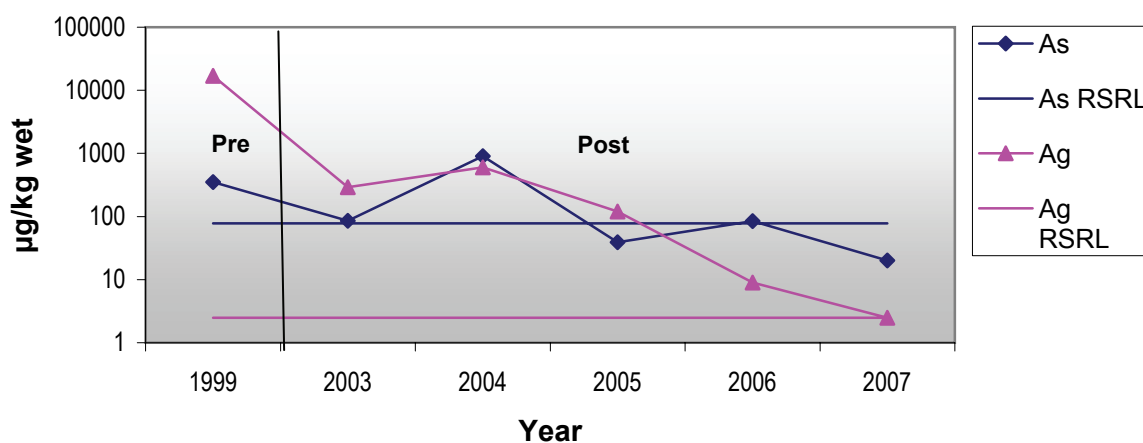


Figure 8-9. Mean arsenic (As) and silver (Ag) concentrations in birds collected near the DARHT facility at TA-15 from 1996 (pre-operations) through 2007 (during operations) compared with the regional statistical reference levels (RSRL). Note the logarithmic scale on the vertical axis.

iv. Bee Result

Most concentrations of radionuclides (Table S8-12) and TAL elements (Table S8-13) in bees sampled from four hives located northeast of the DARHT facility were below the BSRLs. The exceptions included uranium-234 and uranium-238 in three out of the four bee samples and barium and copper in all of the samples. The distribution of uranium-234 to uranium-238 indicated the presence of depleted uranium in two of the four samples. However, all concentrations of uranium-234 and uranium-238 were below SLs and, therefore, not a significant hazard to the bees.

C. SPECIAL STUDIES OF BIOTA

1. Characterization of Biotic and Abiotic Media Upstream of the Los Alamos Canyon Weir and the Pajarito Flood Control Retention Structure

In May 2000, a prescribed burn at Bandelier National Monument went out of control and burned nearly 50,000 acres of federal and pueblo land, including approximately 7,500 acres on LANL property. Because the Cerro Grande fire burned substantial amounts of vegetative cover, the Laboratory became concerned about increased sediment (and potential contaminant) transport from LANL to off-site locations. As a preventive measure, the US Army Corps of Engineers constructed two large erosion control structures to control storm water and sediment runoff from burned areas. These structures consist of (1) a low-head, rock-filled gabion weir that lies across the stream bed in Los Alamos Canyon near the junction of SR 4 and SR 502, and (2) a large cement flood retention structure located downstream of the confluence of Two-Mile and Pajarito Canyons.

As part of the Special Environmental Analysis of actions taken in response to the Cerro Grande Fire at LANL (DOE 2000), the DOE identified various mitigation measures that must be implemented under the Mitigation Action Plan as an extension of the fire suppression, erosion, and flood control actions. One of the tasks identified in the Mitigation Action Plan Section 2.1.7, “Mitigation Action for Soil, Surface and Ground Water, and Biota,” mandates the monitoring of soil, surface water, groundwater, and biota at areas of silt or water retention behind (upstream from) flood control structures, within silt retention basins, and within sediment traps to determine if there has been an increase in contaminant concentrations in these areas. To this end, we collected samples of sediment (0- to 6-in. depth), native grasses and forbs (unwashed), and deer mice (*Peromyscus* sp.) in the areas behind the Los Alamos Canyon Weir (LACW) and behind the Pajarito Canyon Flood Retention Structure (PCFRS). Samples were analyzed for some or all of the following constituents: radionuclides, TAL elements, HEs, SVOCs and polychlorinated biphenyls (PCBs). Paragon Analytics, Inc., processed and analyzed the sediment, vegetation, and field mice (whole body) samples for radionuclides and TAL elements; and HEs, SVOCs, and PCBs in sediments. The form of PCBs analyzed in sediment were mixtures (or “formulations”) of individual PCBs (congeners) called Aroclors. Specifically, Aroclors 1016, 1221, 1232, 1142, 1248, 1254, and 1260 were analyzed in sediment. Alta Analytical, Inc., analyzed the field mice (whole body) for individual PCB congeners. A congener is a specific PCB compound with a certain number of chlorine atoms in certain positions; theoretically, there are 209 possible congeners based on the possible number and position of chlorine atoms, but only about 120 congeners have ever been measured. The analytical method used by Alta was EPA Method 1668A—high resolution gas chromatography (GC) and high resolution mass spectrometry (MS). (Note: For additional clarification of the make-up of Aroclors and PCB congeners, see reports by the US Environmental Protection Agency and the Agency for Toxic Substances and Disease Registry (USEPA 2002, USEPA 1996, ATSDR 2000).

The following two sections report the 2007 results of this monitoring.

a. Los Alamos Canyon Weir Results

Concentrations of cesium-137, plutonium-238, plutonium-239/240, and americium-241 (Table S8-14); zinc, cadmium, lead, silver, and mercury (Table S8-15); and Aroclor 1260 (Table S8-16) in sediment upgradient of the LACW in 2007 were detected above the RSRLs. Although many of these constituents appear to be increasing in concentration since 2005 (Figure 8-10 and 8-11), they are still all below SLs and do not pose a potential unacceptable dose or risk to the public.

The results of the radionuclides and inorganic chemical analysis in understory vegetation collected upgradient of the LACW in 2007 are presented in Table S8-17 and Table S8-18, respectively. Most radionuclides and all of the TAL elements were either not detected or were detected below the RSRLs. The only radionuclides that were detected above the RSRLs in understory vegetation growing upgradient of the LACW were strontium-90, plutonium-239/240, and americium-241 (Figure 8-11). However, all concentrations of radionuclides detected in plants growing upgradient of the LACW were still far below SLs and do not pose an unacceptable dose to the plants.

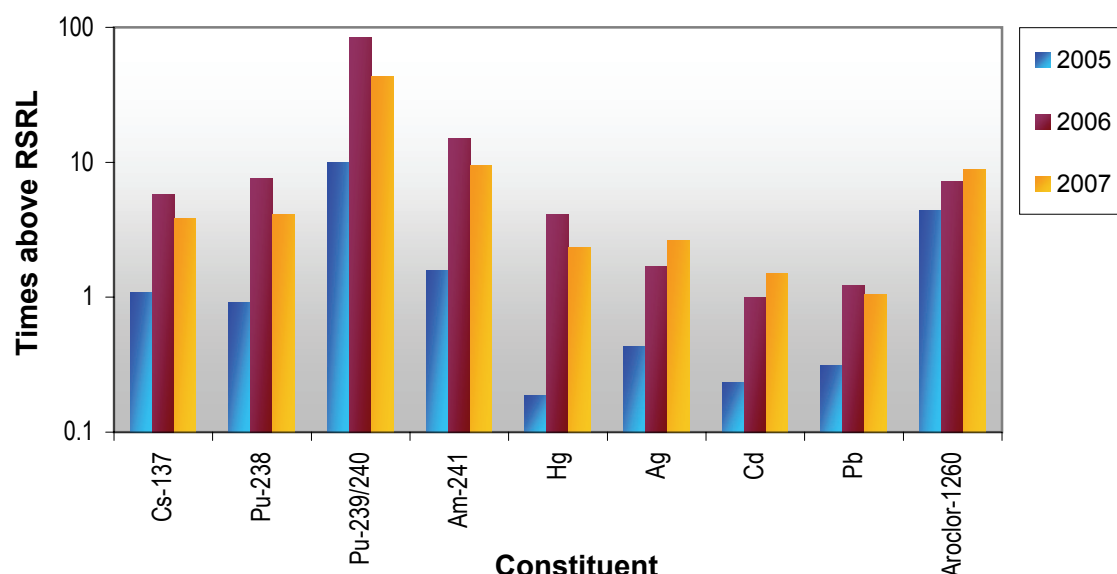


Figure 8-10. Times above the regional statistical reference levels (RSRL) for radionuclides, metals, and PCBs in sediments collected upgradient (upstream) of the Los Alamos Canyon Weir from 2005 through 2007. Note the logarithmic scale on the vertical axis.

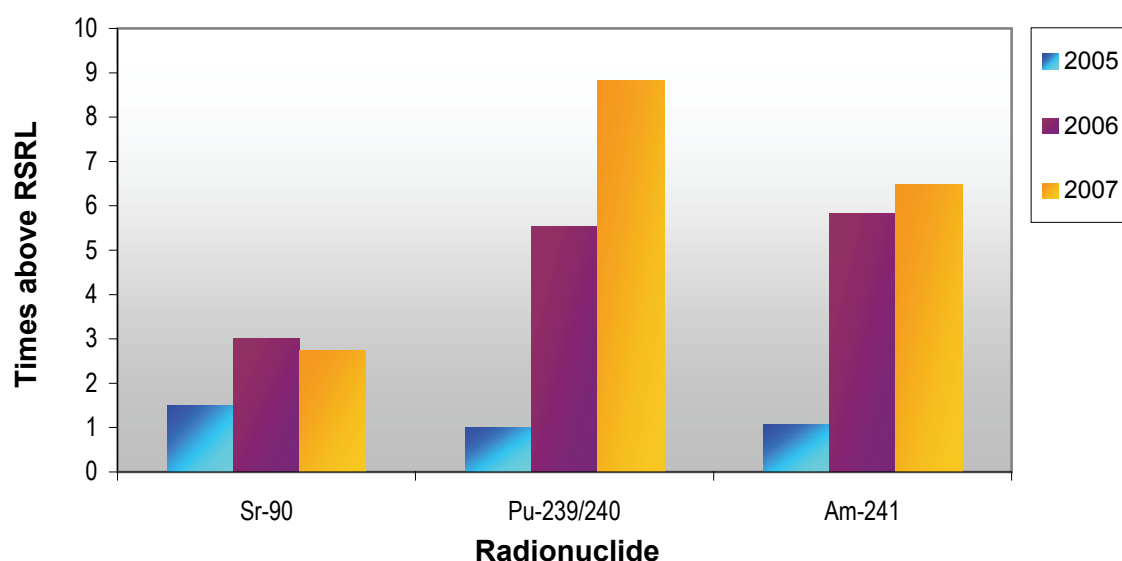


Figure 8-11. Times above the regional statistical reference level (RSRL) for radionuclides in vegetation collected upgradient (upstream) of the Los Alamos Canyon Weir from 2005 through 2007.

The concentrations of radionuclides, TAL elements, and PCBs in whole body mice samples upgradient of the LACW can be found in Tables S8-19, S8-20, and S8-21, respectively. Most concentrations of radionuclides and TAL elements in whole body mice samples were either not detected or below the RSRLs. The only radionuclides that were higher than the RSRLs included uranium-234, uranium-235, and uranium-238. However, the distribution of uranium-234 to uranium-238 indicates naturally occurring uranium and the amounts were below SLs. Thus, the dose to the mice is minimal and not a concern.

Of the TAL elements analyzed in the three field mice samples, only a few were detected above RSRLs. These elements include beryllium and thallium in one sample and cadmium in another sample. Because the amounts of these elements were just above the RSRLs and were not detected consistently across samples, the extent of contamination of these elements in field mice is probably minimal and not a risk to the animals.

Total PCBs (all congeners added) in all three mice samples collected upgradient of the LACW were in higher concentrations than the control sample. (Note: The control sample was collected from the TA-15 area near DARHT. Samples representing regional concentrations of PCBs, particularly from ephemeral stream bottoms containing deposited sediments, will be collected in the coming years to better characterize background; so caution is advised in the interpretation of this year's control data.). A comparison of the homologue classes (groups of biphenyls with the same number of chlorine atoms) show that the mice contained higher levels of total hexa and hepta chlorinated biphenyls than the other homologue groups (Figure 8-12), and the average distribution as a percentage of the total most closely matches the formulation of Aroclor 1260 (Figure 8-13) (EPA 1996). Aroclor 1260 was the only PCB detected in the sediment sample collected upgradient of the LACW (Table S8-16) and for animals of lower trophic levels there is a strong correlation between the sum of Aroclors and the total PCBs obtained from full congener determinations (i.e., it more closely matches the initial formulation in lower trophic level species) (Sather et al. 2001).

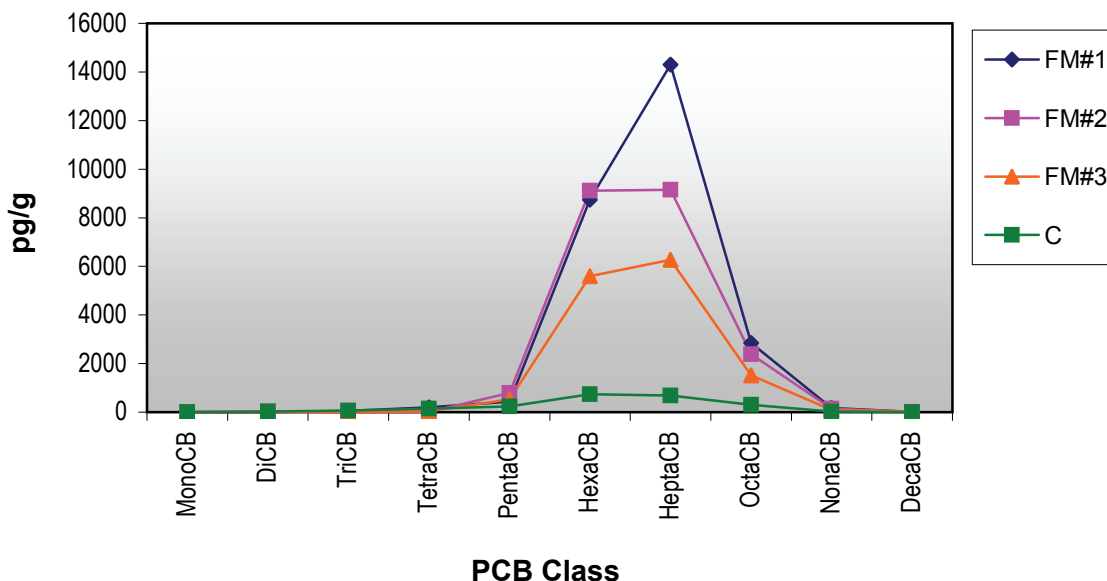


Figure 8-12. PCB homologue distribution for three field mice (FM) samples collected upgradient (upstream) of the Los Alamos Canyon Weir in 2007 with respect to the control (C) concentrations.

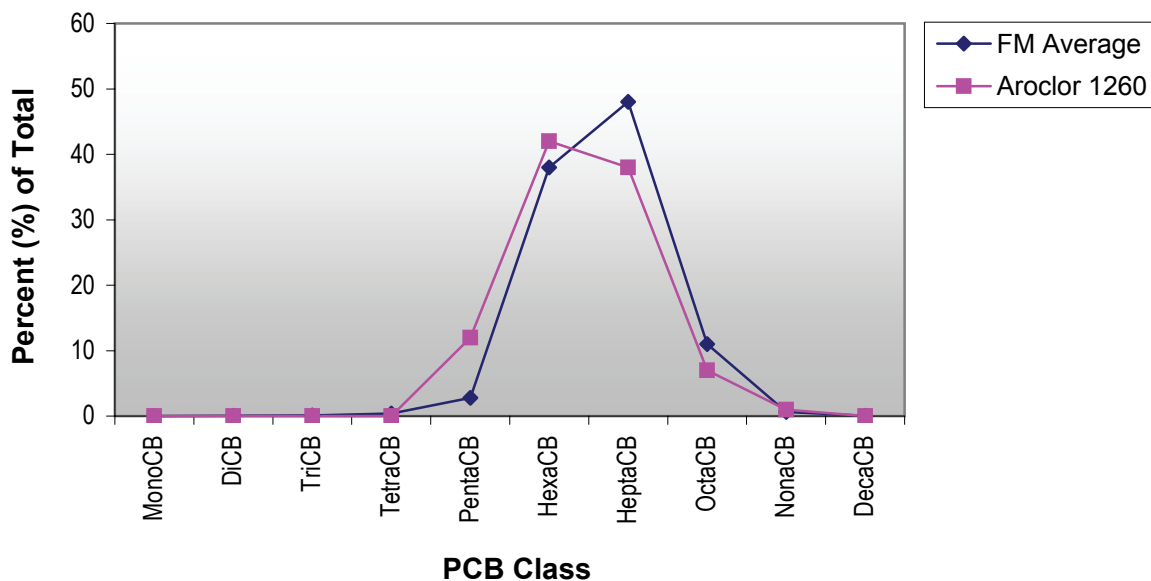


Figure 8-13. PCB homologue distribution for the average of three field mice (FM) collected upgradient (upstream) of the Los Alamos Canyon Weir in 2007 with respect to the formulation of Aroclor 1260 (EPA 1996).

Although the total PCB concentrations in the field mice samples collected upgradient of the LACW were higher than the control sample, the toxicity equivalency quotients (TEQ) in all three of the samples were generally comparable to each other. TEQs are a measure of the degree of toxicity based on the similarity of the 12 dioxin-like PCB congeners (# 77, 81, 105, 114, 118, 123, 126, 156, 157, 167, 169, and 189) to the most toxic dioxin, tetrachlorodibenzodioxin (TCDD). The total TEQ for each sample was derived by multiplying the concentration of each of the 12 dioxin-like PCBs by a TCDD equivalency factor (TEF) and then summing the values (Van den Berg et al. 2006). So there was generally no difference in the toxicity of PCBs in mice above the LACW compared with the control.

Overall, the concentrations of all radionuclides, TAL elements, and PCBs in all biotic and abiotic media sampled upgradient of the LACW were below SLs and do not pose a potential unacceptable dose from radionuclides or risk from chemicals to humans (sediment) or to the biota sampled.

b. Pajarito Canyon Flood Retention Structure Results

Radionuclides, TAL elements, and PCB results from sediment, vegetation, and small mammal samples collected upgradient (upstream) of the PCFRS in 2007 are presented in Table S8-22 through Table S8-29. In general, most concentrations of radionuclides, TAL elements, and/or PCBs in biotic and abiotic media collected upgradient of the PCFRS were either not detected or below the RSRLs. The few exceptions included the following: plutonium-239/240, uranium-238, cadmium, silver, and mercury in sediment (Figure 8-14); sodium in understory vegetation; and uranium-234, uranium-235, and uranium-238 in field mice (Figure 8-15). All of the detected constituents were just above the RSRL and far below SLs (for the radionuclides) and did not change significantly in concentrations from the year before; many, in fact, have decreased.

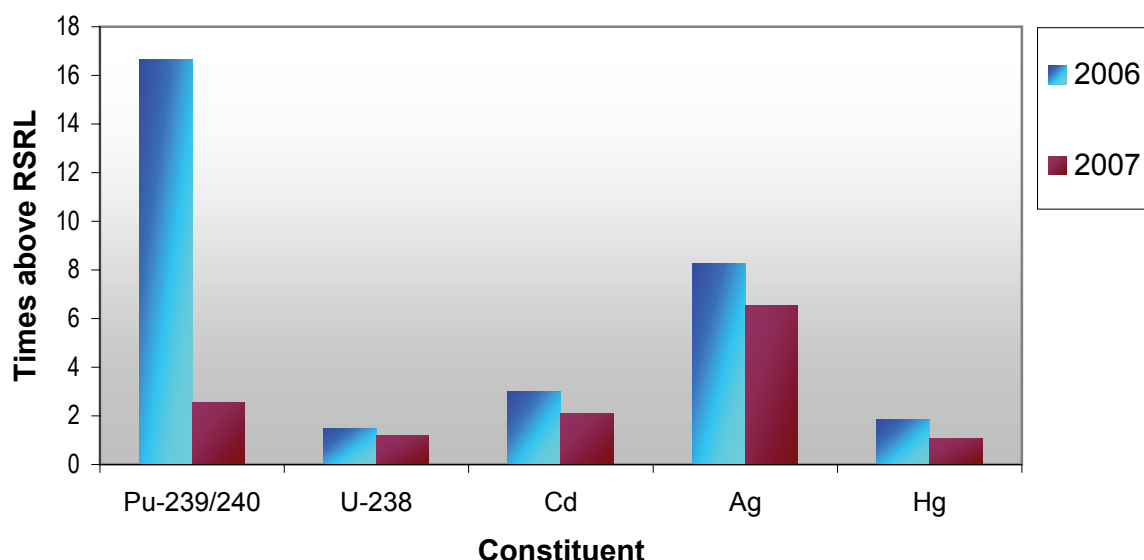


Figure 8-14. Times above the regional statistical reference levels (RSRLs) for radionuclides, and metals in sediments collected upgradient (upstream) of the Pajarito Canyon Flood Retention Structure in 2006 and 2007.

PCBs in field mice samples can be found in Table S8-29. Samples of field mice analyzed for PCBs show mixed results; one sample was similar to the control sample, one sample was slightly above the control sample, and the other sample was quite higher than the control sample (Figure 8-16). (Note: The control sample was collected from the TA-15 area near DARHT and more regional samples, particularly from ephemeral stream bottoms containing deposited sediments, will be collected in the coming years to better characterize background; so caution is advised.) Although there were no Aroclors detected in the sediments upgradient of the PCFRS

in 2007 (Table S8-24) and no detections in storm water runoff within this canyon system (Gallaher 2007, Figure 6-14), we will continue to collect and analyze field mice from this area, including background, to get a better understanding of the extent of PCB contamination, if any, from this area of potential concern. At present, it appears that one out of the three field mice sampled for PCBs may be an outlier, possibly a result of cross contamination during sampling or within the analytical laboratory.

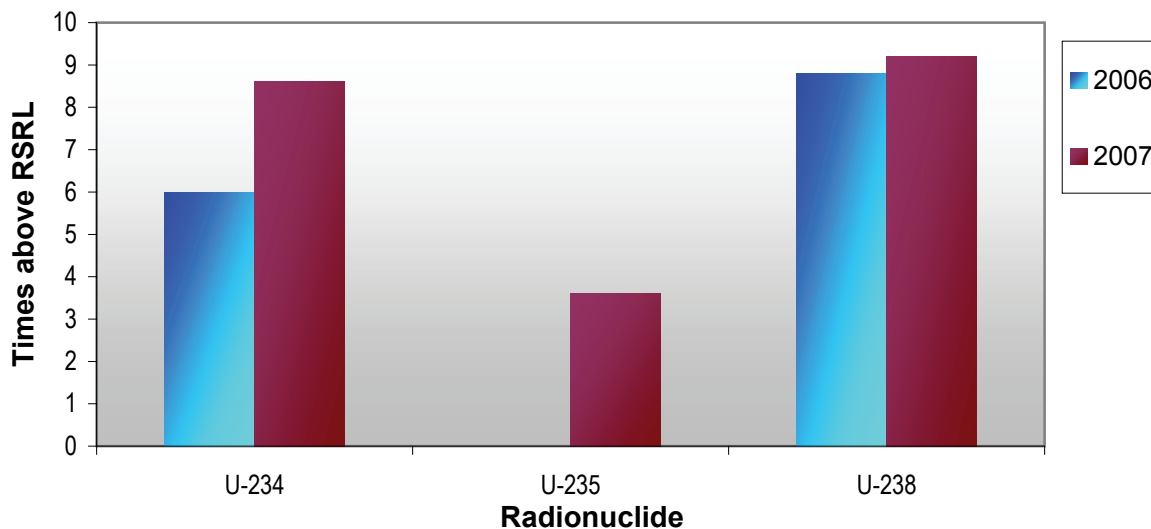


Figure 8-15. Times above the regional statistical reference levels (RSRLs) for uranium-234, uranium-235 and uranium-238 in field mice collected upgradient (upstream) of the Pajarito Canyon Flood Retention Structure in 2006 and 2007.

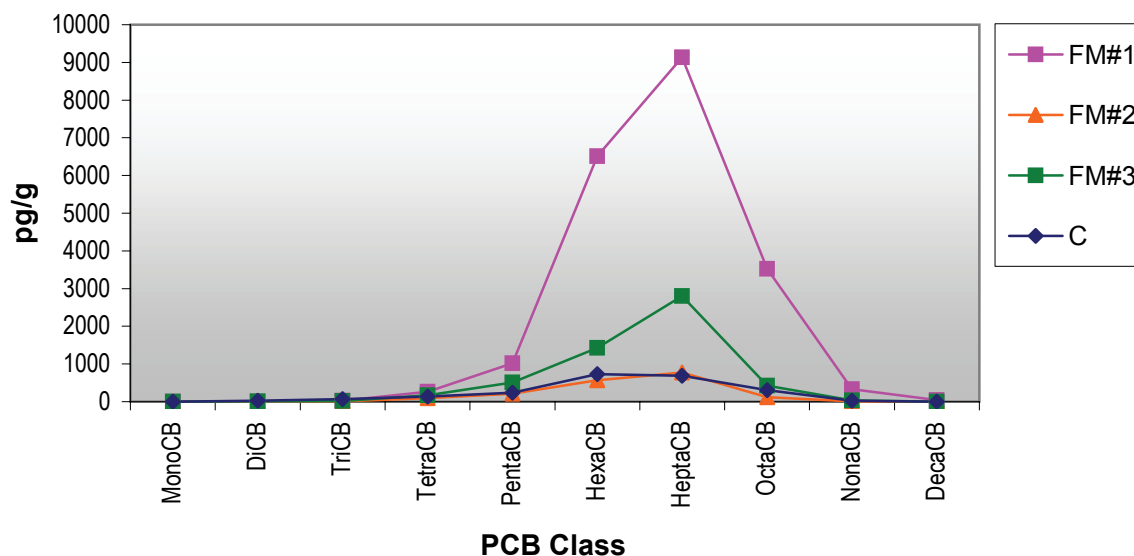


Figure 8-16. PCB homologue distribution for three field mice (FM) samples collected upgradient (upstream) of the Pajarito Canyon Flood Retention Structure in 2007 with respect to control (C) concentrations.

D. QUALITY ASSURANCE FOR THE SOIL, FOODSTUFFS AND BIOTA PROGRAM

This program uses the same quality assurance (QA) protocols and analytical laboratories described in Chapter 7.

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9. Environmental Restoration



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A. INTRODUCTION

The environmental programs at Los Alamos National Laboratory (LANL or the Laboratory) address the problems caused by current and past LANL operations by bringing together multi-disciplinary, world-class science, engineering, and state-of-the-art management practices. The Laboratory's goals are to protect human health and the environment and to meet environmental clean-up requirements. The Environmental Programs (EP) Directorate is leading the Laboratory's effort to clean up sites and facilities formerly involved in weapons research and development.

The New Mexico Environment Department (NMED) regulates the cleanup of hazardous wastes and hazardous constituents under the New Mexico Hazardous Waste Act. Corrective actions for the releases of hazardous waste and hazardous constituents at the Laboratory are subject to the March 1, 2005 Compliance Order on Consent (the Consent Order). The Consent Order was issued pursuant to the New Mexico Hazardous Waste Act (New Mexico Statutes Annotated [NMSA] 1978, § 74-4-10) and the New Mexico Solid Waste Act (NMSA 1978, §74-9-36[D]).

The US Department of Energy (DOE) regulates the cleanup of radioactive contamination. Radionuclides are regulated under DOE Order 5400.5, "Radiation Protection of the Public and the Environment," and DOE Order 435.1, "Radioactive Waste Management." DOE is implementing corrective actions pursuant to the Atomic Energy Act for releases of radionuclides in conjunction with the activities required under the Consent Order.

1. Projects

LANL manages investigation and remediation activities under three projects: the Corrective Actions Project, the Water Stewardship Project, and the Technical Area (TA)-21 Closure Project. The sites under investigation in these projects are designated as consolidated units, solid waste management units (SWMUs), or areas of concern (AOCs). The projects collect, manage, and report environmental data and utilize the data to support site decisions.

a. Corrective Action Project

This project includes the investigation and possible remediation of consolidated units, SWMUs, and AOCs intermixed with active Laboratory operations as well as sites located within the Los Alamos townsite (property currently owned by private citizens, businesses, or Los Alamos County) and on property administered by the US Forest Service (USFS), the National Park Service, and the DOE.

b. Water Stewardship Project

This project includes the canyons investigations, the groundwater monitoring program (implemented through the Interim Facility-Wide Groundwater Monitoring Plan [LANL 2007a]), storm water monitoring, and the implementation of best management practices to minimize erosion.

The purpose of the Water Stewardship Project is to:

- Integrate what is known about sources, pathways, and monitoring data into clean-up decisions and the evaluation and optimization of the groundwater monitoring network
- Protect drinking water

c. TA-21 Closure Project

This project includes the investigation and the implementation of corrective actions for Material Disposal Areas (MDAs) A, B, T, U, and V; various process waste lines; a radioactive waste treatment system; and the Delta Prime (DP) Site Aggregate Area that includes sumps, outfalls, leach fields, historic container storage areas, and other former facilities.

Sites at TA-21 will be stabilized to reduce or eliminate radioactive and hazardous materials releases and the property will remain under institutional control and monitored as part of the environmental surveillance and stewardship process. Properties on the west end adjacent to DP Road will be remediated and, where possible, released for transfer to Los Alamos County or the school district to create a community development corridor.

2. Work Plans and Reports

The three projects wrote and/or revised 23 work plans and 23 reports and submitted them to NMED during calendar year 2007. The work plans propose investigation activities designed to characterize SWMUs, AOCs, consolidated units, aggregates, canyons, and watersheds. The data, which are presented in remedy completion or investigation reports, are used to determine if the nature and extent of contamination are defined and determine the potential risks to human health and the environment posed by contaminants. Depending on the data and the assessment results, sites may require additional investigation, remediation, monitoring, or no further action.

Tables 9-1 and 9-2 summarize the work plans and reports submitted and approved in 2007, the work plans and reports submitted prior to 2007 but approved in 2007, and the work plans and reports submitted in 2007 but not yet approved. Table 9-3 summarizes other reports, plans, and documents submitted in 2007. Table 9-4 summarizes the eight SWMUs and AOCs that have been completed and for which NMED granted Certificates of Completion under the Consent Order during 2007. The remainder of this chapter presents summaries of the investigations for which activities were started, continued, and/or completed in 2007 and those investigations for which reports were submitted in 2007. Figures 9-1 and 9-2 show the locations where significant environmental characterization or remediation work was performed in 2007.



Table 9-1
Work Plans Submitted and/or Approved in 2007

| Document Title | Date Submitted | Date Approved | Status |
|--|----------------|-------------------------|---|
| Pajarito Canyon Biota Investigation Work Plan | 8/1/2006 | 5/29/2007 | Work to be completed in 2008 |
| Investigation Work Plan for South Canyons | 9/28/2006 | 3/28/2007 ^a | Sampling scheduled to start in 2008 |
| Cañon de Valle Aggregate Area Investigation Work Plan | 9/29/2006 | 2/9/2007 ^a | Sampling scheduled to start in 2009 |
| Investigation/Remediation Work Plan for Material Disposal Area B, Solid Waste Management Unit 21-015, at TA-21, Revision 1 | 10/23/2006 | 1/31/2007 ^a | Site preparation underway |
| Addendum to the Work Plan for Sandia Canyon and Cañada del Buey | 1/30/2007 | 3/3/2007 ^a | Work is ongoing |
| Phase 2 Investigation Work Plan for MDA T | 2/15/2007 | 4/9/2007 ^a | Phase 2 report submitted |
| Material Disposal Area C Phase 2 Investigation Work Plan | 4/23/2007 | n/a ^b | Work plan revised |
| MDA C Phase 2 Investigation Work Plan, Revision 1 | 7/30/2007 | 8/13/2007 ^a | Work is ongoing |
| Corrective Measures Implementation Plan, Consolidated Unit 16-021(c)-99 | 5/11/2007 | n/a | Work plan revised |
| Corrective Measures Implementation Plan, Consolidated Unit 16-021(c)-99, Revision 1 | 7/30/2007 | 8/17/2007 | Implementation of corrective measures scheduled |
| Corrective Measures Evaluation Plan for MDA G at TA-54, Revision 1 | 7/13/2007 | n/a | Work plan revised |
| Corrective Measures Evaluation Plan for MDA G at TA-54, Revision 2 | 10/15/2007 | 10/29/2007 ^a | Proceeding with corrective measures evaluation |
| Sampling Data for Area of Elevated Radioactivity Near Location ID 21-02523 and North of Absorption Bed 3, Consolidated Unit 21-018(a)-99, Material Disposal Area V, at TA-21 | 7/3/2007 | 8/9/2007 | Remediation and sampling conducted in 2007 |
| Interim Subsurface Vapor Monitoring Plan for MDA L at TA-54 | 8/31/2007 | n/a | Work plan revised |
| Interim Subsurface Vapor Monitoring Plan for MDA L at TA-54, Revision 1 | 10/30/2007 | 11/8/2007 ^a | Vapor monitoring is ongoing |
| Sandia Canyon Biota Investigation Work Plan | 9/19/2007 | — ^c | Under review in 2007 |
| S-Site Aggregate Area Investigation Work Plan | 9/30/2007 | n/a | Work plan revised |
| S-Site Aggregate Area Investigation Work Plan, Revision 1 | 12/21/2007 | — | Under review in 2007 |
| S-Site Aggregate Area Historical Investigation Report | 9/30/2007 | n/a | n/a |
| North Ancho Canyon Aggregate Area Investigation Work Plan | 9/30/2007 | n/a | Work plan revised |
| North Ancho Canyon Aggregate Area Investigation Work Plan, Revision 1 | 12/14/2007 | — | Under review in 2007 |
| North Ancho Canyon Aggregate Area Historical Investigation Report | 9/30/2007 | n/a | n/a |
| Subsurface Vapor Monitoring Plan MDA T at TA-21 | 10/19/2007 | 10/31/2007 ^a | Vapor monitoring is ongoing |
| Work Plan for Implementing SVE Pilot Test for MDA G | 10/25/2007 | 11/19/2007 ^a | Soil vapor extraction test to start in 2008 |

Table 9-1 (continued)

| Document Title | Date Submitted | Date Approved | Status |
|--|----------------|---------------|----------------------|
| Middle Cañada del Buey Aggregate Area Investigation Work Plan | 10/31/2007 | n/a | Work plan revised |
| Middle Cañada del Buey Aggregate Area Investigation Work Plan, Revision 1 | 12/21/2007 | — | Under review in 2007 |
| Middle Cañada del Buey Aggregate Area Historical Investigation Report | 10/31/2007 | n/a | n/a |
| Investigation Work Plan for Non-Nuclear Environmental Sites at TA-49 | 10/31/2007 | — | Under review in 2007 |
| Historical Investigation Report for Non-Nuclear Environmental Sites at TA-49 | 10/31/2007 | n/a | n/a |
| Investigation Work Plan for Nuclear Environmental Sites at TA-49 | 10/31/2007 | — | Under review in 2007 |
| Historical Investigation Report for Nuclear Environmental Sites at TA-49 | 10/31/2007 | n/a | n/a |

^a Work plans approved with modifications and/or directions.

^b n/a = Not applicable.

^c “—” = Approval not received in 2007.

Table 9-2
Reports Submitted and/or Approved in 2007

| Document Title | Date Submitted | Date Approved | Status |
|---|----------------|------------------------|---|
| Corrective measures Report for Material Disposal Area H, Solid Waste Management Unit 54-004, at TA-54, Revision 1 | 6/1/2005 | 11/5/2007 | NMED selected corrective measures/remedies for MDA H pending public comment |
| Interim Measures Completion Report Solid Waste Management Unit 73-001(a) at TA-73 | 3/1/2004 | 5/21/2007 ^a | Work completed |
| Los Alamos and Pueblo Canyons Supplemental Investigation Report (revised risk assessment) | 12/15/2005 | 8/30/2007 ^a | Additional activities required |
| Investigation Report for Solid Waste Management Units 03-010(a) and 03-001(e) at TA-3 | 4/20/2006 | 5/14/2007 | Additional investigation required |
| Status Report for the Solid Waste Management Units 03-010(a) and 03-001(e) at TA-03 | 7/16/2007 | 8/30/2007 | Interim measures and monitoring implemented |
| Investigation Report for Material Disposal Area T, Consolidated Unit 21-016(a)-99, at TA-21 | 9/18/2006 | 2/15/2007 ^a | Phase 2 Work Plan submitted and work completed |
| MDA T Phase 2 Investigation Report | 11/15/2007 | — ^b | Under review in 2007 |
| Investigation Report for Material Disposal Area A, Solid Waste Management Unit 21-014, at TA-21 | 11/9/2006 | 2/12/2007 ^a | Collected additional pore gas samples, abandoned boreholes, and submitted status report |
| Final Status Report for Supplemental Sampling at MDA A, TA-21 Table 9-2 (continued) | 12/5/2007 | — | Under review in 2007 |
| Remedy Completion Report for Area of Concern 16-024(v) and Solid Waste Management Units 16-026(r) and 16-031(f) | 3/9/2007 | n/a ^c | Report revised |
| Remedy Completion Report for Area of Concern 16-024(v) and Solid Waste Management Units 16-026(r) and 16-031(f), Revision 1 | 6/19/2007 | 6/27/2007 | Work completed |

Table 9-2 (continued)

| Document Title | Date Submitted | Date Approved | Status |
|---|----------------|-------------------------|---|
| Summary of North Canyons Phase 1 Sediment Investigations | 3/12/2007 | 5/7/2007 | Phase 2 sampling completed |
| Summary of North Canyons Phase 1 Sediment Investigations Addendum 1 | 4/11/2007 | 5/7/2007 | Phase 2 sampling completed |
| Summary of Pajarito Canyon Phase 2 Sediment Investigations | 3/26/2007 | 5/29/2007 | Phase 3 sampling ongoing |
| Remedy Completion Report for SWMU 61-002 | 5/3/2007 | n/a | Report revised |
| Remedy Completion Report for SWMU 61-002, Revision 1 | 11/30/2007 | — | Under review in 2007 |
| Addendum to the Investigation Report for Material Disposal Area G, Consolidated Unit 54-013(b)-99, at TA-54 | 5/16/2007 | 6/8/2007 ^a | Proceeding with CME |
| Addendum to the Investigation Report for MDA L | 5/31/2007 | 7/18/2007 ^a | Proceeding with CME |
| Remedy Completion Report DOE-LASO Airport landfill SWMUs 73-001(a) and 73-001(d) | 4/15/2007 | 8/8/2007 | Work completed |
| Mortandad Canyon Investigation Report | 10/27/2006 | 2/23/2007 ^a | Risk assessments revised |
| Revised Risk Assessments for Mortandad Canyon Investigation Report | 7/2/2007 | n/a | Approved response |
| Investigation Report for Consolidated Unit 73-002-99 and Corrective Action of Solid Waste Management Unit 73-002 at TA-73 | 7/6/2007 | 8/13/2007 | Work completed |
| Investigation Report for Consolidated Unit 21-018(a)-99, Material Disposal Area V, at TA-21, Revision 1 | 7/16/2007 | 8/13/2007 | Additional investigation activities required |
| Investigation Report for Mortandad/Ten Site Canyons Aggregate Area, Revision 1 | 7/20/2007 | — | Under review in 2007 |
| Investigation Report for Intermediate and Regional Groundwater, Consolidated Unit 16-021(c)-99 | 8/31/2006 | 11/29/2006 ^c | Additional drilling and sampling activities required |
| CME Report for Intermediate and Regional Groundwater Associated with Consolidated Unit 16-021(c)-99 | 8/31/2007 | — | Under review in 2007 |
| Investigation Report for Guaje, Barrancas, Rendija Canyons Aggregate Areas | 8/31/2007 | n/a | Report revised |
| Summary of Sandia Canyon Phase 1 Sediment Investigations | 9/14/07 | n/a | Under review in 2007 |
| Investigation Report for Guaje, Barrancas, Rendija Canyons Aggregate Areas, Revision 1 | 11/29/2007 | — | Under review in 2007 |
| Investigation Report for DP Site Aggregate Area | 11/7/2007 | — | Under review in 2007 |
| Investigation Report for Consolidated Units 16-007(a)-99 and 16-008(a)-99 | 11/15/2007 | — | Under review in 2007 |
| Investigation Report for the TA-16-340 Complex | 1/31/2006 | 10/25/2006 ^c | Additional sampling to be implemented in FY 2008 |
| Interim Measures Investigation Report for Chromium Contamination in Groundwater | 11/30/2006 | 12/27/2006 ^c | Additional investigation activities required; Drilling, modeling and geochemistry studies implemented |

^a Reports approved with modifications and/or directions.

^b "—" = Approval not received in 2007.

^c n/a = Not applicable.

Table 9-3
Additional Plans and Reports Submitted in 2007

| Document Title | Date Submitted |
|--|----------------|
| Periodic Monitoring Reports | |
| Los Alamos Watershed | 1/25/2007 |
| Pajarito Watershed | 3/12/2007 |
| White Rock Watershed | 6/8/2007 |
| Sandia Watershed | 6/8/2007 |
| Ancho Watershed | 8/16/2007 |
| Water Canyon/ Cañon de Valle Watershed | 9/19/2007 |
| Mortandad Watershed | 10/22/2007 |
| Sandia Watershed | 10/22/2007 |
| Ancho Watershed | 11/30/2007 |
| White Rock Watershed | 11/30/2007 |
| Water Canyon/ Cañon de Valle Watershed | 11/30/2007 |
| Los Alamos Watershed | 11/30/2007 |
| Pajarito Watershed | 11/30/2007 |
| Monthly Groundwater Data Reviews | Monthly |
| Vapor Sampling MDA H | 11/30/2007 |
| Vapor Sampling MDA L | 12/10/2007 |
| Well Work Plans and Reports | |
| Well Screen Analysis Report, Revision 1 | 2/20/2007 |
| Pilot Well Rehabilitation Study Summary Report | 3/16/2007 |
| Amendment to Drilling Methodology for Regional Groundwater Monitoring Well R-28 | 3/23/2007 |
| Final Completion Report for Intermediate Well R-3i | 4/30/2007 |
| Plan for Screen Isolation/Abandonment and Well Replacement (R-25) | 4/30/2007 |
| Evaluation of Suitability of Wells near TA-16 for Monitoring Contaminant Releases from SWMU 16-021(c)-99 | 4/30/2007 |
| Well Screen Analysis Report, Revision 2 | 5/10/2007 |
| Work Plan for R-Well Rehabilitation and Replacement, Revision 1 | 6/13/2007 |
| Mortandad Canyon Well Evaluation and Network Recommendations | 6/28/2007 |
| Drilling Work Plan for Regional Aquifer Well R-25b | 6/29/2007 |
| Drilling Work Plan for Regional Well R-36 | 6/29/2007 |
| Summary Report on Potential Sources of Perchlorate Found in Perched-Intermediate and Regional Groundwater Beneath the Los Alamos and Pueblo Canyon Watershed | 7/9/2007 |
| Well Evaluation and Network Recommendations, TA-54 | 7/31/2007 |
| Work Plan for R-Well Rehabilitation and Replacement, Revision 2 | 7/31/2007 |
| Evaluation of Sampling Systems for Multiple-Completion Regional Aquifer Wells at LANL | 8/27/2007 |
| Work Plan for R-Well Rehabilitation and Replacement, Revised Table | 9/7/2007 |
| Completion Report for Regional Aquifer Wells R-35a and R-35b | 9/14/2007 |
| Evaluation of Suitability of Wells near TA-16 for Monitoring Contaminant Releases from SWMU 16-021(c)-99, Revision 1 | 9/28/2007 |

Table 9-4
SWMUs and AOCs Granted Certificates of Completion in 2007

| Site | Corrective Action Complete with Controls | Corrective Action Complete without Controls | Date Approved |
|----------------|---|--|---------------|
| SWMU 54-007(a) | X | | 5/29/2007 |
| AOC 16-024(v) | | X | 6/29/2007 |
| SWMU 16-031(f) | | X | 6/29/2007 |
| SWMU 73-002 | X | | 8/13/2007 |
| AOC 73-003 | X | | 8/13/2007 |
| SWMU 73-004(a) | X | | 8/13/2007 |
| SWMU 73-004(b) | X | | 8/13/2007 |
| SWMU 73-006 | X | | 8/13/2007 |



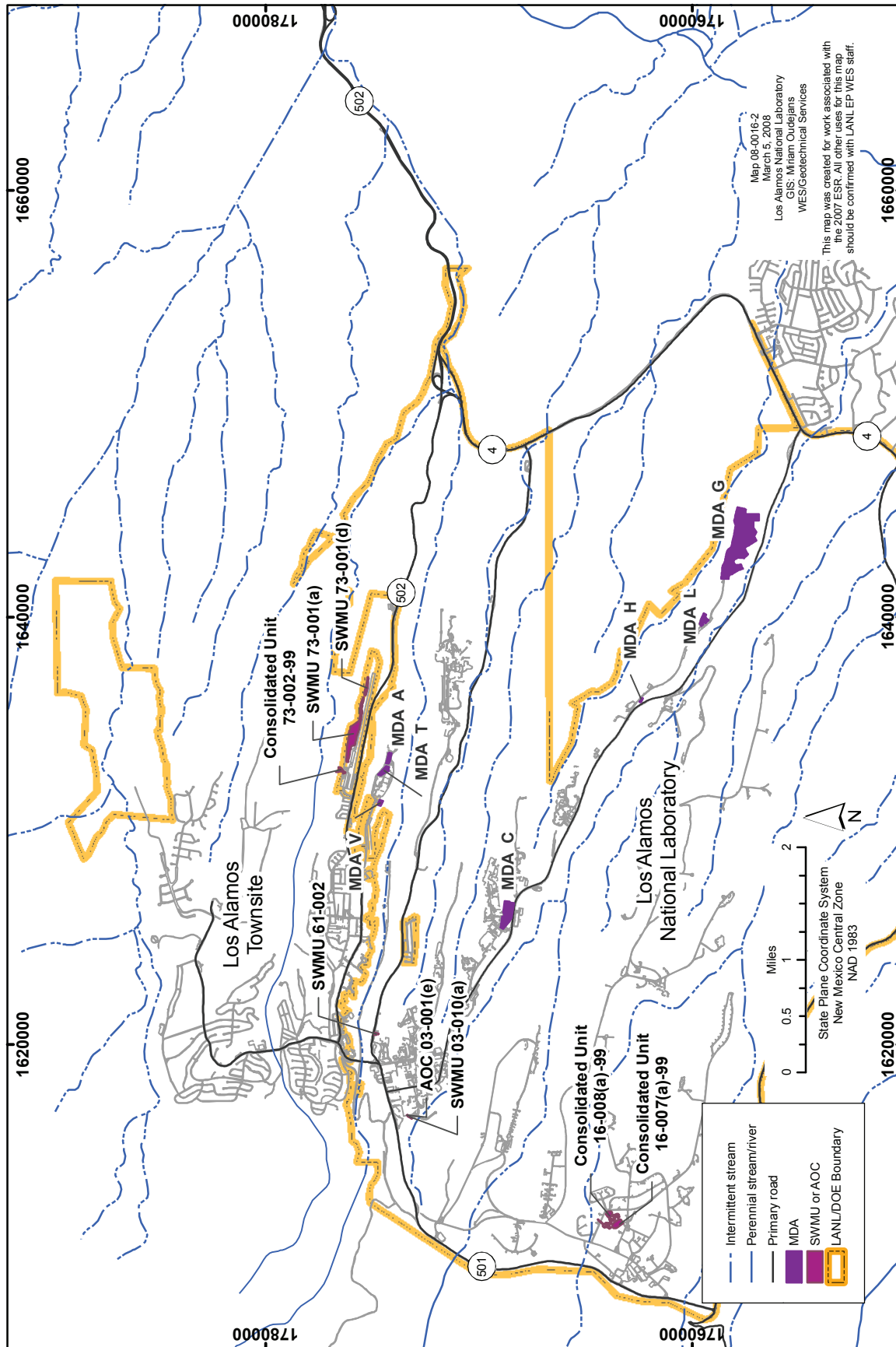


Figure 9-1. Location of MDAs and other SWMUs or AOCs where remediation and/or characterization work was performed in 2007.

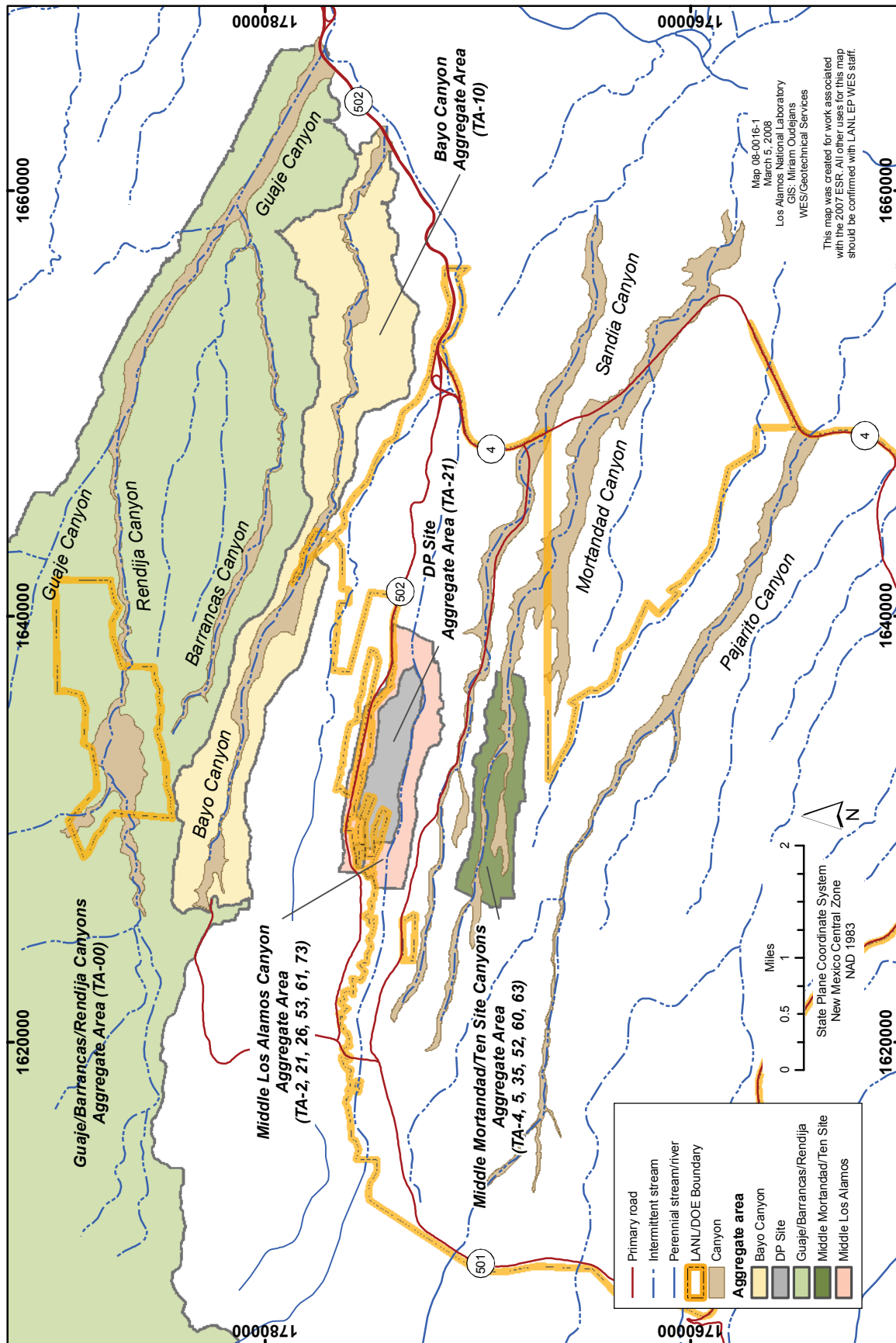


Figure 9-2. Location of canyons and aggregate areas where remediation work was performed in 2007.

B. CORRECTIVE ACTION PROJECT

The Laboratory and DOE conducted the following investigations and activities in 2007:

- Investigation of SWMU 61-002 was completed, and the remedy completion report was submitted.
- Phase 2 work plan for MDA C was submitted and approved; required additional sampling was started.
- Investigations for the Guaje, Barrancas, Rendija Canyons Aggregate Areas were completed, and the investigation report was submitted.
- The remedy completion report for AOC 16-024(v) and SWMUs 16-026(r) and 16-031(f) was submitted and approved.
- Field investigations were concluded for Consolidated Units 16-007(a)-99 (30s Line) and 16-008(a)-99 (90s Line), and the investigation report was submitted.
- Field investigations were completed for the Bayo Canyon Aggregate Area and the Middle Los Alamos Canyon Aggregate Area.
- Interim measures and monitoring at SWMUs 03-010(a) and 03-001(e) were implemented. The status report was submitted.
- Supplemental sampling at MDA G was completed. An addendum to the investigation report for MDA G was submitted and approved.
- Supplemental sampling at MDA L was completed. An addendum to the investigation report for MDA L was submitted and approved.
- A vapor monitoring plan for MDA L and revision 1 was submitted and approved. Vapor monitoring activities are ongoing.
- Investigation/remediation at Consolidated Unit 73-002-99 (Airport Ashpile) was completed. The investigation report was submitted and approved.
- Additional sampling and remediation for the Middle Mortandad/Ten Site Canyons Aggregate Area was conducted, and the revised investigation report was submitted.
- Vapor monitoring at MDAs H and L was conducted, and periodic monitoring reports were submitted.

In addition, the NMED approved the corrective measures study report for MDA H (LANL 2006a) and selected proposed remedies for MDA H pending public comment (NMED 2007a). The remedies include the complete encapsulation of the disposal shafts, the installation of an engineered evapotranspiration cover, and a soil vapor extraction system.

The following sections summarize the investigations started, continued, and/or completed in 2007.

1. SWMU 61-002

a. Site Description and History

SWMU 61-002 is a former storage area located east of the Radio Repair Shop on the south side of Jemez Road. The SWMU was historically used to store capacitors, transformers, oil-filled containers, and unmarked containers. Before 1985, used oil contaminated with polychlorinated biphenyls (PCBs) was stored in containers within the fenced area. The area was also used to store large spools of wire and cable.

b. Remediation and Sampling Activities

The Laboratory initially conducted corrective action activities at SWMU 61-002 because this site was in the path of the security perimeter road and would be inaccessible after construction (LANL 2005a). During the 2005 investigation, the Laboratory discovered an area of petroleum-contaminated soil and buried fuel lines in the northwest portion of the SWMU.

Additional sampling was conducted to characterize the extent of the petroleum contamination (LANL 2006b; NMED 2006a). Fifteen samples were collected from eight borehole locations in and around the area of petroleum hydrocarbon contamination.

c. Conclusions and Recommendations

The Laboratory completed additional fieldwork at SWMU 61-002 in 2006 and submitted the remedy completion report in 2007, describing all the activities conducted in 2005 and 2006 and presenting the results (LANL 2007b).

Data confirmed that the residual petroleum hydrocarbon contamination is limited to a small subsurface area. The site is characterized and the nature and extent of contamination are defined. The risk screening assessments indicate there is no potential unacceptable risk to human health for the industrial and construction worker scenarios as well as ecological receptors. In addition, a Tier One Evaluation conducted in accordance with Title 20, Chapter 5, Part 12 of the New Mexico Administrative Code (20.5.12 NMAC) shows that the residual contamination does not pose a potential future hazard to groundwater.

The Laboratory requested a Certificate of Completion for Corrective Action Complete with Controls for SWMU 61-002 based on the results of the investigation and remediation activities. The recommendation for Corrective Action Complete with Controls is appropriate because the cleanup levels and goals under an industrial scenario were met; controls are required to restrict land use of the property. The Laboratory intends to retain ownership of the property indefinitely and will continue to restrict the property to industrial use only. Controls on future construction activities will be implemented to ensure protection of construction workers through LANL's Permits and Requirements Identification System and Excavation Permit System.

Following NMED review, a revised remedy completion report was submitted (LANL 2007c). The site recommendation is pending NMED review.

2. AOC 16-024(v) and SWMUs 16-026(r) and 16-031(f)

a. Site Description and History

AOC 16-024(v) and SWMUs 16-026(r) and 16-031(f) are located on a mesa top of the Pajarito Plateau in the western portion of TA-16.

AOC 16-024(v) is the location of a former high explosive (HE) storage magazine constructed in 1944 and located approximately 100 ft east of the TA-16 steam plant. The structure was used as an HE magazine until 1946 and then used for general storage until it was removed in 1968.

SWMU 16-026(r) is an inactive drainline and outfall from the oil-water separator at fire station #5. The oil-water separator and discharge line are inactive and the floor drains are rerouted to the sanitary sewer.

SWMU 16-031(f) is the former outfall from a decommissioned drinking water chlorination station. The building was constructed in 1944, stripped of all usable equipment in 1953 when the new chlorination station was brought online, and removed in 1992.

b. Remediation and Sampling Activities

The Laboratory conducted an accelerated corrective action at AOC 16-024(v) and SWMU 16-026(r) in 2006 according to the approved work plan (LANL 2006c; NMED 2006b). Investigation activities at AOC 16-024(v) and SWMU 16-026(r) included collection of samples and removal of contaminated soil. Characterization or remediation activities were not conducted at SWMU 16-031(f) because historical operating information indicated there have been no activities conducted at the former chlorination facility that would warrant an environmental investigation.

c. Conclusions and Recommendations

The Laboratory reported the results of the investigations in a remedy completion report submitted in early 2007 (LANL 2007d).

The Laboratory requested a Certificate of Completion Corrective Action Complete without Controls for SWMU 16-031(f) and AOC 16-024(v). Although the current and reasonably foreseeable future land use for SWMU 16-031(f) and AOC 16-024(v) is industrial, the sites do not pose potential unacceptable risks to human health for the residential scenario or to the environment. Therefore, it is appropriate to conclude that no site controls and future actions are necessary.

The Laboratory will conduct additional sampling within the outfall area of SWMU 16-026(r) to determine the extent of contamination as part of the Cañon de Valle Aggregate Area investigation. All the sampling results will be reported in the Cañon de Valle Aggregate Area investigation report. In addition, the roof drainline and outfall will be rerouted pursuant to Title 20, Chapter 6, Part 2, Section 1203 – Notification of Discharge Removal of NMAC of the New Mexico WQCC regulations.

Following NMED review, a revised remedy completion report was submitted (LANL 2007e), which was then approved (NMED 2007b). NMED determined that the corrective action is complete, and the requirements of the Consent Order have been satisfied for AOC 16-024(v) and SWMU 16-031(f) and issued Certificates of Completion for Corrective Action Complete without Controls for these sites (NMED 2007b). NMED also agreed with the recommendation of completing the investigation for SWMU 16-026(r) as part of the Cañon de Valle Aggregate Area investigation.

3. Guaje/Barrancas/Rendija Canyons Aggregate Area

a. Site Description and History

The Guaje/Barrancas/Rendija Canyons Aggregate Area consists of SWMU 00-011(a), a mortar impact area; SWMU 00-011(c), a possible mortar impact area; SWMU 00-011(d), a bazooka firing area; SWMU 00-011(e), an ammunition impact area; AOC C-00-020, a possible mortar impact area; AOC C-00-041, an asphalt batch plant and tar remnant site; and AOC 00-015, the Sportsmen's Club small-arms firing range.

b. Remediation and Sampling Activities

The Laboratory conducted field investigations in 2006 based on the approved work plan (LANL 2005b; NMED 2006c). The investigation of AOC 00-015 is deferred until the site is no longer active. Munitions and explosives surveys were completed at the sites to verify similar surveys conducted in the early 1990s. Both munitions and explosives of concern and geophysical surveys were used to identify and remove any remaining mortar, small arms ammunition, or munitions debris from former impact/firing areas. Soil samples were collected at sites with past and current munitions and explosives of concern and munitions debris recovery.

c. Conclusions and Recommendations

The Laboratory completed investigation activities and submitted the investigation report in 2007 (LANL 2007f).

The munitions-debris surveys did not locate any munitions or explosives of concern at SWMU 00-011(c) or AOC C-00-020. Because no munitions debris was found during this survey or in previous surveys, no further investigation was conducted, per the approved work plan. The Laboratory requested Certificates of Completion for Corrective Action Complete without Controls for these sites because no site controls and future actions are necessary.

Based on the characterization data from the 2006–2007 investigation, the nature and extent of surface and subsurface contamination are defined for SWMUs 00-011(a), 00-011(d), and 00-011(e). Asphalt remains at AOC C-00-041, but the nature and extent of total petroleum hydrocarbon contamination are defined for this site. SWMUs 00-011(a), 00-011(d), and 00-011(e) and AOC C-00-041 do not pose potential unacceptable risks

to human health under the residential scenario and to ecological receptors. Therefore, the Laboratory requested Certificates of Completion for Corrective Action Complete without Controls for these sites.

Following NMED review, a revised investigation report was submitted (LANL 2007g); site recommendations did not change. However, semiannual inspections of the drainage below AOC C-00-041, coinciding with the end of snowmelt and the monsoon season, will be conducted to evaluate the need to remove additional tar and asphalt. A more detailed plan for evaluating and removing tar and asphalt from AOC C-00-041 will be submitted in 2008; no further sampling for asphalt-related contaminants is needed.

The Sportsmen's Club (AOC 00-015) is being evaluated as part of the NPDES permitting process. If AOC 00-015 has the potential to discharge pollutants to surface water, it will be included in the NPDES permit and will be subject to requirements for storm water monitoring, sampling, and erosion control.

The recommendations are pending NMED review.

4. Consolidated Units 16-007(a)-99 (30s Line) and 16-008(a)-99 (90s Line)

a. Site Description and History

TA-16 is located in the southwest corner of the Laboratory and covers approximately 2,410 acres (3.8 mi²). Consolidated Units 16-007(a)-99 (the 30s Line) and 16-008(a)-99 (the 90s Line) are located near the western end of TA-16. These consolidated units consist of former HE processing buildings, former materials storage buildings, production facilities, sumps, drainlines, and outfall systems (drainages) associated with the 30s and 90s Lines. Historically, the 30s Line and the 90s Line were used for HE-processing operations, including electroplating and machining. The settling ponds were used to store wastewater generated in the nearby buildings during HE-processing operations. All the ponds were/are unlined and likely received wastes contaminated with HE and barium and possibly uranium, organic cleaning agents, and machining oils.

Consolidated Unit 16-007(a)-99 operated from 1944 to the early 1950s, and Consolidated Unit 16-008(a)-99 operated from 1950 to 1970. The 90s Line Pond is all that remains of the 30s Line and 90s Line production facilities. Buildings associated with the discharge to the 30s Line Ponds were destroyed by intentional burning. The buildings associated with the discharge to the 90s Line Pond were decommissioned, which included the demolition of buildings and the removal of sumps, blast shields, drainlines, earthen berms, and asphalt roadways.

b. Remediation and Sampling Activities

NMED approved the investigation work plan that addressed Consolidated Units 16-007(a)-99 (the 30s Line) and 16-008(a)-99 (the 90s Line) (LANL 2005c; NMED 2005a). Field investigations began in 2006. Boreholes were drilled at the 30s Line and 90s Line ponds and in areas associated with former structures and discharge areas. A total of 90 boreholes were drilled: six intermediate-depth boreholes drilled to approximately 150 ft and 84 shallower boreholes drilled approximately 9 ft to 65 ft below ground surface (bgs). Surface and shallow subsurface samples were collected within the 90s Line drainages and from all borehole drilling locations as well as from the 30s Line and 90s Line areas associated with the former structures.

Perched water was encountered in one intermediate borehole near the 90s Line Pond. A groundwater sample was collected from the undeveloped well and submitted for analyses. A monitoring well was installed and the well design was approved before the well was constructed.

Surface-water samples were collected quarterly from the 90s Line Pond as part of the corrective measures evaluation for Consolidated Unit 16-021(c)-99. Additionally, a sample of surface water from the 90s Line Pond was collected in August 2007.

c. Conclusions and Recommendations

Data from investigations conducted in 1995, 1996, and 2004 were combined with the 2006–2007 investigation data (LANL 2007h) to provide a comprehensive understanding of site contamination and potential human health and ecological risks. Based on the sampling results, the vertical and lateral extent of contamination is not defined for all contaminants at Consolidated Units 16-007(a)-99 (30s Line) and 16-008(a)-99 (90s Line). The risk screening assessments indicate that the sites do not pose potential unacceptable risks to human health under the industrial and construction worker scenarios or to ecological receptors.

The following actions were recommended (LANL 2007h):

- For Consolidated Unit 16-008(a)-99, one deep borehole (300-ft depth) is proposed. Remediation is recommended at one location due to hexavalent chromium.
- For Consolidated Unit 16-007(a)-99, a single location with an elevated concentration of research department explosive (RDX) (also referred to as hexahydro-1,3,5-trinitro-1,3,5-triazine) is proposed for removal.
- Perched groundwater will be sampled once per quarter for four quarters. A pressure transducer to monitor water level fluctuations on a continuous basis will be installed.
- Best management practices will be installed in the drainages to the pond to reduce runoff from the former 90s Line building footprints. Periodic sampling of the pond sediment will be conducted.

The recommendations are pending NMED review.

5. Bayo Canyon Aggregate Area

a. Site Description and History

The Bayo Canyon Aggregate Area consists of TA-10 in the lower central portion of Bayo Canyon, between Kwage Mesa to the south and Otowi Mesa to the north, approximately 0.5 mi west of the Los Alamos County Sewage Treatment Plant. TA-10 was used as a firing test site from 1943 through 1961, and the area and related structures were constructed to test assemblies that contained conventional HE, including components made from depleted or natural uranium. TA-10 also included ancillary facilities associated with waste disposal, particularly for the radiochemistry laboratory. Associated facilities included sanitary and radioactive liquid waste sewage lines, manholes, septic tanks, seepage pits, and solid radioactive waste disposal pits.

TA-10 consists of Consolidated Unit 10-001(a)-99 [SWMUs 10-001(a–e) and 10-005, and AOCs 10-001(e) and 10-008], Consolidated Unit 10-002(a)-99 [SWMUs 10-002(a, b), 10-003(a–o), 10-004(b), and 10-007], SWMU 10-004(a), and AOCs C-10-001 and 10-009. The SWMUs and AOCs include firing sites, disposal pits, industrial waste manholes and lines, septic tanks and drainlines, a leach field, soil contamination areas, and landfills. The area underwent extensive decontamination and decommissioning (D&D) from 1960 to 1963; all explosive testing ceased in 1961. After D&D, the site was released to Los Alamos County in 1967 but remains under DOE administrative control.

b. Remediation and Sampling Activities

The Laboratory conducted field investigations in 2007 based on the approved work plan (LANL 2005d; LANL 2005e; NMED 2005b). A geodetic survey, a site-wide radiological survey, and geophysical surveys were conducted before the start of characterization and remediation activities. Both drilling and surface and shallow subsurface sampling activities were conducted.

Borehole sampling was conducted to characterize SWMUs 10-005 and 10004(a), Consolidated Unit 10-002(a)-99, and AOC 10-009. The approved work plan included a total of 53 boreholes to be drilled to a minimum of 25 to 30 ft bgs and sampled at 5-ft intervals.

Surface and shallow subsurface samples were collected at Consolidated Unit 10-001(a)-99 and AOC C-10-001 from 0 to 0.5 ft bgs and 1.5 to 2.0 ft bgs. Samples were to be collected from 22 locations across Consolidated Unit 10-001(a)-99 and from five locations at AOC C-10-001.

c. Conclusions and Recommendations

The results of the investigation for the Bayo Canyon Aggregate Area will be provided in an investigation report in 2008.

6. Middle Los Alamos Canyon Aggregate Area

a. Site Description and History

The Middle Los Alamos Canyon Aggregate Area includes TAs 2, 21, 26, and 61 and is located on the northern boundary of the Laboratory, immediately east-southeast of the Los Alamos townsite. The aggregate area extends from the mesa top to the stream channels in two adjacent canyons: DP Canyon to the north and Los Alamos Canyon to the south.

TA-2 is located in Los Alamos Canyon at the western end of the aggregate area. A small, intermittent stream (Los Alamos Creek) passes through the bottom of the canyon. TA-2 was used to house a series of research reactors from 1943 through 2003. The main reactor building was constructed in 1943 and housed five separate nuclear reactors: three iterations of water-boiler-type reactors located on the east side of the building, one plutonium-fueled reactor (the Clementine reactor) followed by an enriched uranium reactor, and the Omega West Reactor (OWR). The facility was active from 1943 through 1993 (LANL 2003a). The OWR was put on standby status in 1993 and remained inactive until decommissioned in 2003 (LANL 2003a).

All TA-2 facilities remaining on-site underwent D&D in September 2003. The site was cleared, the material disposed of in an appropriate off-site disposal facility, and the land returned to original contour and reseeded (LANL 2003a). The former reactor site is fenced, and access is controlled by the Laboratory.

TA-21 is located on DP Mesa on the northern boundary of the Laboratory, immediately east-southeast of the Los Alamos townsite. DP West operations began in September 1945, primarily to produce metal and alloys of plutonium. Other operations performed at DP West included nuclear fuel reprocessing. In 1977, a transfer of work to the new plutonium facility at TA-55 began, and much of the DP West complex was vacated. DP East operations also began in September 1945. These facilities were used to process polonium and actinium and to produce initiators.

TA-26 is a former technical area located south of State Highway 502, to the east and south of the Los Alamos County airport, and to the west of the East Gate Industrial Park. TA-26 consists of four SWMUs: SWMU 26-001 (a disposal area); SWMU 26-002(a) (an acid sump system); SWMU 26-002(b) (equipment room drainage system); and SWMU 26-003 (sanitary septic system). The area was demolished in 1965 and 1966.

b. Remediation and Sampling Activities

Samples were collected in 2007 at TA-2 as described in the approved investigation work plan (LANL 2006d; NMED 2006d). A total of 336 boreholes were drilled at TA-2 with samples collected from the surface and at several depths. Total depth of the boreholes ranged from 2 ft bgs to 39 ft bgs.

The investigations of the TA-21 sites were coordinated with other investigations at TA-21. Specifically, the proposed sampling activities at Consolidated Unit 21-006(e)-99 and AOC 21-028(c) were performed concurrently with the investigations of the DP Site Aggregate Area.

Samples at Consolidated Unit 21-006(e)-99 were collected from around the perimeter of the former building and within the building footprint. The building footprint was previously excavated and backfilled. Samples were collected in 2007 from 15 locations at three depths starting at approximately 2.0 to 3.0 ft bgs with a maximum sample depth of 13.0 ft bgs.

Samples at AOC 21-028(c) were collected from the approximate locations of the four satellite container storage areas and from 10 ft laterally around these locations. The building footprint was previously excavated and backfilled. Samples were collected in 2007 from 17 locations from three depths starting at approximately 2.0 to 3.0 ft with a maximum sample depth of 13.0 ft bgs.

Samples at TA-26 were collected on the mesa top at the former locations of the excavated structures and along the excavated pipelines as directed by the approved work plan (LANL 2006d; NMED 2006d). Samples were collected in 2007 from a minimum of three depths at 39 locations, with a maximum sample depth of 13.5 ft bgs. In addition, samples were collected on the topographical bench beneath the cliff from three depths.

c. Conclusions and Recommendations

The results of the investigation for the Middle Los Alamos Canyon Aggregate Area will be provided in an investigation report in 2008.

7. Consolidated Unit 73-002-99 (Airport Ashpile)

a. Site Description and History

Consolidated Unit 73-002-99 is located at the Los Alamos County Airport on the eastern end of the Los Alamos townsite. Consolidated Unit 73-002-99 consists of four inactive SWMUs and one inactive AOC.

- SWMU 73-002, a former waste incinerator, located in Building 73-02, and the ash surface disposal area located on the canyon slope north of the former waste incinerator building. The Laboratory operated the incinerator from 1947 to 1948 to destroy classified Laboratory documents, after which time it was used to burn municipal trash.
- AOC 73-003, a former steam-cleaning facility (former Structure 00-1123) for garbage trucks, cans, and dumpsters used to collect municipal waste from the Los Alamos townsite. The Laboratory used the steam-cleaning facility from 1949 to 1970 and demolished it in 1971.
- SWMU 73-004(a), a former septic system (septic tank, drainline, and outfall) that received sanitary waste from toilets and showers in the incinerator building (Building 73-02). The inlet drainline and septic tank were removed in 1996.
- SWMU 73-004(b), a former septic system (septic tank, drainline, and outfall) that received wash water from the steam-cleaning facility (AOC 73-003).
- SWMU 73-006, two former drainlines that discharged to Pueblo Canyon from floor drains in the incinerator building (Building 73-02). The drains are presumed to have handled wash water and to have operated concurrently with the incinerator.

b. Remediation and Sampling Activities

The primary objective of this investigation was to complete characterization of Consolidated Unit 73-002-99. Work was conducted in accordance with the approved investigation work plan (ITSI 2005; NMED 2005c). Remediation of contaminated soil and tuff at SWMUs 73-002, 73-004(b), and 73-006 continued into 2007. Remediation resulted in 36 yd³ of PCB-contaminated soil removed from the outfall associated with SWMU 73-004(b) and 25 yd³ of contaminated soil removed from SWMU 73-006 (LANL 2007i). Approximately 3,544 yd³ of ash, debris, and contaminated soil was removed from the hillside at SWMU 73-002 (LANL 2007i). Confirmation samples were collected in 2007 following the removal of the contaminated material to define the extent of contamination and to verify that cleanup levels were met.

c. Conclusions and Recommendations

Based on the characterization data from the 2005, 2006, and 2007 investigations and from previous investigations conducted at the site, the nature and extent of contamination in surface and subsurface media are defined for Consolidated Unit 73-002-99 (LANL 2007i).

The risk screening assessments indicate no potential unacceptable risks or doses to human health under a residential scenario at SWMUs 73-002, 73-004(a), 73-004(b), and 73-006 and AOC 73-003 (LANL 2007i). The results of the ecological risk screening assessments indicate no potential risk to ecological receptors (LANL 2007i). Therefore, further investigation and corrective action are not warranted based on potential risks/doses to human health and the environment.

Following NMED review, the investigation report was approved (NMED 2007c). NMED granted Certificates of Completion for Corrective Action Complete with Controls for each of the sites within the consolidated unit based on the intended use of the land by Los Alamos County (NMED 2007c). NMED determined that the corrective measures at the sites are protective of human health and the environment and concurred with the transfer of property to Los Alamos County under the current land use (i.e., industrial).

8. MDA C

a. Site Description and History

MDA C (SWMU 50-009) is an inactive 11.8-acre landfill located within TA-50 at the head of Ten Site Canyon. MDA C consists of seven disposal pits and 108 shafts; the depths of the pits range from 12 to 25 ft and the depth of the shafts range from 10 to 25 ft below the original ground surface. Ten shafts in Shaft Group 3 (Shafts 98–107) are lined with 12-in.-thick concrete, while the rest of the pits and shafts are unlined. MDA C operated from May 1948 to April 1974 but received waste only intermittently from 1968 until it was decommissioned in 1974. Wastes disposed of at MDA C consisted of liquids, solids, and containerized gases generated from a broad range of nuclear energy research and development activities conducted at the Laboratory. These wastes included uncontaminated classified materials, metals, hazardous materials, and radioactively contaminated materials.

b. Remediation and Sampling Activities

Investigation activities at MDA C began in 2005 and continued in 2006 and 2007 according to the approved MDA C investigation work plan (LANL 2005f; NMED 2005d; NMED 2005e). The field activities, data review, and risk assessments conducted through 2006 are presented in the *Investigation Report for Material Disposal Area C, Solid Waste Management Unit 50-009, at Technical Area 50* (LANL 2006e).

Additional characterization activities at MDA C were conducted in 2007. The Laboratory drilled four vertical boreholes between Pits 2 and 3. Samples of fill and tuff as well as pore gas were collected.

c. Conclusions and Recommendations

The analytical results from the four vertical boreholes between Pits 2 and 3 are consistent with the data from the other 36 boreholes drilled at MDA C as presented in the report (LANL 2006e). Submission of these data completed the requirements in the approved MDA C work plan (LANL 2005f; NMED 2005d; NMED 2005e).

The Laboratory developed and submitted a Phase 2 investigation work plan (LANL 2007j), which was approved (NMED 2007d) and is scheduled to be implemented in 2008.

9. SWMUs 03-010(a) and 03-001(e)

a. Site Description and History

SWMUs 03-010(a) and 03-001(e) are located within TA-3 next to the general warehouse (Building 03-0030). SWMU 03-010(a) is located about 30 ft west of Building 03-0030 and SWMU 03-001(e) is immediately adjacent to the western edge of Building 03-0030. Both SWMUs are operationally inactive.

SWMU 03-010(a) was a surface disposal site for vacuum-pump oil containing mercury and radionuclides, generated from a vacuum repair shop located in Building 03-0030. During the 1950s, it is estimated that the Laboratory discarded more than 100 lbs of mercury-contaminated vacuum-pump oil onto the canyon edge.

SWMU 03-001(e) was an active storage area for vacuum-pump repair waste from 1957 to 1992. The Laboratory stored waste oil in drums on the ground, and the drums periodically overflowed.

b. Remediation and Sampling Activities

A status report presenting the results to date of four interim-measure activities conducted at SWMUs 03-010(a) and 03-001(e) was submitted in 2007 (LANL 2007k). The objective of the interim-measure activities is to obtain sufficient information to determine an effective control for the groundwater recharge system, thereby supporting a final remedy for the site.

The results of the video-logging of the culvert leading from the roof drains on the southern half of the building show a significant break near the building foundation. This break may be the pathway that allows precipitation from the roof drains to recharge the perched groundwater.

c. Conclusions and Recommendations

The Laboratory repaired the culvert and provided written certification that such repairs were completed (LANL 2007l). In addition, the Laboratory continued to monitor groundwater in two of the three sampling wells (wells B-10 and B-13) on a quarterly basis.

10. MDA L

a. Site Description and History

MDA L (SWMU 54-006) is located at TA-54 in the east-central portion of the Laboratory on Mesita del Buey, within an 1,100 ft by 3,000 ft (2.5-acre) fenced area known as Area L. MDA L is a decommissioned (removed from service) area established for disposing of nonradiological liquid chemical waste, including containerized and uncontainerized liquid wastes; bulk quantities of treated aqueous waste; batch-treated salt solutions; electroplating wastes, including precipitated heavy metals; and small-batch quantities of treated lithium hydride.

The MDA consists of one inactive subsurface disposal pit (Pit A); three inactive subsurface treatment and disposal impoundments (Impoundments B, C, and D); and 34 inactive disposal shafts (Shafts 1 through 34) excavated into the overlying soil and unit 2 of the Tshirege Member of the Bandelier Tuff. Upon decommissioning, the pit and impoundments were filled and covered with clean, crushed, consolidated tuff. When the shafts were filled to within approximately 3 ft of the surface, they were capped with a 3-ft concrete plug.

b. Remediation and Sampling Activities

The Laboratory submitted the investigation report for MDA L (LANL 2005g) and in 2006 submitted a revised investigation report (LANL 2006f). A supplemental investigation work plan (LANL 2006g) was submitted per NMED direction and approval (NMED 2006e; NMED 2006f). The work plan presents the scope of work for drilling three new vertical boreholes. The three boreholes were completed as vapor-phase monitoring boreholes, allowing continued monitoring of the volatile organic compound (VOC) plume. Tuff samples were also collected from the boreholes and analyzed to confirm that the nature and extent of contamination are defined.

c. Conclusions and Recommendations

An addendum to the investigation report (LANL 2007m) was submitted, which summarizes the results of the additional activities conducted at MDA L. The tuff and pore-gas sample results from the newly installed and existing boreholes confirm the results from the Phase I Resource Conservation and Recovery Act (RCRA) facility investigation (RFI) (LANL 2003b), the 2004–2005 investigation (LANL 2005g; LANL 2006f), and the quarterly pore-gas monitoring.

NMED approved the investigation report and the addendum to the investigation report for MDA L with direction (NMED 2007e). The Laboratory will develop a corrective measures report and continues to monitor VOCs and tritium in subsurface pore gas at MDA L.

An interim subsurface vapor monitoring plan was submitted and approved with modifications (LANL 2007n; NMED 2007f); it describes proposed subsurface monitoring activities and the frequencies at which sampling is conducted within the vadose zone beneath MDA L. The eight boreholes drilled in 2004–2005 and the three boreholes drilled in 2007 provide complete coverage across the site and encompass all the subsurface rock units down to and including the basalt. Pore-gas monitoring data are reported in a quarterly periodic monitoring report.

11. MDA G

a. Site Description and History

MDA G, Consolidated Unit 54-013(b)-99, is located in the east-central portion of the Laboratory at TA-54, Area G, on Mesita del Buey. Portions of the disposal units at MDA G are covered with concrete to house ongoing waste-management activities conducted at Area G. Surface runoff from the site is controlled and discharges into drainages to the north (towards Cañada del Buey) and the south (towards Pajarito Canyon).

MDA G is a decommissioned (removed from service) subsurface site at TA-54 established for disposition of low-level waste, certain radioactively contaminated infectious waste, asbestos-contaminated material, and PCBs. It was also used for the retrievable storage of transuranic waste. It consists of inactive subsurface units that include 32 pits, 194 shafts, and four trenches. When operations ceased, the remaining capacity of the pits, shafts, and trenches was backfilled with clean, crushed, compacted tuff and closed. The disposal shafts were capped with a concrete plug.

b. Remediation and Sampling Activities

The Laboratory submitted the investigation report for MDA G (LANL 2005h) in 2005. A supplemental investigation work plan (LANL 2006h) was subsequently submitted per NMED direction (NMED 2006g; NMED 2006h) and approval (NMED 2006i). The supplemental work plan is designed to complete additional investigation activities to determine the vertical extent of vapor-phase VOC contamination in the eastern and northern portions of MDA G. The additional investigation activities included the advancement of four pre-existing boreholes approximately 13 ft to 21.5 ft into the Cerros del Rio basalt, resulting in total depths ranging from 201 ft to 306.5 ft. In addition, a new borehole was installed 21.5 ft into the basalt, with a final depth of 191.5 ft. Pore-gas samples were collected from each vapor-sampling port and submitted for VOC analysis. Pore-gas samples were collected from each vapor sampling port in the new borehole and submitted for tritium analysis.

c. Conclusions and Recommendations

An addendum to the investigation report (LANL 2007o) was submitted, which summarizes the results of additional investigation activities conducted at MDA G. The results of pore-gas sampling from boreholes extended into the basalt confirm the results of the RFI (LANL 2000), previous quarterly monitoring, and the 2005 site investigation (LANL 2005h).

NMED approved the investigation report (LANL 2005h) and the addendum to the investigation report for MDA G (LANL 2007o) with direction (NMED 2007g).

The Laboratory continues to monitor VOCs and tritium in subsurface pore gas at MDA G. In addition, the Laboratory submitted a work plan for the implementation of a soil-vapor extraction pilot study in 2007 at MDA G (LANL 2007p), which may be implemented as a remedial option. The work plan was approved with direction (NMED 2007h), and work is scheduled to be conducted in 2008. A corrective measure evaluation plan for MDA G was submitted, revised (LANL 2007q), and approved by NMED with direction (NMED 2007i). The corrective measure report was submitted in early 2008 (LANL 2008).

12. Middle Mortandad/Ten Site Canyons Aggregate Area

a. Site Description and History

The Middle Mortandad/Ten Site Canyons Aggregate Area consists of consolidated units, SWMUs, and AOCs in TAs 4, 5, 35, 52, 60, and 63. The SWMUs and AOCs occupy a narrow mesa (Ten Site Mesa) and adjacent slopes between Mortandad and Ten Site Canyons, the floor of a small tributary canyon to Ten Site Canyon (named Pratt Canyon) and adjacent Mesita del Buey and Sigma Mesa as well as part of the floor of Ten Site Canyon. The aggregate area was divided into seven subareas for ease of investigation and presentation. The subareas are Mesa Top, Ten Site Slope, Mortandad Slope, Pratt Canyon, Ten Site Canyon, East Ten Site Slope, and Sigma Mesa.

b. Remediation and Sampling Activities

Characterization activities were initially conducted in 2004–2005 (LANL 2002; LANL 2004a). A complete description of the field activities, data review, and risk assessments for this site were presented in the *Investigation Report for the Middle Mortandad/Ten Site Aggregate* (LANL 2005i).

Investigation activities in 2007 included sampling for the nature and extent of the contamination at SWMUs 35-016(o), 35-016(p), 05-001(c), and Consolidated Units 35-003(d)-00, 35-016(k)-00, and 05-001(a)-99; excavation of contaminated soil at SWMUs 35-016(o) and 35-016(p) and collection of confirmation samples (LANL 2007r). An additional 74 samples were collected from the Mortandad Slope, Pratt Canyon, and East Ten Site Slope Subareas, and approximately 0.23 yd³ of soil was excavated from SWMUs 35-016(o) and 35-016(p) (LANL 2007r).

c. Conclusions and Recommendations

A revised investigation report was submitted in 2007 (LANL 2007r). The nature and extent of contamination for the subareas are defined. None of the SWMUs, AOCs, and consolidated units (except for AOC 35-018[a]) in the seven subareas pose a potential unacceptable risk/dose under either a residential, industrial, or recreational scenario. Ecological risk screening was also conducted for all seven subareas within the Middle Mortandad/Ten Site Aggregate Area, and no potential unacceptable ecological risk was found in any of the subareas.

The Laboratory requested Certificates of Completion for Corrective Action Complete without Controls from NMED for those sites that do not pose potential unacceptable risks or doses to human health under the residential scenario (LANL 2007r). Because these sites pose no unacceptable risk to human health under the residential scenario and no risk to the environment, neither site controls nor future actions are necessary.

The Laboratory requested Certificates of Completion for Corrective Action Complete with Controls from NMED for those sites that do not pose potential unacceptable risks or doses to human health under either an industrial or recreational scenario (LANL 2007r). Based on the results of the human health risk-screening assessments, controls are required to restrict residential use of those properties. The Laboratory intends to retain ownership of the properties indefinitely and will continue to maintain current site conditions and restrict the properties to industrial or recreational use only.

The recommendations are pending NMED review.

C. WATER STEWARDSHIP PROJECT

The Laboratory conducted the following investigations and activities in 2007:

- A summary of the North Canyons Phase 1 sediment investigation was submitted and approved. Phase 2 investigations were completed.
- A summary of the Phase 2 sediment investigation in Pajarito Canyon was submitted and approved. Phase 3 sediment investigations were approved and are ongoing.

- A summary of the Sandia Canyon Phase 1 sediment investigation was submitted. Phase 2 investigations are ongoing.
- The investigation report of the Mortandad Canyon watershed was approved. The revised risk assessments were submitted. Additional work is scheduled to start in 2008.
- The addendum to the work plan for Sandia Canyon and Cañada del Buey was submitted, approved, and implemented. Additional drilling, modeling, and geochemistry studies for the chromium investigations are being implemented under the addendum.
- The Pajarito Canyon Biota Investigation Work Plan was approved and implemented.
- Additional information and reports were submitted, including periodic monitoring reports, well completion reports, other well work plans and reports, the General Facility Information (annual update), the Interim Facility-Wide Groundwater Monitoring Plan (annual update), and the Groundwater Background Investigation Report, Revision 3.

The following sections include brief summaries of the investigation activities started, continued, or completed in 2007.

1. North Canyons

a. Site Description and History

The Bayo, Barrancas, Rendija, and Guaje Canyon systems are referred to as the “north canyons systems.” These canyons head in the northern part of the Pajarito Plateau north of the Laboratory and are addressed by one work plan because of similarities common to all four canyons.

- Bayo Canyon is located north of Pueblo Canyon and extends across Los Alamos County land and Pueblo de San Ildefonso land to its confluence with Los Alamos Canyon.
- Barrancas Canyon is located north of Bayo Canyon and extends across Los Alamos County land, USFS land, Laboratory property, and Pueblo de San Ildefonso land to its confluence with Guaje Canyon.
- Rendija Canyon is located north of the Los Alamos townsite and extends across USFS land, private land, Los Alamos County land, and General Services Administration land to its confluence with Guaje Canyon.
- Guaje Canyon is located north of Rendija Canyon and Barrancas Canyon and extends across USFS land and Pueblo de San Ildefonso land to the confluence with Los Alamos Canyon.

SWMUs and AOCs associated with TA-10 within the Bayo Canyon Aggregate Area and the SWMUs and AOCs associated with Rendija Canyon have been addressed in separate investigation work plans and reports (see previous text under Corrective Action Project).

b. Remediation and Sampling Activities

The Laboratory performed a Phase 1 field investigation of sediment deposits in Barrancas, Bayo, Guaje, and Rendija Canyons in 2006 following the *Work Plan for the North Canyons* (LANL 2001), as modified by agreements with the NMED (LANL 2005j; NMED 2005f; LANL 2006i). Following NMED review, additional sampling was conducted in 2007 in reach R-3 in Rendija Canyon to define the nature and extent of inorganic chemicals and radionuclides (LANL 2007s).

c. Conclusions and Recommendations

With the additional samples collected, no additional sediment characterization is necessary at this time; the goals of the sediment sampling and analysis plan presented in the work plan (LANL 2001) and in subsequent agreements with NMED (LANL 2005j; NMED 2005f; LANL 2006i) have been met. NMED agrees that the Laboratory should proceed with preparation of the north canyons investigation report.

2. Pajarito Canyon

a. Site Description and History

Pajarito Canyon is located in the central part of the Laboratory. The canyon heads in the Santa Fe National Forest west of the Laboratory boundary and empties into the Rio Grande in White Rock Canyon. The main channel is approximately 14.8 miles long and the watershed area is approximately 8 mi². Twomile Canyon and Threemile Canyon are major tributaries that join Pajarito Canyon and have watershed areas of 3.1 mi² and 1.7 mi², respectively. Sites within the Pajarito Canyon watershed are located at TAs 3, 8, 9, 12, 15, 18, 23, 27, 48, 54, 55, 59, 64, and 69.

b. Remediation and Sampling Activities

The Laboratory conducted a Phase 2 field investigation of sediment deposits in the Pajarito Canyon watershed in 2006 according to the Pajarito Canyon Phase 1 summary report (LANL 2006j; NMED 2006j). A Phase 2 summary report of the sediment investigation, which included proposed Phase 3 sampling, was submitted in 2007 (LANL 2007t).

The proposed Phase 3 sediment investigation in the Pajarito Canyon watershed is focused on improving estimates of average concentrations of contaminants that are important for evaluating potential human health risk, the extent of contamination, and the effects of a large flood in August 2006.

The *Pajarito Canyon Biota Investigation Work Plan* (LANL 2006k) was submitted in 2006 and approved by NMED (NMED 2007j). A number of biota studies are proposed for the Pajarito Canyon watershed. The proposed studies are based on assessment endpoints developed to protect the terrestrial and aquatic ecosystems within canyons in the watershed. The proposed studies complement previous studies conducted in the Los Alamos and Pueblo Canyons, Cañon de Valle, and Mortandad Canyon watersheds.

c. Conclusions and Recommendations

NMED reviewed the summary report and approved the Phase 3 sediment investigations proposed by the Laboratory (NMED 2007k). The results of all of the sediment investigations conducted will be included in the Pajarito Canyon investigation report.

The Pajarito Canyon biota studies were implemented in 2007 according to the approved work plan and will continue into 2008. The results of the biota investigation will be reported as part of the Pajarito Canyon investigation report.

3. Sandia Canyon and Cañada del Buey

a. Site Description and History

Sandia Canyon is located in the central part of the Laboratory, heads within TA-3, trends east-southeast across the Laboratory, Bandelier National Monument, and Pueblo de San Ildefonso land, and empties into the Rio Grande in White Rock Canyon. The main channel is approximately 9.4 miles long and the watershed area is approximately 5.5 mi². Sandia Canyon on Laboratory property extends for a distance of 5.6 mi and has a watershed area of 2.65 mi². Sites within the Sandia Canyon watershed are located at TAs 3, 53, 60, 61, and 72 and former TA-20.

Cañada del Buey, located in the central part of the Laboratory, is the largest tributary to Mortandad Canyon. The canyon heads within TA-52 and TA-36 and trends east-southeast across the Laboratory, Pueblo de San Ildefonso land, and Los Alamos County, and ends at the confluence with Mortandad Canyon. The main channel is approximately 8.2 miles long, and the watershed area is approximately 4.3 mi². Cañada del Buey on Laboratory property extends for a distance of 5 mi and has a watershed area of 2.1 mi². On Laboratory property, Cañada del Buey has one main tributary (south fork of Cañada del Buey) and a smaller tributary referred to as the TA-46 tributary or the Sanitary Wastewater Consolidation System Canyon tributary. Sites within the Cañada del Buey watershed are located at TAs 18, 46, 51, 52, and 54 and former TA-4.

b. Remediation and Sampling Activities

The Phase 1 field investigation of potentially contaminated sediment deposits in Sandia Canyon was performed in 2007 as proposed in the *Work Plan for Sandia Canyon and Cañada del Buey* (LANL 1999), as modified by several subsequent documents (LANL 2003c; LANL 2005k), and approved by NMED (NMED 2005g).

Sediment samples were collected in six reaches in Sandia Canyon, as specified in the approved work plan (LANL 1999) and in the *Addendum to the Work Plan for Sandia Canyon and Cañada del Buey* (LANL 2007v). Prior to sampling, field investigations included detailed geomorphic mapping and associated geomorphic characterization in these six reaches. Samples selected for off-site analysis included the location in each reach with the highest chromium concentration based on x-ray fluorescence measurements. A subset of the Phase 1 samples included a geochemical characterization to help evaluate the presence of trivalent chromium (Cr[III]) and hexavalent chromium (Cr[VI]) in the sediment deposits.

Most contaminants have maximum concentrations in the uppermost part of the watershed (TAs 3, 60, and/or 61). Specific sources for some of these contaminants include releases of cooling water from the power plant at TA-3 and from SWMU 03-056(c), a former transformer storage area. Only nine contaminants have maximum concentrations in downcanyon reaches. The spatial distribution of contamination indicates that contaminants have been transported along the full length of Sandia Canyon from TA-3 at least as far east as New Mexico State Road 4.

The inventory of chromium in sediment deposits was estimated in each sampled reach in Sandia Canyon and was interpolated between reaches to provide a canyon-scale estimate. Paired total chromium and Cr(VI) analyses indicate that the chromium in Sandia Canyon sediment deposits is dominated by Cr(III). Simulations indicate that approximately 65% to 90% of the total chromium inventory in Sandia Canyon sediment deposits is in the uppermost part of the watershed.

Additional activities specified in the approved addendum to the work plan (LANL 2007v; NMED 2007l) include a review of sites in Los Alamos, Sandia, and Mortandad Canyons to identify the potential source(s) of chromium, water balance investigations, surface water and groundwater sampling, fate and transport modeling, testing of regional well R-28, supply well PM-3 zonal sampling, and installation of vadose-zone characterization core holes approximately a mile upstream of station SCC-1.

A biota investigation work plan for Sandia Canyon investigation reaches was submitted in 2007 (LANL 2007w). A number of biota studies are proposed for the Sandia Canyon watershed. The proposed studies are based on assessment endpoints developed to protect the terrestrial and aquatic ecosystems within the watershed. The proposed studies complement previous studies conducted in the Los Alamos and Pueblo Canyons, Cañon de Valle, and Mortandad Canyon watersheds.

c. Conclusions and Recommendations

A Phase 1 summary report of the sediment investigation, which included proposed Phase 2 sampling, was submitted in 2007 (LANL 2007u). Proposed Phase 2 sediment investigations in Sandia Canyon will be focused on evaluating the source and extent of contamination and on improving estimates of average concentrations of contaminants. Sampling in each Phase 2 reach will include both surface and subsurface sediment layers, depending on the thickness of historical (post-1942) sediment in each reach.

The fate and transport report was submitted in 2007 (LANL 2007x), which is part of an ongoing investigation to address the chromium and other contaminants detected in surface water and groundwater beneath Sandia and Mortandad Canyons. Also submitted was the *Completion Report for Regional Aquifer Wells R-35a and R-35b* (LANL 2007y) and the *Work Plan for Geochemical Characterization and Drilling for Fate and Transport of Contaminants Originating in Sandia Canyon* (LANL 2007z). The latter work plan describes geochemistry experiments and analyses intended to further characterize long-term fate and transport of contaminants (particularly chromium) from Sandia Canyon.

The biota investigation work plan for Sandia Canyon is pending NMED review and will be implemented in 2008.

4. Mortandad Canyon

a. Site Description and History

The investigation encompassed Mortandad, Effluent, and Ten Site Canyons and an unnamed tributary canyon that heads in TA-5. This area is collectively referred to as the Mortandad Canyon watershed. Mortandad Canyon is located in the north-central part of the Laboratory and extends for approximately 10 mi from Diamond Drive in TA-3 east-southeast to the Rio Grande. Mortandad Canyon has a total watershed area (excluding Cañada del Buey) of about 6.0 mi². Primary tributary drainages on Laboratory land are Effluent Canyon, which heads in TA-48, and Ten Site Canyon, which heads in TA-50. Cañada del Buey, a major tributary of Mortandad Canyon, joins with Mortandad Canyon upstream of the Rio Grande and has a watershed area of 4.3 mi²; Cañada del Buey will be the subject future investigations and reported on under the Sandia Canyon and Cañada del Buey investigations. The Mortandad Canyon watershed reported on here includes that portion west of State Road 4, which has a drainage area of 3.3 mi² of which 60% is on Laboratory land and 40% is on Pueblo de San Ildefonso land. Technical areas in the watershed include TAs 3, 4, 5, 35, 42, 48, 50, 52, 55, 60, and 63.

b. Remediation and Sampling Activities

The investigation report for Mortandad Canyon was submitted in 2006 (LANL 2006l). Following NMED review, additional actions were required and a revised risk assessment was requested.

Additional activities included conducting a comprehensive assessment and evaluation of each well and well screen intersecting intermediate and regional groundwater in the Mortandad Canyon watershed; replacing gage station E202 to ensure that it is capable of measuring flood events; removing damaged permeable reactive membrane and returning the canyon to pre-permeable reactive membrane conditions; and collecting four rounds of groundwater samples from wells used to support any proposed actions in the upcoming corrective measures evaluation.

c. Conclusions and Recommendations

The Laboratory submitted the revised risk assessments for the Mortandad Canyon investigation (LANL 2007aa). The other required investigation activities will be implemented in 2008.

D. TA-21 CLOSURE PROJECT

Investigations and activities conducted in 2007 included the following:

- Additional investigation sampling at MDA V was conducted and a revised investigation report was submitted.
- Sampling and remediation of an area of elevated radioactivity near absorption bed 3 within and around MDA V was conducted.
- Supplemental sampling at MDA A was conducted and a status report submitted.
- Phase 2 sampling at MDA T was conducted and a Phase 2 investigation report submitted.
- Investigation and removal activities for sites within the DP Site Aggregate Area were conducted and an investigation report submitted.

The following sections summarize the investigations started, continued, and completed in 2007.



1. MDA V

a. Site Description and History

Consolidated Unit 21-018(a)-99 is a 0.88-acre fenced area located on the south side of DP Road west of the TA-21 main gate. The consolidated unit is comprised of four SWMUs and one AOC.

- SWMU 21-018(a) (MDA V) received radioactive liquid waste derived from the TA-21 laundry facility (SWMU 21-018[b]). The Laboratory constructed the absorption beds in 1945 and operated them until 1961.
- SWMU 21-018(b), the former laundry facility, was located south of DP Road. The Laboratory operated the laundry facility from 1945 to 1961.
- SWMU 21-023(c), a former septic system that consisted of a tank, inlet and outlet lines, and an outfall served a waste treatment laboratory. The Laboratory put the septic system into service in 1948 and removed it from service in 1965.
- SWMU 21-013(b) and AOC 21-013(g) are surface debris disposal sites located on the south-facing slope above BV Canyon. It is not known how long these sites received building debris; however, they did not receive wastes later than 1994.

b. Remediation and Sampling Activities

The Laboratory submitted the investigation report for MDA V in 2006 (LANL 2006m). Following NMED review, additional investigations were warranted. Additional confirmatory sampling was completed in 2007 on the northwest slope of SWMU 21-013(b). The results of the SWMU 21-013(b) sampling are provided in revision 1 of the investigation report (LANL 2007bb), which was submitted in 2007.

Investigation and remediation of an area of elevated radioactivity identified north of former absorption bed 3 (SWMU 21-018[a]) during the post-remediation walkover survey are in progress.

c. Conclusions and Recommendations

The nature and extent of contamination are defined for this consolidated unit, with the exception of low levels of tritium in subsurface pore gas. The human health risk screening assessments indicated no potential risks or doses under a residential scenario. The ecological risk screening assessment indicated no potential risk to ecological receptors.

The revised human health risk assessment included an evaluation of the potential inhalation risk from pore gas via an indoor air pathway for residential receptors. All of the chemicals evaluated are carcinogens; the cumulative cancer risks do not exceed 1×10^{-5} for any of the indoor air model site conditions evaluated (LANL 2007bb).

The results of the investigation and remediation of the area of elevated radioactivity north of former absorption bed 3 will be provided in a supplemental investigation report in 2008.

2. MDA T

a. Site Description and History

MDA T, Consolidated Unit 21-016(a)-99, is an area of approximately 2.2 acres located within TA-21 on DP Mesa. MDA T includes 25 SWMUs and AOCs associated with decommissioned radioactive liquid waste treatment facilities and various storage areas. The SWMUs and AOCs associated with MDA T were operational from 1945 to 1986. The Laboratory discharged approximately 18.3 million gallons of wastewater to the MDA T absorption beds between 1945 and 1967. The SWMUs and AOCs include inactive absorption beds, a retrievable waste storage area, asphalt-lined disposal shafts, sumps, acid holding tanks, acid sumps, effluent holding tanks, sodium hydroxide storage tank, an americium raffinate storage tank, acid valve pit manholes, underground steel

tanks, a septic tank, grit chamber or settling tank, and airborne releases from incinerators used to burn waste oils and organics after testing (oil spills from the incinerators are known to have occurred). Also included are eight AOCs that are not part of Consolidated Unit 21-016(a)-99 but are within the footprint of the consolidated unit. These sites consist of four unintentional releases or one-time spills and four former storage and treatment tanks.

b. Remediation and Sampling Activities

Recent investigation activities at MDA T began in 2005 and concluded in 2006 according to the approved work plan (LANL 2004b; NMED 2005h). The Laboratory submitted the investigation report for MDA T in 2006 (LANL 2006n). Following NMED review, additional investigations were warranted and a Phase 2 investigation work plan was submitted and approved (LANL 2007cc, NMED 2007m). The objectives of the 2007 investigation were to (1) continue characterization of tritium and VOC vapors beneath MDA T; (2) define the extent of americium-241, plutonium-238, and plutonium-239 at locations on the DP Canyon slope; (3) assess if americium-241, plutonium-238, and plutonium-239 activities in surface soil has been impacted by recent storm runoff and the December 2006 water main leaks at TA-21; and (4) acquire nitrate and supplemental perchlorate data on the DP Canyon slope.

The additional activities included the installation of three permanent vapor-monitoring wells in the three deepest boreholes and a vapor monitoring work plan (LANL 2007cc). The Laboratory submitted a vapor monitoring plan (LANL 2007dd), which was approved with modifications (NMED 2007n). Each of the three vapor monitoring wells will be sampled and analyzed quarterly for VOCs and tritium for one year, after which the need for additional sampling will be evaluated.

c. Conclusions and Recommendations

The Phase 2 investigation report was submitted in 2007 (LANL 2007ee).

Pore-gas results from the first round of quarterly sampling confirm low concentrations of VOCs and low activities of tritium. Three additional quarters of pore-gas monitoring data will be collected. The nature and extent of pore gas will be comprehensively evaluated and presented in a report following completion of planned vapor-monitoring activities.

The DP Canyon slope data indicate that the nature and extent of americium-241, plutonium-238, plutonium-239, nitrate, and perchlorate are defined. The extent of contamination beyond the toe of the slope into DP Canyon is defined and presented in the Los Alamos and Pueblo Canyons investigation report (LANL 2004c). Migration of radionuclides into DP Canyon is being monitored as part of the Laboratory's storm water and sediment monitoring programs.

Doses from americium-241, plutonium-238, and plutonium-239/240 under the recreational and residential scenarios are slightly lower or equivalent to the doses presented in the investigation report (LANL 2007dd).

3. MDA A

a. Site Description and History

MDA A, SWMU 21-014, is comprised of a 1.25-acre, fenced, and radiologically controlled area situated on the eastern end of DP Mesa between DP Canyon to the north and Los Alamos Canyon to the south. The Laboratory used MDA A between 1945 and 1978 to store solid and liquid wastes.

MDA A currently contains the following features:

- Two 50,000-gal. cylindrical steel storage tanks (referred to as the General's Tanks) are buried at the western end of MDA A. The tanks received waste solutions containing plutonium-239/240 and americium-241 from 1947 to 1974. Liquid waste was removed from the tanks in 1975 and 1976, but an unknown volume of sludge remains in the bottom of the tanks.

- Two 4-ft diameter, 65-ft deep vertical shafts located south of the General's Tanks. The shafts were constructed in 1975 but never used and were filled with soil in 1977.
- Two eastern disposal pits were excavated to receive radioactive solid waste from DP East in 1945. In 1946, crushed Bandelier Tuff was used to backfill and cover the pits.
- One central pit was excavated in the center of MDA A to receive and store TA-21 decontamination and decommissioning debris potentially contaminated with radionuclides. This pit received waste from 1969 to 1977. The pit was decommissioned in 1978, and a cover (crushed tuff) was placed over the pit.

Several hundred 55-gal drums containing iodide waste were stored on the surface at the eastern end of MDA A. These drums contained sodium hydroxide solution and stable iodine. The drum storage area was used from the late 1940s until 1960.

b. Remediation and Sampling Activities

The Laboratory began and concluded investigation activities in 2006 at MDA A according to the approved work plan (LANL 2005l; LANL 2006o; NMED 2005i). The Laboratory submitted the investigation report for MDA A in 2006 (LANL 2006p). Following review of the report, NMED requested additional drilling and sampling for pore-gas (NMED 2007o). The objectives of the 2007 supplemental investigation were to (1) assess the vertical extent of tritium pore gas beneath MDA A, (2) further characterize tritium and VOC extent in pore gas beneath MDA A with additional sampling, and (3) plug and abandon open boreholes. One borehole was extended to 115 ft bgs, sampled for pore gas, and analyzed for tritium and VOC from 15 ft bgs to 115 ft bgs in. In addition, a second round of vapor-phase VOCs and tritium samples were collected from previously sampled depths in four other boreholes.

c. Conclusions and Recommendations

A status report of the supplemental sampling at MDA A was submitted in 2007 (LANL 2007ff). The 2007 supplemental sampling field activities included deepening one sample and sampling pore gas from it, collecting an additional round of pore-gas samples from five other existing boreholes, and plugging and abandoning twelve open boreholes.

VOC pore-gas results from 2007 indicate fewer VOCs detected and at lower concentrations. The vertical extent of pore-gas VOCs is defined by the two deeper boreholes. Lateral extent of VOCs in pore gas is defined.

Tritium results from 2007 are over an order of magnitude lower than the levels measured at the same locations in 2006. The vertical and lateral extent of tritium in pore gas is defined at MDA A.

The VOCs in subsurface pore gas at MDA A are not a potential source of groundwater contamination. The maximum detected level of tritium was approximately 5% of the EPA drinking water standard (20,000 pCi/L) for tritium. Therefore, the tritium detected in the subsurface at MDA A is not a potential source of groundwater contamination.

The report is pending NMED review.

4. DP Site Aggregate Area

a. Site Description and History

TA-21 is located on DP Mesa on the northern boundary of LANL and is immediately east-southeast of the Los Alamos townsite. From 1945 to 1978, TA-21 was used primarily for plutonium research, metal production, and related activities. Since 1978, various administrative and research activities have been conducted at TA-21. The DP Site Aggregate Area consists of SWMUs and AOCs located throughout TA-21. The SWMUs and AOCs consist of container storage areas, surface disposal areas, a PCB storage area, septic systems, sumps, drainlines, outfalls, a waste treatment laboratory, a sewage treatment plant, and seepage pits.

b. Remediation and Sampling Activities

Site characterization and remediation activities were conducted in 2006 and 2007 based on the approved work plan (LANL 2004d; LANL 2005m; LANL 2006q; NMED 2005j). Sites were identified as (1) investigation sites; (2) facility-unimpacted corrective action sites; and (3) facility-impacted corrective action sites (corrective actions and sampling are ongoing). Because utilities and structures are present and significant planning is needed to address health and safety hazards, the facility-impacted sites will be addressed only after utility location, isolation, and health and safety clearance are completed.

The scope of activities at the investigation sites included surface and shallow subsurface sampling and excavation of the septic tank and drainline at one site. Scope of activities for the facility-unimpacted corrective action sites included surface and subsurface sampling as well as the removal of the blowdown pits, the seepage pits, the blowdown tank, and pipelines at one site; removal of several septic tanks and the associated pipelines; the removal of sumps and all pipelines; the removal of a dosing siphon chamber and the main pipeline extending to the outfall; and the removal of several pipelines.

c. Conclusions and Recommendations

The vertical and lateral extent of contamination at three of the investigation sites and all of the facility-unimpacted corrective action sites are not defined (LANL 2007gg). All of these sites require additional sampling to determine the vertical and lateral extent of contamination. Facility-impacted corrective action field activities will be reported on when completed and the data become available.

PCB concentrations are above the Toxic Substances Control Act (TSCA) cleanup level of 1 mg/kg at two investigation sites. Remediation of the PCBs under TSCA is recommended at both sites. Data collected at the suspected PCB-contaminated outfall are collected to facilitate the determination of the source of PCBs in storm water.

E. QUALITY ASSURANCE PROGRAM

1. Quality Assurance Program Development

The EP Directorate's quality assurance objectives are to perform work in a quality manner while minimizing potential hazards to the environment, public, or workers. All work is performed by using approved instructions, procedures, and other appropriate means that implement regulatory or contractual requirements for technical standards, administrative controls, and other hazard controls. The Quality Management Plan establishes the principles, requirements, and practices necessary to implement an effective quality assurance program.

The use of a graded approach determines the scope, depth, and rigor of implementing the quality assurance criteria for a specific activity. Activities are managed through systems that are commensurate with the quality requirements, risk, and hazards involved in the activity. Such a selective approach allows the Laboratory to apply extensive controls to certain elements of activities and limited controls to others. The control measures applied to any particular activity are covered in documents such as procedures, statements of work, project-specific work plans, and procurement contracts associated with the activity.

2. Field Sampling Quality Assurance

Overall quality is maintained through the rigorous use of carefully documented procedures that govern all aspects of the sample collection activities.

Soil, water, vapor, and biota samples are (1) collected under common EPA chain-of-custody procedures using field notebooks and sample collection logs and (2) prepared and stored in certified pre-cleaned sampling containers in a secure and clean area for shipment. Samples are delivered to analytical laboratories under full chain-of-custody, including secure FedEx shipment to all external vendors, and tracked at all stages of their collection and analysis.

3. Analytical Laboratory Quality Assessment

The Laboratory writes specific statements of work to govern the acquisition and delivery of analytical chemistry services after the Data Quality Objective process defines the project needs. These statements of work are sent to potentially qualified suppliers who are National Environmental Laboratory Accreditation Conference (NELAC)-certified and Department of Energy Consolidated Audit Program (DOECAP) for a pre-award assessment by experienced and trained quality systems and chemistry laboratory assessors. Statement of work specifications, professional judgment, and quality system performance at each laboratory (including recent past performance on nationally conducted performance-evaluation programs) are the primary criteria used to award contracts for specific types of radiochemical, organic chemical, and inorganic chemical analyses.

Each analytical laboratory conducts its chain-of-custody and analytical processes under its own quality plans and analytical procedures. The analytical laboratory also submits a full set of hard copy records that serves as the legally binding copy of the data. Each set of samples contains all the internal quality assurance/quality control data the analytical laboratory generates during each phase of chemical analysis (including laboratory control standards, process blanks, matrix spikes, duplicates, and replicates, when applicable). The electronic data are uploaded into the database and verified and validated according to its corresponding variety of quality and consistency checks. All parts of the data-management process are tracked electronically, and periodic reports to management are prepared.

4. Analytical Laboratory Assessments

The EP Directorate has eight contracts with external analytical laboratories. The laboratories are audited as long as they keep their NELAC and DOE Contract Audit Program certifications. During 2007, external laboratory audits were performed for the following six laboratories: General Engineering, Test America St. Louis, Assaigai, Paragon Analytics, Inc., American Radiation Services and Vista Analytical. All laboratories participated in national performance-evaluation studies during 2007 and the results are included in the assessment report. Overall, the study sponsors judged the analytical laboratories to have acceptable performance for almost all analytes attempted in all matrices.

5. Program Audits and Assessments

The Laboratory's Performance Assurance Division—Operations Support and the Facilities Division performed internal audits of the Sample Management Office (SMO). The Performance Assurance audit found no issues, while the Facilities audit required postings for radioactivity and quarterly radiological surveys of the SMO.

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Appendix A

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 450.1, “Environmental Protection Program;” 5400.5, “Radiation Protection of the Public and the Environment;” and 231.1A, “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 EPA dose factors from Federal Guidance Report No. 13 (EPA 1999). The dose factors EPA 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 for the public (NCRP 1987). Table A-1 lists currently applicable radiation protection standards, now referred to as public dose limits, for operations at the Laboratory. DOE’s comprehensive public dose limit 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. For one specific activity or pathway, DOE guidance specifies a “dose constraint” of 25 mrem per year (DOE 1999.) The public dose limits and the DOE occupational dose limits 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. External dose factors were obtained from Federal Guidance Report No. 12 (EPA 1993).

Radionuclide concentrations in water are compared with DOE’s Derived Concentration Guides (DCGs) to evaluate potential impacts to members of the public. 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. Table A-2 shows the DCGs. For comparison with drinking-water systems, the DCGs are multiplied by 0.04 to correspond with the EPA limit of 4 mrem per year.

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.

Table A-1
DOE Dose Limits for External and Internal Exposures

| Exposure pathway | Dose Equivalent ^a at Point of Maximum Probable Exposure |
|---|--|
| Exposure of Any Member of the Public^b | |
| All Pathways | 100 mrem/yr ^c |
| One Specific Pathway (dose constraint) | 25 mrem/yr ^d |
| Air Pathway Only ^e | 10 mrem/yr |
| Drinking Water | 4 mrem/yr |
| Occupational Exposure^b | |
| Stochastic Effects | 5 rem/yr (TEDE) ^f |
| Nonstochastic Effects | |
| Lens of eye | 15 rem/yr |
| Extremity | 50 rem/yr |
| Skin of the whole body | 50 rem/yr |
| Skin of the whole body | 50 rem/yr |
| Embryo/Fetus of Declared Pregnant Worker | 0.5 rem/gestation period |

^a Refer to Glossary for definition.

^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 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 Guidance (DOE 1999.)

^e This level is from EPA's regulations issued under the Clean Air Act (40 CFR 61, Subpart H) (EPA 1989a).

^f Refer to Glossary for definition.

Table A-2
DOE's Derived Concentration Guides for Water^a

| Nuclide | DCGs for Water Ingestion in Uncontrolled Areas (pCi/L) | DCGs for Drinking Water Systems (pCi/L) ^b |
|-------------------|--|--|
| ³ H | 2,000,000 | 80,000 |
| ⁷ Be | 1,000,000 | 40,000 |
| ⁸⁹ Sr | 20,000 | 800 |
| ⁹⁰ Sr | 1,000 | 40 |
| ¹³⁷ Cs | 3,000 | 120 |
| ²³⁴ U | 500 | 20 |
| ²³⁵ U | 600 | 24 |
| ²³⁸ U | 600 | 24 |
| ²³⁸ Pu | 40 | 1.6 |
| ²³⁹ Pu | 30 | 1.2 |
| ²⁴⁰ Pu | 30 | 1.2 |
| ²⁴¹ Am | 30 | 1.2 |

^a Guides for uncontrolled areas are based on DOE's public dose limit for the general public (DOE 1990). Guides apply to concentrations in excess of those occurring naturally or that are due to worldwide fallout.

^b Drinking water DCGs are 4% of the DCGs for non-drinking water.

Nonradioactive Air Quality Standards

Table A-3 shows federal and state ambient air quality standards for nonradioactive pollutants.

Table A-3
National (40 CFR 50) and New Mexico (20.2.3 NMAC) Ambient Air Quality Standards

| Pollutant | Averaging Time | Unit | New Mexico Standard | Federal Standards | |
|------------------------------|------------------|-------------------|---------------------|-------------------|-----------|
| | | | | Primary | Secondary |
| Sulfur dioxide | Annual | ppm | 0.02 | 0.030 | |
| | 24 hours | ppm | 0.10 | 0.14 | |
| | 3 hours | ppm | | | 0.5 |
| Hydrogen sulfide | 1 hour | ppm | 0.010 | | |
| Total reduced sulfur | 1/2 hour | ppm | 0.003 | | |
| Total Suspended Particulates | Annual | µg/m ³ | 60 | | |
| | 30 days | µg/m ³ | 90 | | |
| | 7 days | µg/m ³ | 110 | | |
| | 24 hours | µg/m ³ | 150 | | |
| PM-10 ^a | Annual | µg/m ³ | | 50 | 50 |
| | 24 hours | µg/m ³ | | 150 | 150 |
| PM-2.5 ^b | Annual | µg/m ³ | | 15 | 15 |
| | 24 hours | µg/m ³ | | 65 | 65 |
| Carbon monoxide | 8 hours | ppm | 8.7 | 9 | |
| | 1 hour | ppm | 13.1 | 35 | |
| Ozone | 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 Particles ≤10 µm in diameter.

^b Particles ≤2.5 µm in diameter.

National Pollutant Discharge Elimination System

The types of monitoring required under National Pollutant Discharge Elimination System (NPDES) and the limits established for sanitary and industrial outfalls can be found at http://www.lanl.gov/environment/h2o/cw_npdes.shtml.

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 (NMEIB 1995). To view the New Mexico Drinking Regulations go to http://www.nmenv.state.nm.us/Common/regs_idx.html. 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 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 with 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) (http://www.nmenv.state.nm.us/NMED_regs/swqb/20_6_4_nmac.pdf). 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. The specific compounds analyzed in each suite are listed in the supplemental tables for Chapters 5 and 6.

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Appendix B

UNITS OF MEASUREMENT

Throughout this report the US Customary (English) system of measurement has generally been used because those are the units in which most data and measurements are collected or measured. 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 conversion factors for converting US Customary Units into SI units.

Table B-1
Approximate Conversion Factors for Selected US Customary Units

| Multiply US Customary units | by | to Obtain SI (Metric) Unit |
|---------------------------------|----------|--------------------------------------|
| Fahrenheit (°F) | 5/9 - 32 | Celsius (°C) |
| inches (in.) | 2.54 | centimeters (cm) |
| cubic feet (ft ³) | 0.028 | cubic meters (m ³) |
| acres | .4047 | hectares (ha) |
| ounces (oz) | 28.3 | grams (g) |
| pounds (lb) | 0.453 | kilograms (kg) |
| miles (mi) | 1.61 | kilometers (km) |
| gallons (gal.) | 3.785 | liters (L) |
| feet (ft) | 0.305 | meters (m) |
| parts per million (ppm) | 1 | micrograms per gram (µg/g) |
| parts per million (ppm) | 1 | milligrams per liter (mg/L) |
| square miles (mi ²) | 2.59 | square kilometers (km ²) |
| picocurie (pCi) | 37 | millibecquerel (mBq) |
| rad | 0.01 | gray (Gy) |
| millirem (mrem) | 0.01 | millisievert (mSv) |

Table B-2 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-3 presents abbreviations for common measurements.

Table B-2
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-3
Common Measurement Abbreviations and Measurement Symbols

| Symbol | Abbreviation | Symbol | Abbreviation |
|------------------------|------------------------------|--------------------------|---|
| aCi | attocurie | mrem | millirem |
| Bq | becquerel | mSv | millisievert |
| Btu | British thermal unit | nCi | nanocurie |
| Ci | curie | nCi/dry g | nanocurie per dry gram |
| cm ³ /s | cubic centimeters per second | nCi/L | nanocurie per liter |
| cpm/L | counts per minute per liter | ng/m ³ | nanogram per cubic meter |
| fCi/g | femtocurie per gram | pCi/dry g | picocurie per dry gram |
| ft | foot or feet | pCi/g | picocurie per gram |
| ft ³ /min | cubic feet per minute | pCi/L | picocurie per liter |
| ft ³ /s | cubic feet per second | pCi/m ³ | picocurie per cubic meter |
| kg | kilogram | pCi/mL | picocurie per milliliter |
| kg/h | kilogram per hour | pg/g | picogram per gram |
| m ³ /s | cubic meter per second | pg/m ³ | picogram per cubic meter |
| μ Ci/L | microcurie per liter | PM ₁₀ | small particulate matter (less than 10 μ m diameter) |
| μ Ci/mL | microcurie per milliliter | PM _{2.5} | small particulate matter (less than 2.5 μ m diameter) |
| μ g/g | microgram per gram | R | roentgen |
| μ g/m ³ | microgram per cubic meter | s, SD, or σ | standard deviation |
| mL | milliliter | sq ft (ft ²) | square feet |
| mm | millimeter | > | greater than |
| μ m | micrometer | < | less than |
| μ mho/cm | micro mho per centimeter | \geq | greater than or equal to |
| mCi | millicurie | \leq | less than or equal to |
| mg | milligram | \pm | plus or minus |
| mR | milliroentgen | \sim | approximately |
| mrad | millirad | | |

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 standard equation:

$$s = (\Sigma (c_i - \bar{c})^2 / (N - 1))^{1/2}$$

where

c_i = sample i ,

\bar{c} = mean of samples from a given station or group, and

N = number of samples in the station or group.

This value is reported as one standard deviation ($1s$) for the station and group means.

REFERENCE

Gilbert 1975: R. O. Gilbert, "Recommendations Concerning the Computation and Reporting of Counting Statistics for the Nevada Applied Ecology Group," Battelle Pacific Northwest Laboratories report BNWL-B-368 (September 1975).

Appendix C

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 1-3. The main programs conducted at each of the areas are listed in this Appendix.

| Technical Area | Activities |
|---|--|
| TA-0 (Offsite Facilities) | This TA designation is assigned to structures leased by DOE that are located outside LANL's boundaries in the Los Alamos townsite and White Rock. |
| TA-2 (Omega Site or Omega West Reactor) | Omega West Reactor, an 8-MW nuclear research reactor, was located here. It was placed into a safe shutdown condition in 1993 and was removed from the nuclear facilities list. The reactor was decontaminated and decommissioned in 2002. |
| TA-3 (Core Area or South Mesa Site) | This TA is LANL's core scientific and administrative area, with approximately half of LANL's employees and total floor space. It is the location of a number of the LANL's Key Facilities, including the Chemistry and Metallurgy Research Building, the Sigma Complex, the Machine Shops, the Material Sciences Laboratory, and the Nicholas C. Metropolis Center for Modeling and Simulation. |
| TA-5 (Beta Site) | This TA is largely undeveloped. Located between East Jemez Road and the San Ildefonso Pueblo, it contains physical support facilities, an electrical substation, and test wells. |
| TA-6 (Two-Mile Mesa Site) | This TA, located in the northwestern part of LANL, is mostly undeveloped. It contains a meteorological tower, gas-cylinder-staging buildings, and aging vacant buildings that are awaiting demolition. |
| TA-8 (GT-Site [Anchor Site West]) | This TA, located along West Jemez Road, is a testing site where nondestructive dynamic testing techniques are used for the purpose of ensuring the quality of materials in items ranging from test weapons components to high-pressure dies and molds. Techniques used include radiography, radioisotope techniques, ultrasonic and penetrant testing, and electromagnetic test methods. |
| TA-9 (Anchor Site East) | This TA is located on the western edge of LANL. Fabrication feasibility and the physical properties of explosives are explored at this TA, and new organic compounds are investigated for possible use as explosives. |
| TA-11 (K-Site) | This TA is used for testing explosives components and systems, including vibration analysis and drop-testing materials and components under a variety of extreme physical environments. Facilities are arranged so that testing may be controlled and observed remotely, allowing devices that contain explosives, radioactive materials, and nonhazardous materials to be safely tested and observed. |
| TA-14 (Q-Site) | This TA, located in the northwestern part of LANL, is one of 14 firing areas. Most operations are remotely controlled and involve detonations, certain types of high explosives machining, and permitted burning. |
| TA-15 (R-Site) | This TA, located in the central portion of LANL, is used for high explosives research, development, and testing, mainly through hydrodynamic testing and dynamic experimentation. TA-15 is the location of two firing sites, the Dual Axis Radiographic Hydrodynamic Test Facility, which has an intense high-resolution, dual-machine radiographic capability, and Building 306, a multipurpose facility where primary diagnostics are performed. |
| TA-16 (S-Site) | TA-16, in the western part of LANL, is the location of the Weapons Engineering Tritium Facility, a state-of-the-art tritium processing facility. The TA is also the location of high explosives research, development, and testing, and the High Explosives Wastewater Treatment Facility. |

| Technical Area | Activities |
|---|---|
| TA-18 (Pajarito Site) | This TA, located in Pajarito Canyon, is the location of the Los Alamos Critical Experiment Facility, a general-purpose nuclear experiments facility. It is the location of the Solution High-Energy Burst Assembly and is also used for teaching and training related to criticality safety and applications of radiation detection and instrumentation. All Security Category I and II materials and activities have been relocated to the Nevada Test Site. |
| TA-21 (DP-Site) | TA-21 is on the northern border of LANL, next to the Los Alamos townsite. In the western part of the TA is the former radioactive materials (including plutonium) processing facility that has been partially decontaminated and decommissioned. In the eastern part of the TA are the Tritium Systems Test Assembly and the Tritium Science and Fabrication Facility. Operations from both facilities have been transferred elsewhere as of the end of 2006. |
| TA-22 (TD-Site) | This TA, located in the northwestern portion of LANL, houses the Los Alamos Detonator Facility. Construction of a new Detonator Production Facility began in 2003. Research, development, and fabrication of high-energy detonators and related devices are conducted at this facility. |
| TA-28 (Magazine Area A) | TA-28, located near the southern edge of LANL, was an explosives storage area. The TA contains five empty storage magazines that are being decontaminated and decommissioned. |
| TA-33 (HP-Site) | TA-33 is a remotely-located TA at the southeastern boundary of LANL. The TA is used for experiments that require isolation, but do not require daily oversight. The National Radioastronomy Observatory's Very Long Baseline Array telescope is located at this TA. |
| TA-35 (Ten Site) | This TA, located in the north central portion of LANL, is used for nuclear safeguards research and development, primarily in the areas of lasers, physics, fusion, materials development, and biochemistry and physical chemistry research and development. The Target Fabrication Facility, located at this TA, conducts precision machining and target fabrication, polymer synthesis, and chemical and physical vapor deposition. Additional activities at TA-35 include research in reactor safety, optical science, and pulsed-power systems, as well as metallurgy, ceramic technology, and chemical plating. Additionally, there are some Biosafety Level 1 and 2 laboratories at TA-35. |
| TA-36 (Kappa-Site) | TA-36, a remotely-located area in the eastern portion of LANL, has four active firing sites that support explosives testing. The sites are used for a wide variety of nonnuclear ordnance tests. |
| TA-37 (Magazine Area C) | This TA is used as an explosives storage area. It is located at the eastern perimeter of TA-16. |
| TA-39 (Ancho Canyon Site) | TA-39 is located at the bottom of Ancho Canyon. This TA is used to study the behavior of nonnuclear weapons (primarily by photographic techniques) and various phenomenological aspects of explosives. |
| TA-40 (DF-Site) | TA-40, centrally located within LANL, is used for general testing of explosives or other materials and development of special detonators for initiating high explosives systems. |
| TA-41 (W-Site) | TA-41, located in Los Alamos Canyon, is no longer actively used. Many buildings have been decontaminated and decommissioned; the remaining structures include historic properties. |
| TA-43 (the Bioscience Facilities, formerly called the Health Research Laboratory) | TA-43 is adjacent to the Los Alamos Medical Center at the northern border of LANL. Two facilities are located within this TA: the Bioscience Facilities (formerly called the Health Research Laboratory) and NNSA's local Site Office. The Bioscience Facilities have Biosafety Level 1 and 2 laboratories and are the focal point of bioscience and biotechnology at LANL. Research performed at the Bioscience Facilities includes structural, molecular, and cellular radiobiology; biophysics; radiobiology; biochemistry; and genetics. |
| TA-46 (WA-Site) | TA-46, located between Pajarito Road and the San Ildefonso Pueblo, is one of LANL's basic research sites. Activities have focused on applied photochemistry operations and have included development of technologies for laser isotope separation and laser enhancement of chemical processes. The Sanitary Wastewater Systems Plant is also located within this TA. |

| Technical Area | Activities |
|--|---|
| TA-48 (Radiochemistry Site) | TA-48, located in the north central portion of LANL, supports research and development in nuclear and radiochemistry, geochemistry, production of medical radioisotopes, and chemical synthesis. Hot cells are used to produce medical radioisotopes. |
| TA-49 (Frijoles Mesa Site) | TA-49, located near Bandelier National Monument, is used as a training area and for outdoor tests on materials and equipment components that involve generating and receiving short bursts of high-energy, broad-spectrum microwaves. A fire support building and helipad located near the entrance to the TA are operated by the U.S. Forest Service. |
| TA-50 (Waste Management Site) | TA-50, located near the center of LANL, is the location of waste management facilities including the Radioactive Liquid Waste Treatment Facility and the Waste Characterization, Reduction, and Repackaging Facility. The Actinide Research and Technology Instruction Center is also located in this TA. |
| TA-51 (Environmental Research Site) | TA-51, located on Pajarito Road in the eastern portion of LANL, is used for research and experimental studies on the long-term impacts of radioactive materials on the environment. Various types of waste storage and coverings are studied at this TA. |
| TA-52 (Reactor Development Site) | TA-52 is located in the north central portion of LANL. A wide variety of theoretical and computational research and development activities related to nuclear reactor performance and safety, as well as to several environmental, safety, and health activities, are carried out at this TA. |
| TA-53 (Los Alamos Neutron Science Center) | TA-53, located in the northern portion of LANL, includes the LANSCE. LANSCE houses one of the largest research linear accelerators in the world and supports both basic and applied research programs. Basic research includes studies of subatomic and particle physics, atomic physics, neutrinos, and the chemistry of subatomic interactions. Applied research includes materials science studies that use neutron spallation and contributes to defense programs. LANSCE has also produced medical isotopes for the past 20 years. |
| TA-54 (Waste Disposal Site) | TA-54, located on the eastern border of LANL, is one of the largest TAs at LANL. Its primary function is management of solid radioactive and hazardous chemical wastes, including storage, treatment, decontamination, and disposal operations. |
| TA-55 (Plutonium Facility Complex Site) | TA-55, located in the center of LANL, is the location of the Plutonium Facility Complex and is the chosen location for the Chemistry and Metallurgy Research Building Replacement. The Plutonium Facility provides chemical and metallurgical processes for recovering, purifying, and converting plutonium and other actinides into many compounds and forms. The Chemistry and Metallurgy Research Building Replacement, currently under construction, will provide chemistry and metallurgy research, actinide chemistry, and materials characterization capabilities. |
| TA-57 (Fenton Hill Site) | TA-57 is located about 20 miles (32 kilometers) west of LANL on land administered by the U.S. Forest Service. The primary purpose of the TA is observation of astronomical events. TA-57 houses the Milagro Gamma Ray Observatory and a suite of optical telescopes. Drilling technology research is also performed in this TA. |
| TA-58 (Twomile North Site) | TA-58, located near LANL's northwest border on Twomile Mesa North, is a forested area reserved for future use because of its proximity to TA-3. The TA houses a few LANL-owned storage trailers and a temporary storage area. |
| TA-59 (Occupational Health Site) | This TA is located on the south side of Pajarito Road adjacent to TA-3. This is the location of staff who provide support services in health physics, risk management, industrial hygiene and safety, policy and program analysis, air quality, water quality and hydrology, hazardous and solid waste analysis, and radiation protection. The Medical Facility at TA-59 includes a clinical laboratory and provides bioassay sample analytical support. |
| TA-60 (Sigma Mesa) | TA-60 is located southeast of TA-3. The TA is primarily used for physical support and infrastructure activities. The Nevada Test Site Test Fabrication Facility and a test tower are also located here. Due to the moratorium on testing, these buildings have been placed in indefinite safe shutdown mode. |

| Technical Area | Activities |
|---|--|
| TA-61 (East Jemez Site) | TA-61, located in the northern portion of LANL, contains physical support and infrastructure facilities, including a sanitary landfill operated by Los Alamos County and sewer pump stations. |
| TA-62 (Northwest Site) | TA-62, located next to TA-3 and West Jemez Road in the northwest corner of LANL, serves as a forested buffer zone. This TA is reserved for future use. |
| TA-63 (Pajarito Service Area) | TA-63, located in the north central portion of LANL, contains physical support and infrastructure facilities. The facilities at this TA serve as localized storage and office space. |
| TA-64 (Central Guard Site) | This TA is located in the north central portion of LANL and provides offices and storage space. |
| TA-66 (Central Technical Support Site) | TA-66 is located on the southeast side of Pajarito Road in the center of LANL. The Advanced Technology Assessment Center, the only facility at this TA, provides office and technical space for technology transfer and other industrial partnership activities. |
| TA-67 (Pajarito Mesa Site) | TA-67 is a forested buffer zone located in the north central portion of LANL. No operations or facilities are currently located at the TA. |
| TA-68 (Water Canyon Site) | TA-68, located in the southern portion of LANL, is a testing area for dynamic experiments that also contains environmental study areas. |
| TA-69 (Anchor North Site) | TA-69, located in the northwestern corner of LANL, serves as a forested buffer area. The new Emergency Operations Center, completed in 2003, is located here. |
| TA-70 (Rio Grande Site) | TA-70 is located on the southeastern boundary of LANL and borders the Santa Fe National Forest. It is a forested TA that serves as a buffer zone. |
| TA-71 (Southeast Site) | TA-71 is located on the southeastern boundary of LANL and is adjacent to White Rock to the northeast. It is an undeveloped TA that serves as a buffer zone for the High Explosives Test Area. |
| TA-72 (East Entry Site) | TA-72, located along East Jemez Road on the northeastern boundary of LANL, is used by protective force personnel for required firearms training and practice purposes. |
| TA-73 (Airport Site) | TA-73 is located along the northern boundary of LANL, adjacent to Highway 502. The County of Los Alamos manages, operates, and maintains the community airport under a leasing arrangement with DOE. Use of the airport by private individuals is permitted with special restrictions. |
| TA-74 (Otowi Tract) | TA-74 is a forested area in the northeastern corner of LANL. A large portion of this TA has been conveyed to Los Alamos County or transferred to the Department of the Interior in trust for the Pueblo of San Ildefonso and is no longer part of LANL. |

Appendix D

RELATED WEB SITES

For more information on environmental topics at Los Alamos National Laboratory, access the following web sites:

| | |
|---|---|
| Environmental Surveillance reports and supplemental data tables | http://www.lanl.gov/environment/all/esr.shtml |
| Los Alamos National Laboratory web site | http://www.lanl.gov |
| DOE/NNSA Los Alamos Site Office web site | http://www.doeal.gov/laso/default.aspx |
| Department of Energy web site | http://www.energy.gov |
| LANL's air quality pages | http://www.lanl.gov/environment/air/index.shtml |
| LANL's water quality pages | http://www.lanl.gov/environment/h2o/index.shtml |
| LANL's waste pages | http://www.lanl.gov/environment/waste/index.shtml |
| LANL's biological resources pages | http://www.lanl.gov/environment/bio/index.shtml |
| LANL's risk reduction pages | http://www.lanl.gov/environment/risk/index.shtml |
| LANL's clean-up pages | http://www.lanl.gov/environment/cleanup/index.shtml |

Glossary

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| 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. |
| AOC | Area of concern. |
| 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. |

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| 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. |
| 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. Los Alamos National Laboratory is managed by the NNSA, an agency within the DOE. |

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| dose | A term denoting the quantity of radiation energy absorbed. |
| absorbed dose | The energy absorbed by matter from ionizing radiation per unit mass of irradiated material at the place of interest in that material. The absorbed dose is expressed in units of rad (or gray) (1 rad = 0.01 gray). |
| dose equivalent | The product of absorbed dose in rad (or gray) in tissue, a quality factor, and other modifying factors. Dose equivalent is expressed in units of rem (or sievert) (1 rem = 0.01 sievert). |
| TEDE | Total 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. |
| 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. |

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|----------------------------|---|
| 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, foodstuffs, 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. |
| 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. |
| 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 ($\frac{1}{2} \times \frac{1}{2}$), after three half-lives, one-eighth ($\frac{1}{2} \times \frac{1}{2} \times \frac{1}{2}$), and so on. |

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|-----------------------------|--|
| 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). |

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| 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. |
| MDA | Material disposal area. |
| 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. |
| NNSA | National Nuclear Security Agency. An agency within the DOE that is responsible for national security through the military application of nuclear energy. |
| 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. |

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| 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. PCBs are extremely persistent in the environment because they do not break down into new and less harmful chemicals. PCBs are stored in the fatty tissues of humans and animals through the bioaccumulation process. EPA banned the use of PCBs, 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). |
| PE Curie | One PE curie is the quantity of transuranic material that has the same radiation inhalation hazard as one curie of Pu-239. The PE curie is described in Appendix B of http://www.wipp.energy.gov/library/wac/WAC.pdf |
| perched groundwater | A groundwater body above a slow-permeability 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. |

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| ppb | Parts per billion. A unit measure of concentration equivalent to the weight/volume ratio expressed as $\mu\text{g/L}$ or ng/mL . Also used to express the weight/weight ratio as ng/g or $\mu\text{g/kg}$. |
| 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 $\mu\text{g/g}$ 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 | <p>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.</p> <p style="text-align: center;">$1 \text{ rad} = 1,000 \text{ millirad (mrad)}$</p> |
| 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. |

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| rem | <p>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.</p> $\text{rem} = \text{rad} \times \text{quality factor}$ $1 \text{ rem} = 1,000 \text{ millirem (mrem)}$ |
| SAL | Screening Action Limit. A defined contaminant level that if exceeded in a sample requires further action. |
| 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. |

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| 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. |
| 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. |

Acronyms and Abbreviations

| | |
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| AIRNET | Ambient Air Monitoring Network |
| AOC | area of concern |
| AQA | Analytical Quality Associates |
| BCG | Biota Concentration Guides |
| BSRL | baseline statistical reference level |
| CFR | Code of Federal Regulations |
| CGP | Construction General Permit |
| CMR | Chemistry and Metallurgy Research (LANL building) |
| CWA | Clean Water Act |
| DAC | derived air concentration (DOE) |
| DARHT | Dual Axis Radiographic Hydrotest facility |
| DCG | Derived Concentration Guide (DOE) |
| DOB | DOE Oversight Bureau |
| DOE | Department of Energy |
| DRO | diesel-range organic compound |
| DU | depleted uranium |
| EA | Environmental Assessment |
| EIS | Environmental Impact Statement |
| EMS | Environmental Management System |
| ENV | Environmental Stewardship Division |
| EPA | Environmental Protection Agency |
| EPCRA | Emergency Planning and Community Right-to-Know Act |
| ES&H | environment, safety, & health |
| EU | enriched uranium |
| FY | fiscal year |
| GEL | General Engineering Laboratory |
| GMAP | gaseous mixed air activation products |
| HE | high-explosive |
| HMX | cyclotetramethylenetetranitramine |
| HSWA | Hazardous and Solid Waste Amendments |
| HT | elemental tritium |
| HTO | tritium oxide |
| ISM | Integrated Safety Management (LANL) |
| LANL | Los Alamos National Laboratory (or the Laboratory) |
| LANSCE | Los Alamos Neutron Science Center (TA-53) |
| LASO | Los Alamos Site Office (DOE) |
| LC/MS/MS | liquid chromatography/mass spectrometry/mass spectrometry |
| MAPEP | Mixed-Analyte Performance Evaluation Program |
| MCL | maximum contaminant level |

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| MDA | material disposal area |
| MDL | method detection limit |
| MEI | maximally exposed individual |
| NCRP | National Council on Radiation Protection |
| NESHAP | National Emission Standards for Hazardous Air Pollutants |
| NMAC | New Mexico Administrative Code |
| NMED | New Mexico Environment Department |
| NMWQCC | New Mexico Water Quality Control Commission |
| P2 | Pollution Prevention Program |
| PCB | polychlorinated biphenyls |
| PERC | perchloroethylene |
| PM | particulate matter |
| ppb | parts per billion |
| ppm | parts per million |
| PSTB | Petroleum Storage Tank Bureau (NMED) |
| P/VAP | particulate/vapor activation products |
| QA | quality assurance |
| QAPP | Quality Assurance Project Plan |
| QC | quality control |
| R&D | research and development |
| RCRA | Resource Conservation and Recovery Act |
| RDX | research department explosive (cyclonite) |
| RLWT | Radioactive Liquid Waste Treatment Facility (LANL) |
| RSRL | regional statistical reference level |
| SAL | screening action level |
| SL | screening level |
| SOW | statement of work |
| SPCC | Spill Prevention Control and Countermeasures |
| SR | State Road |
| SWEIS | Site-Wide Environmental Impact Statement |
| SWPP | Storm water Prevention Plan |
| SWMU | solid waste management unit |
| TA | Technical Area |
| TCE | trichloroethylene |
| TLD | thermoluminescent dosimeter |
| TSCA | Toxic Substances Control Act |

Errata in 2006 ESR

1. In the Report “Environmental Surveillance at Los Alamos During 2006,” the estimated doses to residents of White Rock and Los Alamos townsite are incorrect. The doses from AIRNET sources were overlooked when the total dose was summed. The corrected numbers change the values for Los Alamos and White Rock from 0.0125 mrem and 0.0145 mrem to 0.043 mrem and 0.044 mrem, respectively. These calculated levels are still considered extremely low doses and are not a human health risk concern.

The affected paragraphs should read as follows (corrected text is indicated by underline):

Executive Summary, Page 8, Radiological Dose Assessment:

- The doses received in 2006 from LANL operations by an average Los Alamos residence and an average White Rock residence totaled about 0.043 mrem and 0.044 mrem, respectively (about 39% and 73% of the doses in 2005).

Chapter 3, Section B.3.c., page 81:

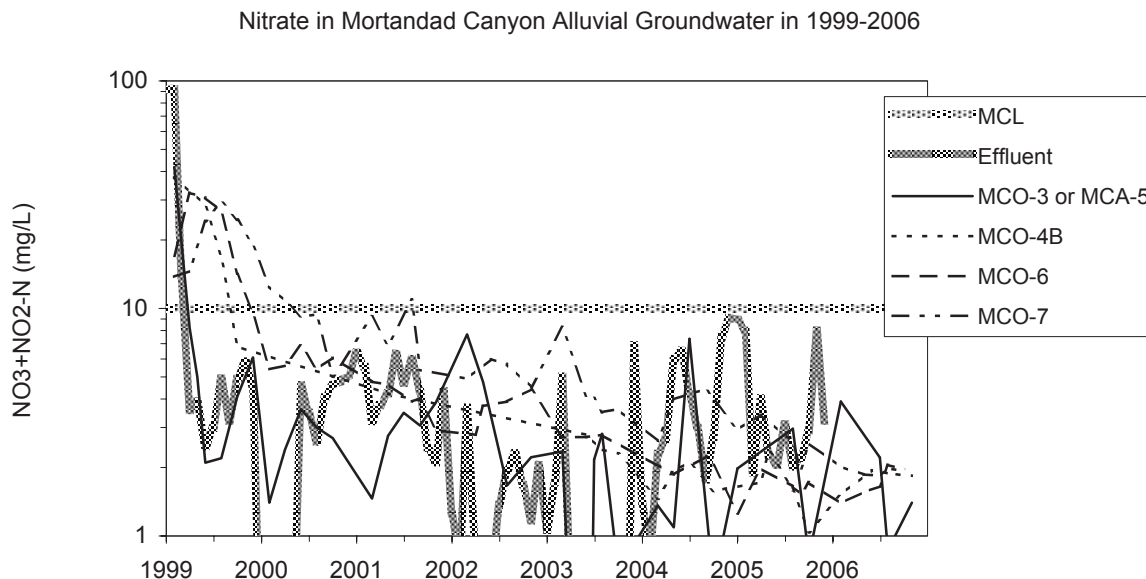
i. Los Alamos

During 2006, the Laboratory contributions to the dose at an average Los Alamos residence were 0.030 mrem calculated from AIRNET station data, and 0.013 mrem/yr from LANSCE and other stacks calculated using CAP88. This results in a total dose to an average Los Alamos resident of approximately 0.043 mrem/yr.

ii. White Rock

During 2006, the Laboratory contributions to the dose at an average White Rock residence were 0.029 mrem calculated from AIRNET station data, and 0.015 mrem/yr from LANSCE and other stacks calculated using CAP88. This results in a total dose to an average White Rock resident of approximately 0.044 mrem/yr.

2. The graph in Figure 5-19 shows trends of Fluoride instead of Nitrate, as the caption indicates. The correct graph for Figure 5-19 is below:



3. In Table 4-16 in Chapter 4, the units in the table heading do not match the units shown in the column headings. The units in the column heading (g/m^3) are correct.

The following Los Alamos National Laboratory organizations perform environmental surveillance, ensure environmental compliance, and provide environmental data for this report:

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