# Environmental Surveillance at Los Alamos During 2006

## Executive Summary

Los Alamos
NATIONAL LABORATORY
EST. 1943

LA-14341-ENV

## EXECUTIVE SUMMARY ➤ 2006

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, the 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.

> ➤ *The Laboratory's environmental management system was fully certified to the international standard by an independent registrar.*
>
> ➤ *NNSA recognized the success of the EMS management by giving the Laboratory the 2006 NNSA "Best in Class" Award for EMS-developed projects.*

During 2006, the EMS was audited three times by an independent third-party ISO 14001 auditor. The auditors concluded that the LANL 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 is the first DOE National Nuclear Security Agency (NNSA) national laboratory and the first University of California-operated facility to receive this distinction. NNSA recognized the success of the EMS management and the core teams' unique approach by giving the Laboratory the 2006 NNSA "Best in Class" Award for EMS-developed projects. The Laboratory's Pollution Prevention Program is an important component of the

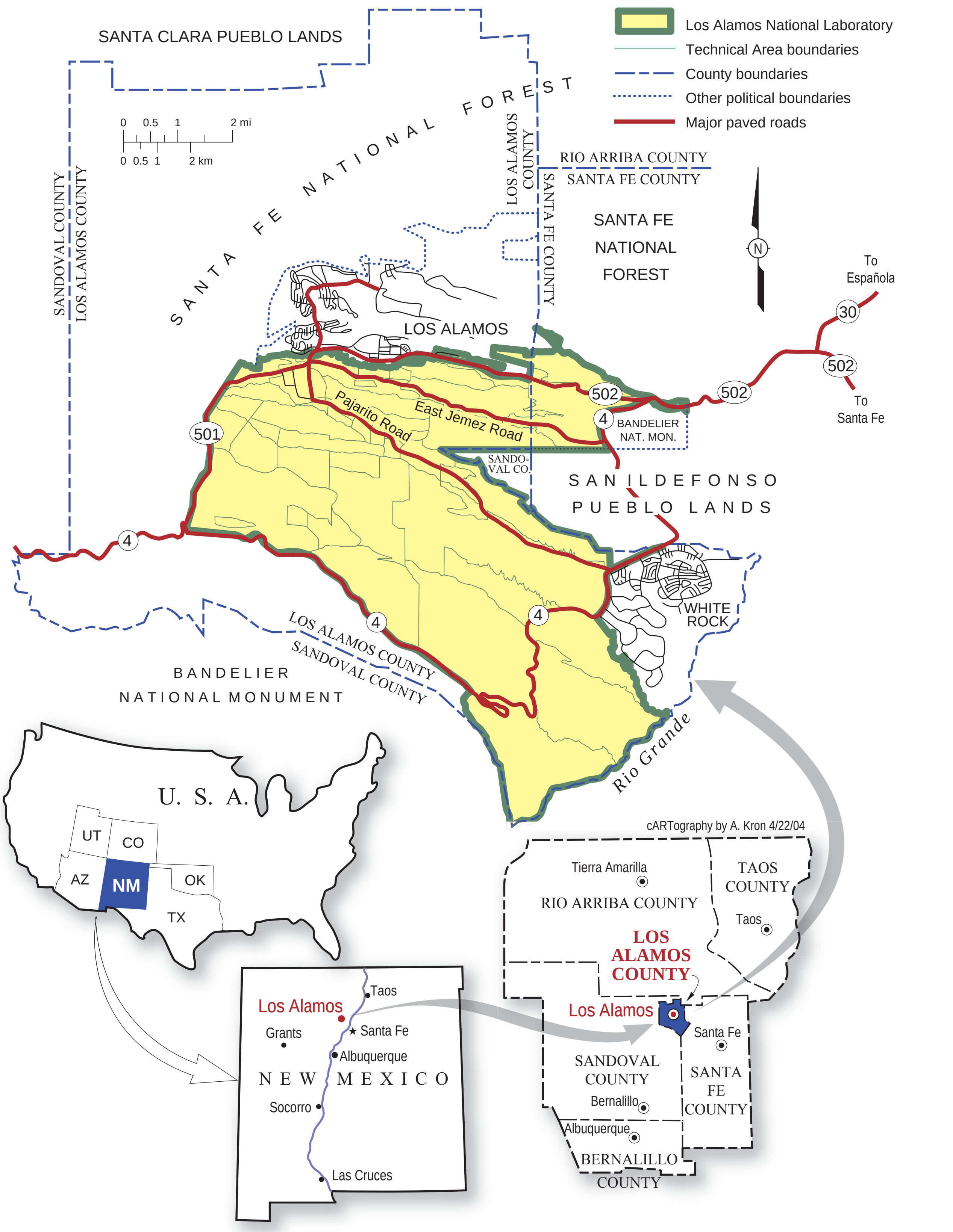


**Figure ES-1. Regional location of Los Alamos National Laboratory.**

EMS and received seven national NNSA Pollution Prevention awards for Laboratory projects in fiscal year 2006 (up from five awards in fiscal year 2005).

### Federal Facility Compliance Agreement

During 2006, 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 NM 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 the LANL's Environmental Restoration Program and 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 2006. The NMED issued three Notices of Violation to LANL and DOE pursuant to the Consent Order for alleged improper disposal of cleanup debris, failure to report a release of a groundwater contaminant, and improper storage of building debris.

> ➤ *The Consent Order is the principal regulatory driver for the Laboratory's Environmental Restoration Program 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 three Notices of Violation to LANL and DOE related to the Consent Order for alleged improper disposal of cleanup debris, failure to report a release of a groundwater contaminant, and improper storage of building debris.*

### Improvement Targets

Improvement goals for the Laboratory include continuing to improve Resource Conservation and Recovery Act (RCRA) compliance. The Laboratory improved its RCRA compliance in 2006. The Laboratory is improving 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 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 by 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 identify actions to protect or improve 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 air-sampling network (AIRNET) and foodstuffs and biota (plants and animals) sampling locations. 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 result in emissions or discharges. 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 2006, the Laboratory collected more than 8400 environmental monitoring samples from 780 locations and requested almost 200,000 analyses or measurements on these samples.

### Compliance

As a key indicator of its environmental performance, the Laboratory uses the status of compliance with environmental requirements. 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.

### Unplanned Releases

There was one unplanned airborne release, of anhydrous ammonia, from LANL in 2006. There were no unplanned releases of radioactive liquids. There were six spills or releases of non-radioactive liquids which included fire suppression water (900 gal.), clean fill sediment from storm water runoff from a construction site, and potable water (44,000 gal.). All liquid releases were reported to NMED and will be administratively closed upon final inspection. A smoke opacity deviation of 24% (just above the permit limit of 20%) was observed at the asphalt plant.

> ➤ *Radiation dose to the hypothetical maximally exposed individual (MEI) was more than 13 times lower in 2006 compared to 2005 and was the lowest since 1999. LANSCE emissions, normally the largest source of public exposure, were greatly reduced because of new emissions controls systems.*
>
> ➤ *The MEI location was determined to be at the Los Alamos County Airport terminal. This location received a combination of low levels of radiation from stack emissions and low levels of contamination from the cleanup of an adjacent debris pile.*

### 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) over the last 13 years at an off-site location; this location was East Gate in all prior years but was determined to be at the Los Alamos County Airport terminal for 2006. The dose to the MEI was approximately 0.47 mrem,

**Table ES-1**
**Environmental Statutes under which LANL Operates and Compliance Status in 2006**

| 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 | NMED conducted one RCRA hazardous waste compliance inspection in 2006 but LANL received no further communication in 2006 regarding the inspection.<br>The Laboratory completed 1,453 self-assessments that resulted in a nonconformance finding rate of 3.02%.<br>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 three Notices of Violation to DOE and LANL that alleged improper disposal of cleanup debris, failure to report a release of a groundwater contaminant, and improper storage of building debris.<br>The Laboratory is in compliance with groundwater monitoring requirements. Six alluvial characterization wells, one intermediate characterization well, and five piezometers (which measure water levels) were installed in Sandia Canyon in 2006. |
| Clean Air Act (CAA) | Air quality and emissions into the air from facility operations | The Laboratory met all permit limits for emissions to the air. Non-radiological air emissions were similar to the previous year. An smoke opacity deviation 4% greater than permit limits occurred at the asphalt plant. LANL continued to eliminate the use of refrigerants. The dose to the maximum exposed individual (MEI) from radioactive air emissions dropped to 0.47 mrem, the lowest level in eight years. |
| Clean Water Act (CWA) | Water quality and effluent discharges from facility operations | Only one (a total residual chlorine level) of 733 samples collected from industrial outfalls and none of the 113 samples collected from the Sanitary Wastewater Systems Plant's outfall exceeded effluent limits.<br>About 94% of the Laboratory's permitted construction sites were compliant with National Pollutant Discharge Elimination System (NPDES) requirements contained in 57 construction site storm water pollution prevention plans. Institutional and programmatic controls were implemented to further improve and assure compliance under the Laboratory's construction general permit.<br>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. |
| Toxic Substances Control Act (TSCA) | Chemicals such as polychlorinated biphenyls (PCBs) | The Laboratory shipped 58 containers of PCB waste, 105 lbs of capacitors, and 2,661 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. |
| 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 11,069 lbs of lead. A leak of anhydrous ammonia exceeded reporting thresholds and was reported as required. No updates to Emergency Planning Notifications were necessary in 2006. Chemical Inventory Reports were updated to the Los Alamos County fire and police departments for 36 chemicals or explosives. |

**Table ES-1 (continued)**

| Federal Statute | What it Covers | Status |
|---|---|---|
| Endangered Species Act (ESA) & Migratory Bird Treaty Act (MBTA) | Rare species of plants and animals | The Laboratory maintained compliance with the ESA and MBTA. The Laboratory prepared biological assessments for three projects and continued to monitor endangered species status. |
| National Historic Preservation Act (NHPA) and others | Cultural resources | The Laboratory maintained compliance with the NHPA. The laboratory identified 13 new archaeological sites and 166 historic buildings. Twenty-three archaeological sites and 65 historic buildings were determined eligible for the National Register of Historic Places. |
| National Environmental Policy Act (NEPA) | Projects evaluated for environmental impacts | The NEPA team prepared or reviewed two analyses: a new LANL Site-wide Environmental Impact Statement and an Environmental Assessment for the construction and operation of a Biosafety Level-3 facility. No non-compliances were reported. |

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

| Source | Dose | Location | Trends |
|---|---|---|---|
| Background (includes man-made sources) | ~470 mrem/yr | All sites | Not applicable |
| Air (humans) | 0.47 mrem/yr | Los Alamos County Airport Terminal | Lowest since 1999; expected to remain low |
| Direct irradiation (humans) | 1.1 mrem/yr | San Ildefonso – offsite | None |
| Food (humans) | <0.1 mrem/yr | All sites | None |
| Drinking water (humans) | <0.1 mrem/yr | All sites | None |
| All (terrestrial animals) | <20 mrad/day | TA-15 EF site, TA-21 material disposal area (MDA) B | None |
| All (aquatic animals) | <85 mrad/day | TA-50 Effluent Canyon | None |
| All (terrestrial plants) | <50 mrad/day | TA-21 MDA B | None |

compared to 6.46 mrem in 2005 and a regulatory limit of 10 mrem (Figure ES-2). Cleanup of a slightly-contaminated debris pile next to the terminal contributed to this low dose. The Laboratory calculated potential radiological doses to members of the public that resulted from LANL emissions and discharges. During 2006, the population within 80 km of LANL received a collective dose of about 0.6 person-rem, which is a substantial decrease from the dose of 2.46 person-rem reported for 2005. The doses received in 2006 from LANL operations by an average Los Alamos residence and an average White Rock residence totaled about 0.0125 mrem and 0.0145 mrem, respectively (about one-ninth and one-fourth, respectively, of the doses in 2005). The decrease in these doses from 2005 was attributable to greatly reduced emissions from the LANSCE accelerator facility, which releases very short-lived radioactive gasses from a location relatively close to the LANL boundary. A leak repair and an improved emissions control system installed in 2005 both helped to reduce emissions.

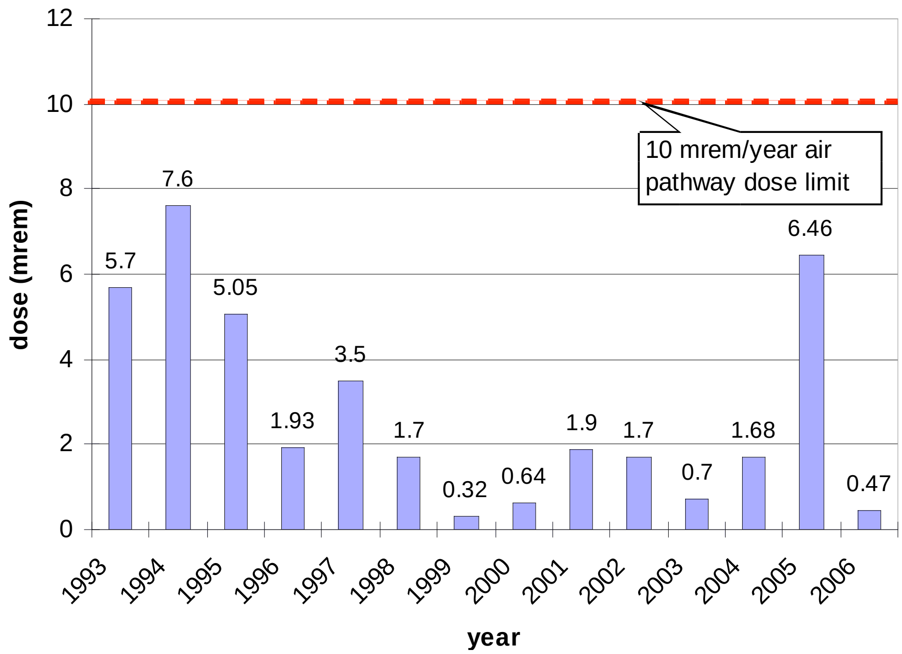


**Figure ES-2. Annual airborne pathway dose (mrem) to the off-site MEI over the past 14 years. For the first time, the location of the calculated MEI changed from East Gate to the Los Alamos County Airport terminal.**

### Biota Dose

The DOE biota dose limits are intended to protect populations, especially with respect to preventing the impairment of reproductive capability within the biota population and are thus applied to biota populations rather than to individual plants and animals. We collected soil, sediment, vegetation, and small mammals from known contaminated areas (material disposal areas or MDAs), canyons, and operational sites (DAHRT). All radionuclide concentrations in terrestrial vegetation sampled were far below the 0.1 rad/day biota dose-based screening level (10% of 1 rad/day dose limit) and all radionuclide concentrations in terrestrial animals sampled were far below the 0.01 rad/day biota dose-based screening level (10% of 0.1 rad/day dose limit). A special dose assessment for plants and animals in Mortandad Canyon, based on new data collected as part of the canyon investigation, confirmed previous dose estimates and indicated the dose was about 0.007 rad/day to plants and 0.005 rad/day to animals, compared to limits of 1.0 rad/day and 0.1 rad/day, respectively.

### Air Emissions and Air Quality

> ➤ *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.*

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 takes 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 plutonium, americium, uranium, and tritium.

In 2006, 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 2006 were approximately 1,290 curies (Ci). Of this total, tritium emissions composed about 893 Ci and short-lived air activation products from LANSCE stacks contributed nearly 398 Ci. Combined airborne emissions of materials, such as plutonium, uranium, americium, and thorium, were less than 0.00002 Ci and emissions of particulate/vapor activation products increased in 2006 to 2.3 Ci.

> ➤ *Emissions from the stacks at LANSCE, normally the source of most radionuclide emissions, were significantly lower in 2006 compared to 2005 because a leak that caused elevated emissions in 2005 was repaired and addition emissions controls were added.*
>
> ➤ *Emissions of radionuclides from other Laboratory stacks were comparable to previous years.*

Radionuclide concentrations from ambient air samples in 2006 were generally comparable with concentrations in past years. As in past years, the AIRNET system detected contamination from known areas of contamination below the Los Alamos Inn, at the Laboratory's waste disposal site at Area G, and from the former plutonium processing site at TA-21. New or increased airborne radioactivity was detected from cleanup operations at the Los Alamos County Airport, cleanup operations at MDA V at TA-21, and from disposal of the contaminated wastes at Area G. At regional locations away from Los Alamos, all air sample measurements were consistent with background. Annual mean radionuclide concentrations at all LANL perimeter stations were less than 1% of EPA limits 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 the southwest LANL boundary) was 9 pCi/m$^3$ (0.6% of the EPA public dose limit of 1,500 pCi/m$^3$). Plutonium was detected at two LANL perimeter stations: near Los Alamos Inn at about 12 aCi/m$^3$ or about 1% of the EPA public dose limit (from historical activities at LANL's old main technical area), and near the Los Alamos County Airport (from remediation work at TA-21). On-site detections of plutonium occurred at TA-21 and at Area G (areas with known low levels of contamination) and were substantially below 0.2% of the DOE limit for workplace exposure. Americium-241 was detected only at TA-21 and at Area G at levels less than 0.001% of worker exposure limits. The maximum annual uranium concentrations were from natural uranium at locations with high dust levels from local soil disturbances such as dirt roads at the Los Alamos County Landfill and Area G. The regional and pueblo samples had higher average concentrations of uranium isotopes than the perimeter group at isotopic ratios that indicate natural sources. Depleted uranium (which has lower radioactivity than natural uranium) was detected in two samples from areas around LANL firing sites where depleted uranium was used in the past.

> ➤ *PM-10 and PM-2.5 particulate measurements in ambient air were well below EPA standards.*
>
> ➤ *Beryllium air concentrations for 2005 were similar to past years and were equal to or less than 2% of the NESHAP standard; a natural origin is indicated by the strong correlation with aluminum concentrations.*

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 average at all locations for PM-10 was about 13 micrograms/m$^3$ and about 7 micrograms/m$^3$ for PM-2.5 and was mostly caused by natural dust and wildfire smoke. These averages are the same as in 2005 and well below the EPA standards. In addition, the 24-hour maxima for both PM-2.5 and PM-10 at all three locations were much less than the 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. Correlation with aluminum concentrations indicates that all measurements of beryllium are from naturally occurring beryllium in resuspended dust. Beryllium air concentrations for 2006 were similar to those measured in recent years. All values are equal to or less than 2% of the National Emission Standard for Hazardous Air Pollutants (NESHAP) standard.

### Groundwater Monitoring

Groundwater at the Laboratory occurs as a regional aquifer (water-bearing rock) 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.

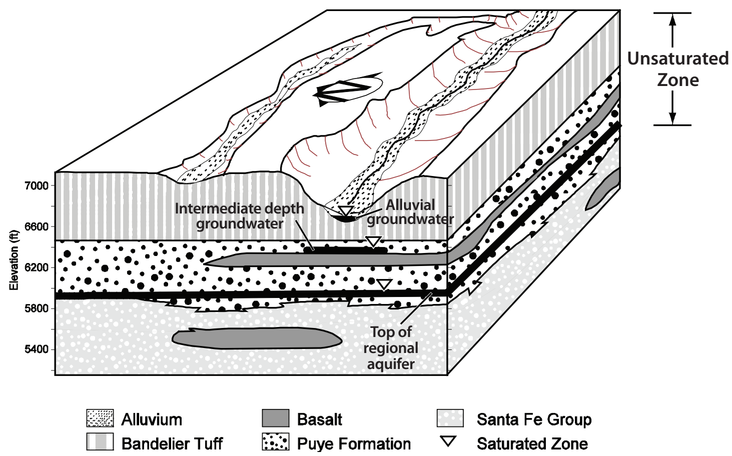


**Figure ES-3. Illustration of geologic and hydrologic relationships in the Los Alamos area, showing the three modes of groundwater occurrence.**

Laboratory contaminants have impacted 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 80%). For 1993 to 1997, total estimated average flow was 1300 million gal./yr; in 2006, the flow was 222 million gal. All discharges met applicable 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. Table ES-3 summarizes contaminants found in portions of the groundwater system.

➤ *In general, groundwater quality is improving as LANL:*
- *Eliminates outfalls,*
- *Reduces quantity of discharges, and*
- *Improves water quality of the discharges.*

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

Drainages that received liquid radioactive effluents in the past include Mortandad Canyon, Pueblo Canyon from its tributary Acid Canyon, and Los Alamos Canyon from its tributary DP Canyon; only Mortandad

**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 |
| Other radionuclides | Alluvial groundwater in DP/Los Alamos, Pueblo, and Mortandad Canyons | No | Not used as a drinking water supply; radionuclides have not penetrated to deeper groundwater | Some constituents are fixed in location; some are decreasing as effluent quality increases |
| 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. Investigations and new wells are being installed to determine extent and predict future movement; source eliminated in 1972. | Insufficient data to define trends |
| Perchlorate | Alluvial and intermediate groundwater in Mortandad Canyon | No | Values near or above EPA Drinking Water Equivalent Level; supply well with values below risk level is permanently off line | Decreasing in Mortandad Canyon alluvial groundwater as effluent quality improves; insufficient data for other groundwater |
| Nitrate | Alluvial and Intermediate groundwater in Pueblo Canyon, regional aquifer in Sandia Canyon, intermediate groundwater and regional aquifer in Mortandad Canyon | Yes, in Pueblo Canyon | In Pueblo Canyon, may be due to Los Alamos County's Bayo Sewage Treatment Plant | Insufficient data in Mortandad Canyon, values in Pueblo Canyon are variable, values in Sandia Canyon rising |
| Molybdenum | Alluvial groundwater in Los Alamos Canyon | No | Not used as drinking water, limited in extent | Near NM groundwater limit for 10 years |
| Barium | Alluvial and intermediate groundwater in Cañon de Valle | No | Not used as drinking water, limited in area | Generally stable, seasonal fluctuations |
| RDX | Alluvial and intermediate groundwater in Cañon de Valle, alluvial groundwater in Pajarito Canyon | No | Limited in area | Generally stable |

[a] Shallow groundwater includes alluvial and intermediate groundwater.

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, all National Pollutant Discharge Elimination System (NPDES) requirements, and has voluntarily met NM groundwater standards for fluoride, nitrate, and total dissolved solids in all but two weeks.

> ➤ *LANL detected chromium contamination in the regional aquifer at concentrations above drinking water standards.*
>
> ➤ *The contamination is likely the result of discharges made in the mid-1950s through the early 1970s containing chromate in cooling tower discharges.*
>
> ➤ *No drinking water wells have been affected by the chromium contamination.*

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 reduced.

Water Canyon and its tributary Cañon de Valle formerly received effluents produced by high explosives (HE) 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. In 2006, the high explosive compound RDX was detected in the regional aquifer for the first time, at Pajarito Canyon 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. Earlier detection of RDX in the regional aquifer at R-25 (to the south of R-18) was probably due to contamination from upper levels during well construction of this deep well. The Laboratory, in cooperation with NMED, is investigating these issues.

> ➤ *The Radioactive Liquid Waste Treatment Facility, which discharges into Mortandad Canyon, has met all DOE radiological discharge standards for 82 of the past 84 months; has met all NPDES requirements for seven consecutive years; and 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 Laboratory found hexavalent chromium and nitrate in several monitoring wells. The hexavalent chromium is above the NM groundwater standard in one regional aquifer well and at 60% of the standard in another. Nitrate reaches 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.

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.

With one exception, drinking water wells in the Los Alamos area have not been adversely 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 EPA's Drinking Water Equivalent Level of 24.5 micrograms per liter (µg/L). 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 requirements.

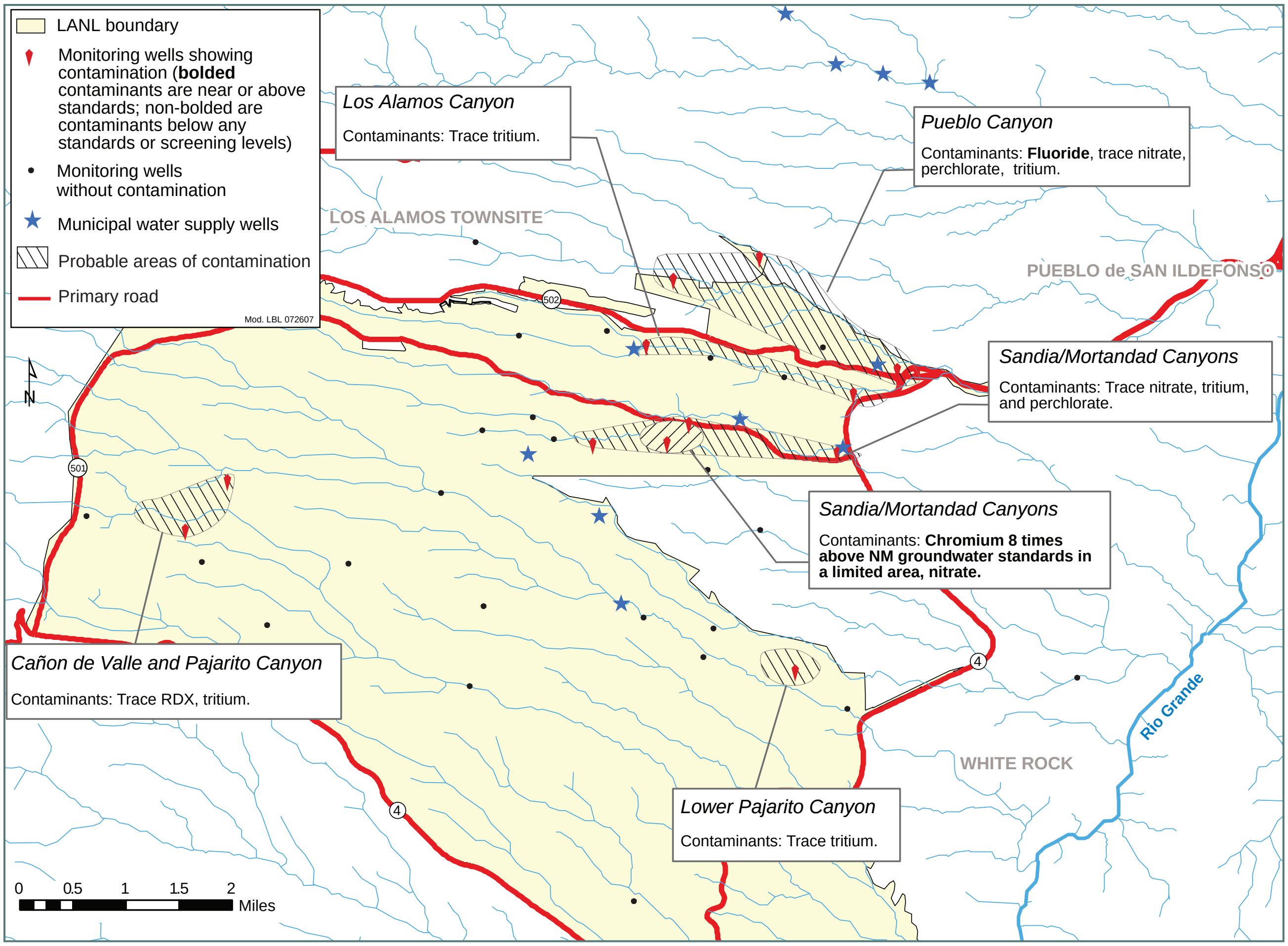


**Figure ES-4. Summary of regional aquifer groundwater quality issues at Los Alamos National Laboratory.**

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. Dioxane[1,4-], a volatile organic compound used as a stabilizer for chlorinated organic solvents, was detected in two intermediate wells in Mortandad Canyon. The Laboratory, in cooperation with the NMED, is investigating this contamination.

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 activities exceed the guidance that is applicable to drinking water (4 mrem/yr). The maximum strontium-90 values in Mortandad Canyon and DP/Los Alamos Canyons alluvial groundwater were also above the EPA's drinking water standard.

Perchlorate is detected in most groundwater samples analyzed from across northern NM. The 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 taken in 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 near zero in 2002 and perchlorate values in alluvial groundwater downstream of the facility's discharge in Mortandad Canyon have been steadily declining.

### Watershed Monitoring

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. No perennial surface water extends completely across the Laboratory in any canyon. Storm water runoff occasionally extends across the Laboratory but is short-lived. Wildlife drink from the stream channels when water is present but the water is not used for any other purpose.

> ➤ *The overall quality of most surface water within the Los Alamos area is very good.*
>
> ➤ *Of the more than 100 analytes, 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.*

Hydrologic conditions in all LANL canyons have recovered to levels near those before the Cerro Grande Fire in 2000. However, flows in Pueblo Canyon continue to increase quickly after rainfall events, principally due to increased urbanization and changes to the storm drainage system that have occurred since the fire. Two near-100-year rainfall events in August 2006 led to record flows at some 20 stream gaging stations across the Pajarito Plateau. Despite the record flows, significant impacts to stream flow and water quality downstream of the Laboratory were not evident. The overall quality of most surface water in the Los Alamos area is very good, with low levels of dissolved solutes. Of the more than 100 constituents measured in sediment and surface water within the Laboratory, most are at concentrations far below regulatory standards or risk-based advisory levels. However, nearly every major watershed has some effect from Laboratory operations, often for just a few constituents.

Approximately eight of 10 surface water samples in 2006 contained gross alpha activity in the suspended sediment greater than the NM surface water standard for livestock watering. However, only alpha activity in Mortandad Canyon can regularly be attributed to Laboratory activities; the vast majority of all other results is due to natural sediment and soil carried in storm runoff. There is strong correlation between gross alpha activity and suspended sediment concentrations in the samples. Overall gross alpha levels in suspended sediments have declined over the past few years with the corresponding decrease in sediment load as fire-burned areas recover. The only radionuclide that is measured at more than 5% of the DOE biota concentration guide is radium-226, which is of natural origin.

> ➤ *Polychlorinated biphenyls (PCBs) are the most significant Laboratory-derived contaminants in surface water samples, with concentrations greater than the NM surface water standard often measured in Sandia and Los Alamos Canyons.*
>
> ➤ *Radioactive elements from past Laboratory operations are being transported by runoff events. All radionuclide levels are well below applicable guidelines or standards.*
>
> ➤ *PCBs and radionuclides adsorb onto sediment particles and thus overall water concentrations can probably be substantially reduced by slowing the stream flows.*

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 for short periods of intense flow. In some cases, sediment contamination is present from Laboratory operations conducted more than 50 years ago. Table ES-4 shows the locations of Laboratory-impacted surface water and sediment. All radionuclide levels are well below applicable guidelines or standards (Table ES-5).

The overall pattern of radioactivity in channel sediment, such as along lower Los Alamos Canyon, has not greatly changed in 2006. Sediment traps and other methods to slow or control sediment transport in these canyons reduce the potential for further transport down the canyons and potentially to the Rio Grande. Such a sediment trap, the Los Alamos Canyon Weir, has decreased transport of sediment from lower Los Alamos Canyon by about two thirds in 2005 and 2006.

**Table ES-4**
**Where Can We See LANL Impacts on Surface Water and Sediment 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 40% of DOE biota concentration guide for year; dose mainly from radium-226 that is of natural origin. | None |
| Gross alpha radioactivity | Mortandad Canyon | No | 80% of surface water results from all canyons greater than NM livestock watering standard. Major source is naturally occurring radioactivity in sediments, except in Mortandad Canyon where there is a LANL contribution. | Steady in Mortandad; downward in fire-affected canyons as stream flows recover to pre-fire levels; upward in Pueblo Canyon as flows remain elevated after the fire due to increased urbanization and drainage system changes. |
| Polychlorinated biphenyls (PCBs) | Detected in sediment in nearly every canyon. Detected in Sandia Canyon runoff and base flow above NM stream standards | Yes, particularly in the Los Alamos/ Pueblo Canyons | Wildlife exposure potential in Sandia Canyon. Elsewhere findings include non-Laboratory and Laboratory sources | None |
| Selenium | No | No | Half of surface water samples after the fire greater than NM wildlife habitat standard. However, none of 2006 samples above standard. | Downward |
| Dissolved copper | Detected in many canyons above NM acute aquatic life standards | Yes, in Los Alamos Canyon | Origins uncertain, probably several sources | None |

**Table ES-5**
**Estimated Annual Average Unfiltered Surface Water Concentrations of Radionuclides in Selected Canyons Compared with the Biota Concentration Guides**

| Radionuclide | BCGs[a] (pCi/L) | Pueblo above Acid | Lower Pueblo Canyon | DP Canyon below TA-21 | LA Canyon between DP and State Road-4 | LA Canyon at Rio Grande | Mortandad Canyon below Effluent Canyon | Max percent of BCG[a] |
|---|---|---|---|---|---|---|---|---|
| Am-241 | 400 | | 0.01 | 0.1 | 0.5 | 0.01 | 9 | 2% |
| Cs-137[b] | 20,000 | 0.1 | 0.2 | 2 | 2 | 0.3 | 33 | 0.2% |
| H-3 | 300,000,000 | | 43 | 21 | 7 | 26 | 294 | <0.01% |
| Pu-238 | 200 | | 0.001 | 0.01 | 0.04 | 0.01 | 5 | 2% |
| Pu-239,240 | 200 | 0.01 | 0.3 | 0.1 | 0.5 | 0.04 | 7 | 4% |
| Sr-90 | 300 | 0.1 | 0.01 | 12 | 0.8 | 0.4 | 4 | 1% |
| U-234 | 200 | 0.3 | 0.4 | 0.6 | 1.3 | 1.5 | 2 | 1% |
| U-235,236 | 200 | 0.01 | 0.01 | 0.02 | 0.1 | 0.1 | 2 | 0.1% |
| U-238 | 200 | 0.4 | 1.0 | 0.4 | 1.3 | 1.4 | 0.1 | 1% |
| Ra-226 | 4 | 0.2 | 0.9 | 0.2 | 0.9 | 1.6 | 0.2 | 40% |

[a] BCG = DOE Biota Concentration Guides
[b] The BCG for cesium-137 is a site-specific modified BCG
Blank cells indicate no analytical laboratory detection in 2006

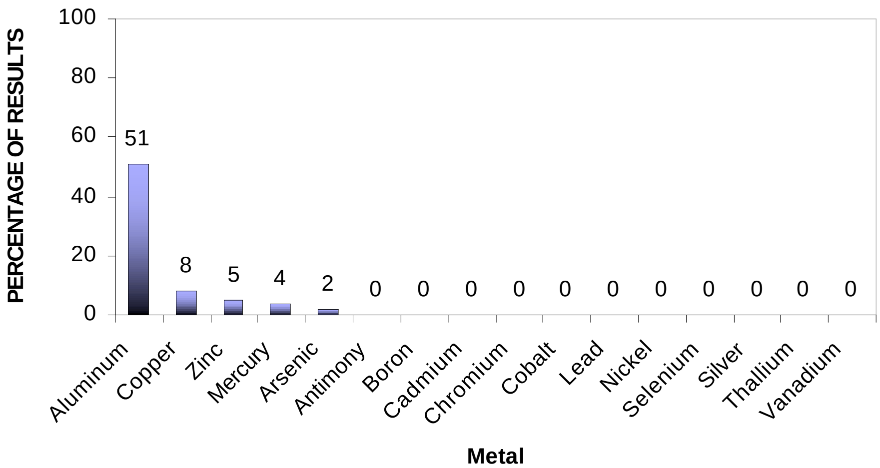


**Figure ES-5. Frequency of metal results greater than the most restrictive NM stream standards.**

In 2006, all metal concentrations in sediment were below screening levels for recreational and residential uses. In surface water, the vast majority of results were below the most stringent applicable state stream standards, other than for metals of natural origin (for example, aluminum; Figure ES-5). Selenium concentrations have progressively declined since the fire in 2000 and no values greater than the wildlife habitat standard were measured in 2006. The water quality trends indicate that the elevated selenium concentrations were due to natural sources, probably the ash from the fire.

The types of organic compounds tested for varied depending on the location and typically included the following suites: pesticides/polychlorinated biphenyls (PCBs), HE, volatile organics, and semi-volatile organics. On average, more than 70 different compounds were assessed at each site. PCBs are the only class of organic compounds that were definitively detected at concentrations greater than the NM water quality standards and are likely Laboratory-derived. The sources of PCBs on Laboratory lands are likely predominantly from past spills and leaks of transformers, rather than current effluent discharges. Despite the higher PCB concentrations measured in runoff within the Laboratory, monitoring results show no measurable effects in the Rio Grande.

All measurements of radioactivity in the Rio Grande and in Cochiti Reservoir were orders of magnitude below recreational or residential screening levels. In river sediments, no appreciable differences in radioactivity were measured above and below the Laboratory. Plutonium-239,240 concentrations were below analytical detection limits in the Rio Grande at both the Frijoles and Otowi stations.

Flows from the Pajarito Plateau (from all canyons combined) into the Rio Grande were never more than $1/1000^{th}$ the flow volume in the Rio Grande. Sediment transport loads in the Rio Grande are 100 to 1000 times that contributed by Los Alamos Canyon. Thus, any impact to the Rio Grande from the transport of contaminated sediment will be very difficult to discern.

### Soil Monitoring

Surface soil (mesa top) samples were collected from 17 on-site locations (generally downwind of major facilities or operations at LANL and not from known contaminated areas), 11 perimeter locations (North Mesa, Sportsman's Club, Quemazon Trail, west airport, east airport, White Rock, San Ildefonso, Otowi, Tsankawi/PM-1, US Forest Service property across from TA-8, and south on Bandelier National Monument property near TA-49), and six regional or background locations (near Ojo Sarco, Dixon, Borrego Mesa near Santa Cruz dam, Rowe Mesa near Pecos, Youngsville, and Jemez).

> ➤ *LANL-derived radionuclides were detected in soils collected from areas generally downwind of major facilities or operations, including the former plutonium facility on DP Road (TA-21) and the waste management area at Area G, TA-54.*
>
> ➤ *No new areas of contamination were detected and levels are comparable to those measured in previous years.*
>
> ➤ *The detected levels of radionuclides in soils around the LANL boundary are all well below levels considered safe for residential uses.*

Table ES-6 summarizes contaminants found in soil around LANL. All radionuclide (activity) concentrations in soil collected from on site and perimeter areas in 2006 were low and most were either not detected or below regional statistical reference levels (RSRLs, equal to the average plus three standard deviations). The few detected radionuclides above RSRLs in soil collected from perimeter areas included cesium-137 and plutonium-239,240 at the TA-8 location; plutonium-239,240 at the west airport location; and uranium-234 and uranium-238 at the Tsankawi/PM-1 location. The locations where plutonium were detected lie north of the Laboratory and mostly downwind of the former plutonium processing facility at TA-21 or east of Area G at TA-54. The ratio of uranium-234 and uranium-238 in the soil at the Tsankawi/PM-1 location indicates the uranium is naturally occurring. All of the radionuclide concentrations in these samples were just slightly above the RSRLs and were below residential screening levels and thus do not pose a potential unacceptable dose to the public.

Nearly all of the inorganic chemical concentrations from on-site and perimeter areas were below RSRLs. The few heavy metals just above the RSRL included mercury at the Sportsman's Club north of LANL and thallium at the Two-Mile Mesa location at TA-6. The concentrations detected are far below the appropriate screening levels and do not pose a potential hazard to human health.

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

| LANL Impact | On-Site | Off-Site | Significance | Trends |
|---|---|---|---|---|
| Tritium | Yes, above background at some sites, particularly 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 Area G | Yes, above background along State Road 502 on the west side of the airport (downwind of TA-21) | 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 and northeast sections of Area G, but not increasing |
| Other Radionuclides | Mostly depleted uranium at DARHT | One sample above background for cesium-137 | Far below residential screening levels | Uranium-238 is increasing over time at DARHT |
| Inorganic Chemicals | Few detections: beryllium at DARHT is just above background | Few detections | Far below industrial and occupational screening levels | Steady |
| PCBs | All below detection limits except one sample at Area G at TA-54 | No | Far below industrial and occupational screening levels | Insufficient data at TA-54; re-sampling to be conducted at same site in 2007 |
| High Explosives | All below detection limits | No | Minimal potential for exposure | None |
| Semi-volatile Organic Compounds (SVOCs) | One sample along State Road 502 on TA-73 contained some SVOCs | No | Far below industrial and occupational screening levels; from asphalt (not a LANL source) | None |

All PCBs, HE, and nearly all semi-volatile organics in soil from perimeter and on-site locations were below detection limits. Only one site showed some semi-volatile organic compounds; this site is located on the south side of State Road 502 and east of the Los Alamos Fire Department and contained considerable amounts of asphalt. Asphalt, a petroleum-based product, contains a host of polyaromatic hydrocarbons, but the amounts detected were all below the occupational screening levels and do not pose a potential risk to human health. Sampling of soil around Area G shows concentrations similar to past years, including above-background concentrations of tritium in soil along the southern portion of Area G where the tritium shafts are located; and above-background americium and plutonium along the perimeter of the northern, northeastern, and eastern sections. After a spill of contaminated soil (during moving operations at Area G), additional soil samples collected around the northwestern perimeter section of Area G contained tritium, americium, and plutonium two to nearly six times higher than previous results. However, all concentrations are below residential screening levels and do not pose a potential unacceptable dose to human health.

Concentrations of americium-241, plutonium-238, and plutonium-239,240 in most of the soil samples collected along a transect starting from the northeast portion of Area G and extending to the Pueblo de

San Ildefonso fence line are above RSRLs. All concentrations are far below residential screening levels, and concentrations of all radionuclides decrease to background levels within a short distance from the Pueblo fence line.

At DARHT, soil samples contain slightly elevated levels of beryllium and greatly elevated levels of depleted uranium near the firing point. However, the concentrations of these elements are not elevated past the DARHT perimeter fence line.

> ➤ *Soil samples from off-site locations show radionuclides and metals have not increased over the past years and are mostly at background levels.*
>
> ➤ *All PCBs, high explosives, and nearly all semi-volatile organics in soil from perimeter and on-site locations are below detection limits.*

An evaluation of beryllium from samples collected around the Laboratory since 1992 shows that all on-site areas, except for DARHT, contained no beryllium levels above RSRLs. There are no increasing trends over time at any of the on-site or perimeter sample sites.

### Foodstuffs and Nonfoodstuffs Biota Monitoring

Data from past years on radionuclides in domestic crop plants (vegetables and fruits) from all communities surrounding the Laboratory are indistinguishable from natural or fallout levels. Similarly, all trace element concentrations in vegetable and fruit samples are within or similar to the RSRLs and show no increasing trends in concentrations.

Table ES-7 summarizes contaminants found in biota around LANL. Foodstuffs samples collected in 2006 included wild edible plants, common lambsquarters, and pigweed amaranth collected from within Mortandad Canyon on Pueblo de San Ildefonso land. Concentrations, trends, and doses were assessed. The only radionuclide detected above the RSRL in both common lambsquarters and pigweed amaranth was strontium-90 in samples from Mortandad Canyon. The levels are similar to levels in other wild food plants collected from this same location in previous years and may be related to the lower calcium content in the soil because both elements are chemically similar and the plants do not differentiate between the two. The highest strontium-90 concentrations are below levels that would result in a dose of 0.1 mrem for each pound of common lambsquarters and pigweed amaranth consumed, which is 0.4% of the DOE pathway dose constraint of 25 mrem/yr.

> ➤ *In vegetation collected at area G (TA-54), all radionuclide concentrations were indistinguishable from background reference levels except tritium and plutonium in samples from areas with known contamination.*
>
> ➤ *At DAHRT, uranium in overstory (but not in understory) vegetation appears to be increasing over the past seven years.*
>
> ➤ *All radionuclides in vegetation and other biota from Area G and DARHT, including bees, birds, and small mammals, were well below screening levels.*

All inorganic chemical concentrations in common lambsquarters and pigweed amaranth samples collected from within Mortandad Canyon on Pueblo de San Ildefonso land are not detected or below RSRLs.

Native understory vegetation was collected from 17 on-site, 11 perimeter, and six regional locations. Most concentrations of radionuclides in native understory plants collected from both on-site and perimeter areas were either not detected or below RSRLs. The very few detected radionuclides higher than RSRLs in vegetation are from on-site and perimeter areas including strontium-90 and plutonium-238 in a sample collected east of Area G at TA-54; cesium-137 in a sample collected east of White Rock; tritium in a sample collected along State Road 502 at TA-73; and plutonium-239,240 in a sample collected west of the former plutonium processing facility

**Table ES-7**
**Where Can We See LANL Impacts on Foodstuffs and Nonfoodstuffs Biota that Result in Values Near or Above Regulatory Standards or Risk Levels?**

| Media | LANL Impact | On-Site | Off-Site | Significance | Trends |
|---|---|---|---|---|---|
| Wild edible plants | Radionuclides | Not collected in 2006, but historically slightly higher in Mortandad Canyon than background | Above background concentrations for strontium-90 in plants from Mortandad Canyon on Pueblo de San Ildefonso land | 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 | Not collected in 2006 | 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 but uranium-238 in trees is increasing over time at DARHT |
| | Inorganic chemicals | Few detections: arsenic in one plant sample at DARHT | No | Above screening levels but other media show no arsenic problems so outlier is suspected | 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 |

at TA-21. All of these detected concentrations are below screening levels (set at 10% of the relevant standard) and do not result in adverse effects to the vegetation.

Most inorganic chemicals in native vegetation from on-site and perimeter areas are below RSRLs. The few inorganic chemicals in native vegetation from on-site and perimeter areas above RSRLs included mostly zinc and cadmium at levels that do not pose a hazard to the plants.

In vegetation collected at Area G at TA-54, all radionuclide concentrations are indistinguishable from background reference levels, except tritium and plutonium in plants next to the disposal area, where results are similar to past years and correlate well with levels measured in soil. All concentrations of inorganic chemicals, with the exception of zinc in both vegetation samples, were either not detected or below the RSRLs.

At DARHT, all radionuclide concentrations in vegetation are indistinguishable from RSRLs, except for uranium in overstory vegetation collected from the north and east sides of the complex. The ratio of uranium-234 to uranium-238 is consistent with that of depleted uranium, which is used as a substitute for enriched uranium in the testing performed at the site. Uranium in overstory (but not in understory) vegetation appears to be increasing over the past seven years. The only inorganic chemical detected above RSRLs is arsenic in one overstory plant sample collected on the south side of the DARHT facility. No other arsenic detections occur in previous or concurrent samples and soil levels are normal.

Deer mice were collected from the north and northeast side of the DARHT facility. Only uranium-234 in the whole body of mice collected downwind of DARHT was detected above RSRLs. The level of uranium-234 is far below the screening level and does not pose a hazard to the mice. The distribution of uranium-234 and uranium-238 indicate the uranium in mice is depleted uranium.

All radionuclides in two composite samples of birds collected west of the DARHT facility are either not detected or below the RSRLs. In contrast, many inorganic chemicals were detected above RSRLs in one bird (a spotted towhee), including aluminum, barium, beryllium, iron, manganese, vanadium, arsenic, lead, and silver. The reason for the elevated levels in only one bird is not understood, but is probably from sources other than DARHT.

Most concentrations of radionuclides and all nonradionuclides in bees sampled from four hives located northeast of the DARHT facility are below RSRLs. The exception is uranium-234 and uranium-238 in three out of the four bee samples. The distribution of these isotopes shows that one of these samples contains depleted uranium.

In sediment upstream of the Los Alamos Canyon Weir, cesium-137, plutonium-238, plutonium-239,240, americium-241, silver, mercury, lead, and Aroclor-1260 were detected in concentrations higher than the RSRLs. Also, strontium-90, plutonium-239,240, americium-241, and lead in overstory plants and plutonium-239,240, americium-241, uranium-234, and uranium-238 in whole body mice are higher than RSRLs. All concentrations are below screening levels and do not pose a potential unacceptable dose to human health or to the biota sampled.

Upstream of the Pajarito Canyon Flood Retention Structure, sediment concentrations of cesium-137, plutonium-239,240, uranium-234, uranium-238, copper, cadmium, silver, mercury, and Aroclor-1254 are above RSRLs; vegetation has concentrations of uranium-234, uranium-238, lead, and silver above RSRLs; and the small mammals have concentrations of plutonium isotopes, americium-241, uranium-234, and uranium-238 above RSRLs. All concentrations of radionuclides and nonradionuclides in all media, however, are below screening levels and do not pose a potential unacceptable dose to human health or to the biota sampled.

> ➤ *All radionuclide concentrations in wild edible plants from Mortandad Canyon on Pueblo de San Ildefonso land were below levels that would result in 0.4% of the DOE pathway dose constraint of 25 mrem/yr.*

Along the north perimeter fence line of MDA B, four composite samples of tree shoot tips were collected from every tree growing along a 100-yard section starting from the east end. Most isotopes are not detected or below RSRLs. The few radionuclides above RSRLs—cesium-137 in one sample and plutonium-239,240 in another sample—are below screening levels used to assess the dose to the trees. Chromium and nickel in one sample and zinc and lead in another sample are above RSRLs; differences between MDA B trees and regional trees were small. All elements are below screening levels and do not cause a significant dose to the trees.

## Environmental Restoration Program

Corrective actions proposed and/or conducted at LANL in 2006 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. Field activities conducted in 2006 included: investigation activities at MDAs A, C, T, U and V; final remedy construction for the TA-73 Airport Landfill; field investigations in Pueblo Canyon, Guaje, Barrancas/Rendija Canyons Aggregate Area, North Canyons, and Pajarito Canyon; accelerated corrective actions at a former storage area with petroleum contamination; and investigations at a former petroleum-contaminated storage area, a site with an oil-water separator and drainline and a former high explosive storage magazine, a former experimental area with potential radionuclide and metals contamination, a former explosives processing site, a former vacuum-pump oil disposal and storage site, and the groundwater in Mortandad Canyon. During 2006, environmental restoration activities collected over 3,330 samples from over 1,100 locations and requested over 418,000 analyses or measurements on these samples.

> ➤ *Characterization and cleanup of sites contaminated or potentially contaminated by past LANL activities follow the Consent Order.*
>
> ➤ *16 investigation work plans and 14 investigation reports were submitted to NMED in 2006.*
>
> ➤ *28 sites were granted certificates of completion.*

Under the Consent Order, 16 investigation work plans and 14 investigation reports were submitted to NMED. In 2006, NMED approved a total of 10 investigation work plans and 10 investigation reports, some with modifications or directions. Of the documents approved, LANL submitted eight work plans and five reports in 2006; the other approved plans were submitted in previous years. A total of 28 SWMUs and areas of concern were granted certificates of completion, which signifies that the investigations have been completed. In addition, NMED is reviewing four work plans and three reports as of the end of the calendar year.

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.

> ➤ *Investigations included drilling a substantial number of boreholes, collecting thousands of samples, and obtaining hundreds of thousands of analytical results.*
>
> ➤ *Cleanup activities included the removal of structures (e.g., buildings, septic systems, sumps, and drainlines), soil vapor extraction, excavation of contaminated media, and confirmatory sampling.*
>
> ➤ *In 2006, 28% of all environmental samples collected and 68% of all sample analyses were for environmental characterization and remediation work at LANL.*

## 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. Models, data, and computer programs are used 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 from these, 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 MDA P. These efforts together 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; additional emission controls added in 2005 to reduce radioactive gas emissions from LANSCE; and numerous investigations and corrective actions at potentially contaminated sites, such as cleanup of a legacy disposal area and landfill site next to the Los Alamos County Airport and the remediation activities at MDA V where three absorption beds and other contaminated soil and tuff were excavated.

The sensitivity of measurements obtained by LANL's environmental surveillance program can detect hazardous and radioactive materials and other contaminants during cleanup or normal operations at near and remote locations. Each possible pathway to people and the environment is 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 and foods. The monitoring of constituents in groundwater keeps track of the movement of previously-released contaminants and their potential migration in the aquifers.

➤ *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 enable the detection of new hazards and the evaluation of the associated level of risk.*