ERID-250963

Los Alamos National Laboratory
Environmental Report 2011
Summary

Los Alamos
NATIONAL LABORATORY
EST. 1943

LA-14467-ENV

Los Alamos National Laboratory Governing Policy for Environment

- We are committed to act as stewards of our environment to achieve our mission in accordance with all applicable environmental requirements.

- We set continual improvement objectives and targets, measure and document our progress, and share our results with our workforce, sponsors, and public.

- We reduce our environmental risk through legacy cleanup, pollution prevention, and long-term sustainability programs.

Black bear in Los Alamos.

Raccoons in Los Alamos.

Mule deer in Los Alamos.

This report is a summary version of the Los Alamos National Laboratory Environmental Report 2011 compiled by a student working at the Laboratory. The full report is available on the web at http://permalink.lanl.gov/object/tr?what=info:lanl-repo/eprr/ERID-228615.

Contents

Virginia's Warbler (Oreothlypis virginia) captured as part of the Monitoring Avian Productivity Project.

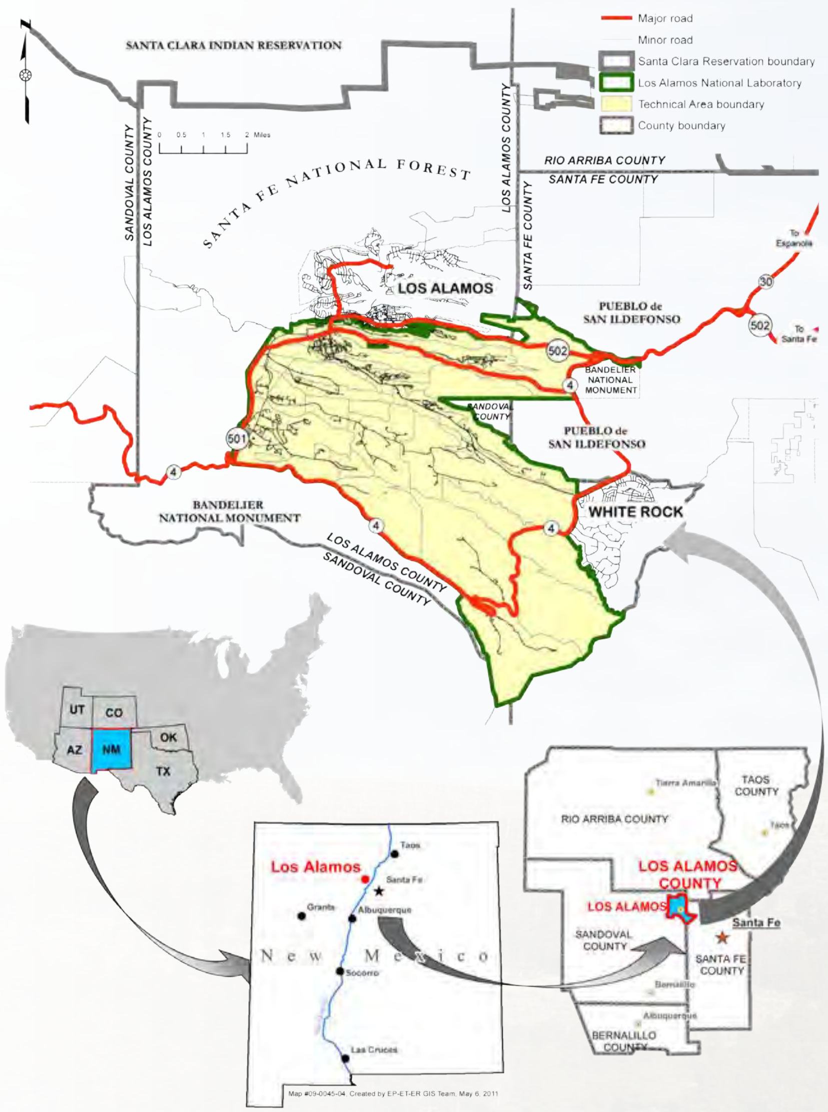
What is the Environmental Report 2011 Summary?

Los Alamos National Laboratory (LANL or the Laboratory) is committed not only to excellence in science and technology but also to completing all work in an environmentally responsible manner. Every year, the Laboratory produces an environmental report in compliance with a U.S. Department of Energy (DOE) order. This report informs the public of the Laboratory's commitment to excellence in environmental stewardship by

- characterizing site environmental management performance, including effluent releases, environmental monitoring, and estimated radiological doses to the public from releases of radioactive materials;
- summarizing environmental occurrences and responses reported during the calendar year;
- confirming compliance with environmental standards and requirements; and
- highlighting significant programs and efforts, including environmental performance indicators and measures.

Where is LANL located?

The Laboratory is located in Los Alamos County in north-central New Mexico. The 36-square-mile Laboratory is situated on the Pajarito Plateau, which is approximately 25 miles northwest of Santa Fe. The plateau, surrounded by the Sangre de Cristo mountains to the east and the Jemez mountains to the west, consists of a series of finger-shaped mesas separated by deep east-to-west-oriented canyons cut by streams. The surrounding land is largely undeveloped, with the exception of the communities of Los Alamos, White Rock, and the Pueblo de San Ildefonso.



Regional Location of Los Alamos National Laboratory.

What is the history of LANL?

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 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, the Laboratory became Los Alamos Scientific Laboratory and in 1981 became Los Alamos National Laboratory.


Scientists at the "Super" Conference held in August 1946.


Omega bridge Los Alamos circa 1965.

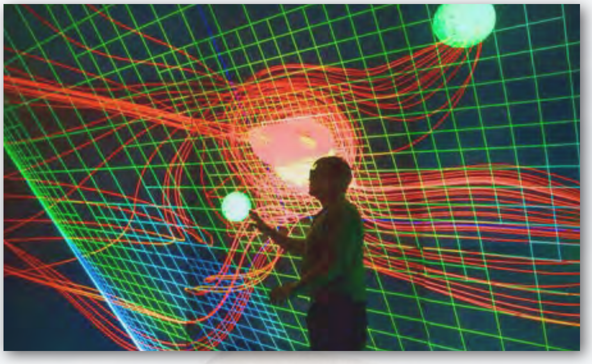
What is LANL's mission today?

With changes in technologies, priorities, and the global community, the Laboratory's original mission to design, develop, and test nuclear weapons has broadened. Today, the Laboratory's mission is to develop and apply science and technology to

- ensure the safety and reliability of the U.S.'s nuclear deterrent;
- reduce global threats; and
- foster energy security by developing clean, sustainable energy sources.

Inseparable from the Laboratory's commitment to excellence in science and technology is its commitment to environmental stewardship and full compliance with environmental protection laws.


East view at dawn of National Security Sciences Building.


Computer simulation of the central light year of our galaxy.


High southwest aerial view of Los Alamos National Laboratory and Los Alamos townsite.


Student performs experiments at the Trident Laser Facility.

What environmental regulations and orders did LANL comply with in 2011?

Federal and State regulations and orders provide standards to protect the public, the biota, and the environment. These standards ensure that it is safe for humans and biota to breathe the air, drink the water, and eat the food. Furthermore, they protect resources such as soil and water for use by future generations.

	US Environmental Protection Agency (EPA)	DOE	New Mexico Environment Department (NMED)	US Fish & Wildlife Service (FWS)	Department of Interior (DOI)
Air	Clean Air Act (CAA) CAA, National Emissions Standards for Hazardous Air Pollutants (NESHAP) Radionuclides	DOE Order 5400.5, Radiation Protection of the Public and the Environment			
Resources	Resource Conservation and Recovery Act (RCRA) Toxic Substances Control Act (TSCA) Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)	DOE Order 436.1, Departmental Sustainability DOE Order 435.1, Radioactive Waste Management	Consent Order		National Historic Preservation Act (NHPA) Archeological Resources Protection Act (ARPA)
Water	National Pollutant Discharge Elimination System (NPDES) Clean Water Act (CWA) Emergency Planning and Community Right-to-Know Act (EPCRA) National Environmental Policy Act (NEPA)	DOE Order 458.1, Radiation Protection of the Public and the Environment	NMED Groundwater Protection		
Biosphere		DOE Order 458.1, Radiation Protection of the Public and the Environment		Endangered Species Act (ESA) Migratory Bird Treaty Act (MBTA)	

Keeping impact as low as reasonably achievable

For a substance to pose a threat to human or environmental health, there must be

1. enough of a source (chemical or radioactive) present to be harmful to a human, plant, or animal;
2. a way for the person, plant, or animal to be exposed to the source;
3. a person, plant, or animal in the vicinity of the source.

To prevent or lower the risk of harm, the Laboratory uses several methods:

1. We remove or lower the amount of contaminant or concentration from the source (e.g., dispose of off-site, cover it, dilute it, or stop producing or emitting it).
2. We contain the source permanently or block the pathway (e.g., package it, retain it with a dam, or stop accessing it for use).
3. Although relocating the person, plant, or animal away from the vicinity of the source is an option, we do not use this method.

Examples of current Laboratory pathways and how these are managed

Source	Pathway	Receptor	Management
Los Alamos Neutron Science Center (LANSCE) target	Airborne radioactivity	Person downwind	Keep the emissions very low
Transuranic (TRU) waste	Neutron radiation	Person at Laboratory boundary	Ship waste off-site for permanent disposal
Outfall (water)	Waterborne radioactivity	Animals that drink the water	Eliminate emissions

Connecting with the community

To be a positive, sustainable influence on our region's economy, educational systems, and the quality of life in northern New Mexico, the Laboratory operates a proactive, interactive program. Through dialog, we include and respond to the communities, tribes, organizations, agencies, and local governments in the region. To increase public knowledge of environmental cleanup and stewardship practices, we use various activities, including tours, presentations, and visits to local organizations, to discuss and share information. We actively solicit stakeholder input to make better stewardship decisions and to improve our understanding of public concerns. Our relationship with the community is our most cherished resource.

Public tour of open burning waste disposal site.

How to learn more and contact us:

Visit the Laboratory's environmental website: www.lanl.gov/environment and sign up for e-mail notification

Explore Long-Term Strategy for Environmental Stewardship and Sustainability: www.lanl.gov/projects/envplan

Visit the electronic Public Reading Room: http://eprr.lanl.gov

Visit the print Public Reading Room:
97 Cities of Gold Road, Pojoaque, NM

Call the Environmental Outreach Office: 505-667-0216

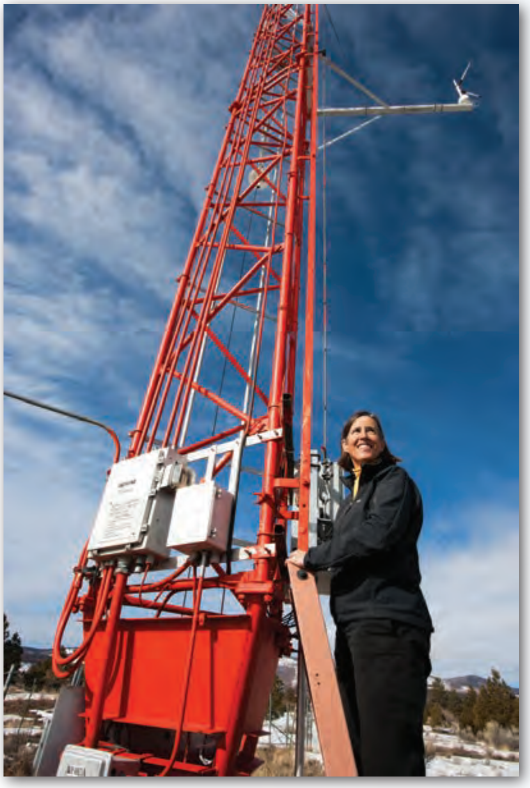
E-mail the Environmental Outreach Office: envoutreach@lanl.gov

Write us at: Environmental Outreach
Los Alamos National Laboratory
P.O. Box 1663, MS M996,
Los Alamos, NM 87545

Visit www.intellusNMdata.com for all sampling data from the Laboratory

Individual permit for storm water team demonstrates erosion control.

Community leaders examine water monitoring in canyons.



One of the Laboratory's meteorological monitoring towers. Jean Dewart (pictured) supports key science missions and provides forecasts to emergency managers for weather closures and delays.

Why does LANL conduct meteorological monitoring?

Meteorological data are essential to many Laboratory activities, such as emergency management and response and environmental surveillance programs. The Laboratory's meteorological monitoring program measures a wide variety of meteorological variables, including wind, temperature, pressure, relative humidity and dew point, precipitation, and solar and terrestrial radiation.

How does LANL conduct meteorological monitoring?

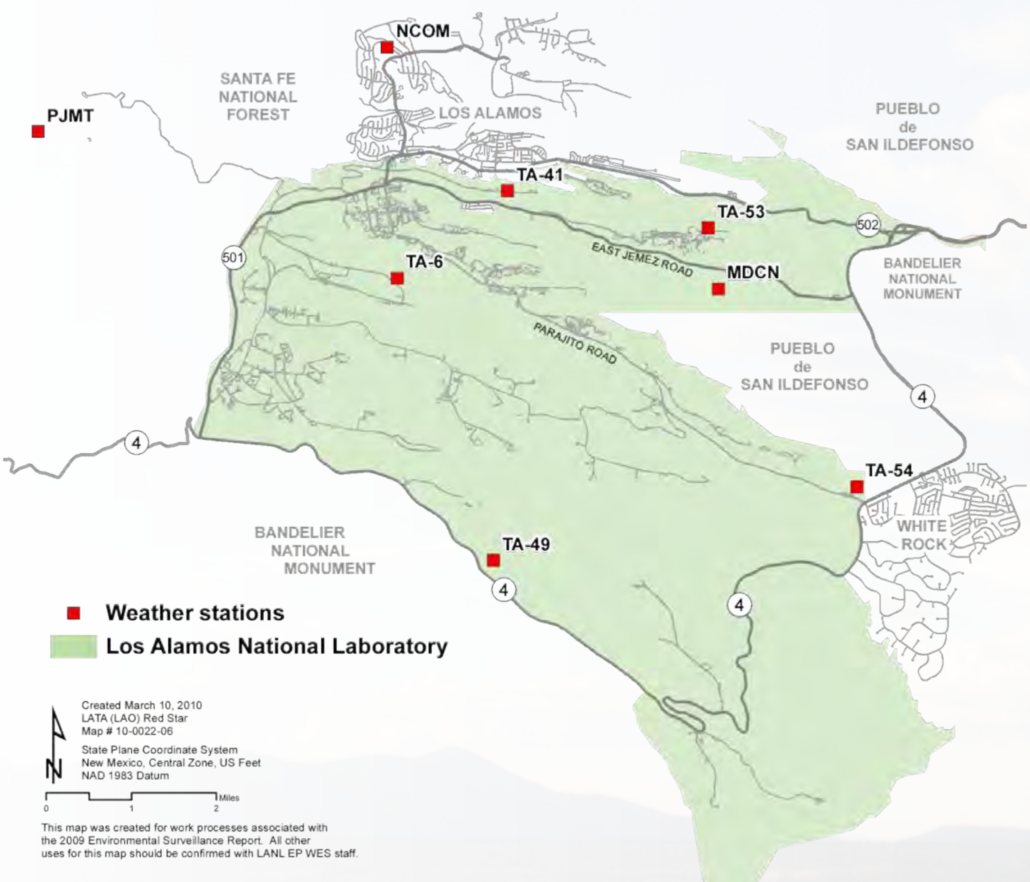
The Laboratory uses a network of seven stations to gather meteorological data. Four of the stations are located on the tops of mesas, two are in canyons, and one on the top of Pajarito Mountain. The meteorological stations are located in areas with good exposure to the elements, usually in open fields.

Meteorology in 2011

In Los Alamos County, 2011 was hotter and drier than average, though it was neither the hottest nor the driest year on record. The hottest year was 1954, and the driest year was 1956. With 5-year averaging, the warm spell during the past decade is not as extreme as the early-to-mid 1950s, though the current warm trend is longer-lived.

June 2011 was exceptionally dry so conditions were conducive to wildfires. The La Niña weather pattern produced higher than average winds that were a contributing factor to the severity of the Las Conchas fire.

Temperature and precipitation history for Los Alamos can be found in the full Laboratory Environmental Report 2011, available at http://permalink.lanl.gov/object/tr?what=info:lanl-repo/eprr/ERID-228615.



Location of meteorological monitoring towers and rain gauges.

The Direct-Penetrating Radiation Network

What is radiation?

Radiation is the transfer of energy through space. The radiation of interest is ionizing radiation and is in the form of alphas, betas, gammas, and neutrons. It is measured in units of millirem (mrem).

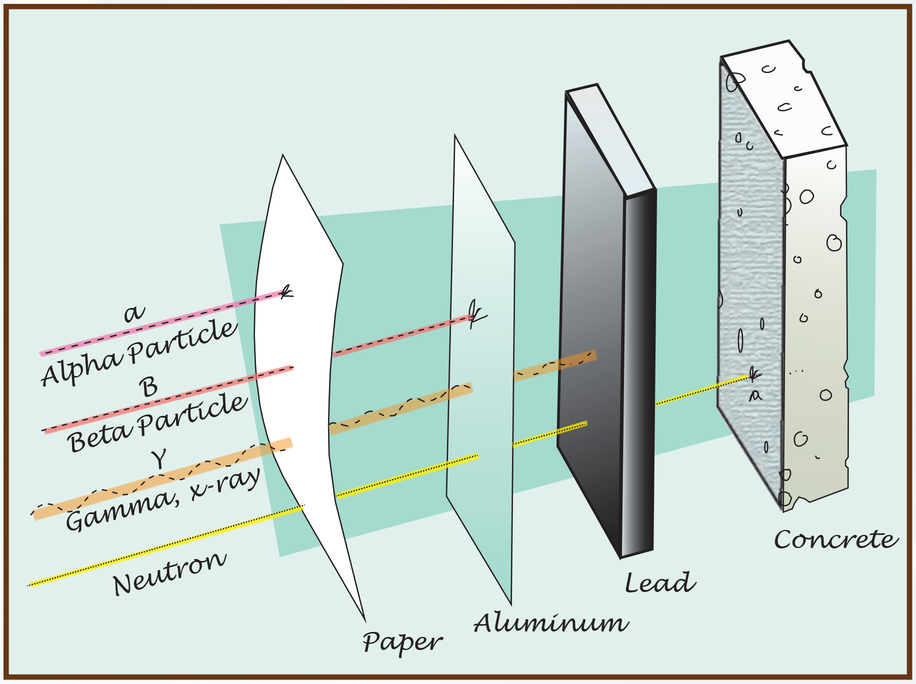
Radiation dose is also measured in mrem. Dose is a measure of the potential risk or harm. The risk or harm is caused by the energy transferred from the radioactive atom to a person, animal, or plant. "Direct-penetrating radiation" is direct because it is the energy that causes the risk or harm.

Is all radiation "penetrating?"

Alpha particles will not penetrate the skin, so they can only do harm if the radioactive material is inside you.

Beta particles will not penetrate more than 7 meters of air, so they can only do harm if the source is close.

Gamma photons and neutrons, which are examples of "direct penetrating radiation," can penetrate more than 100 meters of air.



Why does LANL monitor direct-penetrating radiation?

There are known sources of radiation near Los Alamos. In addition to natural background, there is radiation from current and past operations at locations such as Area G. To ensure the public is protected from these sources, the Laboratory monitors gamma photons and neutrons on the surrounding environment.

Radiation and Radioactive Material

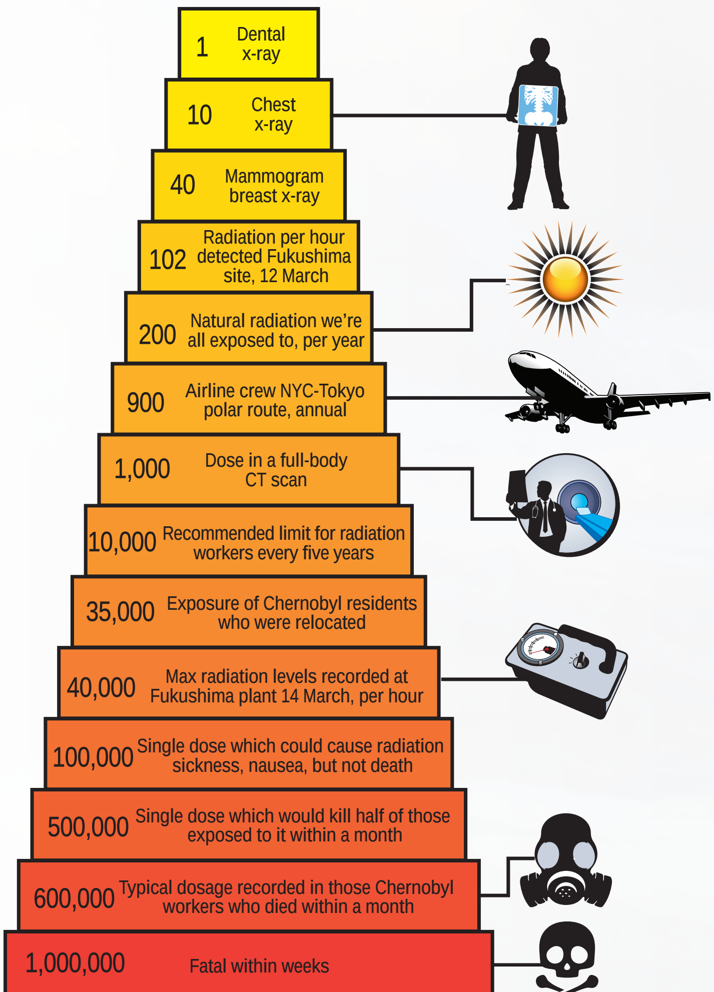
Sun = **radioactive material/source**

Sun rays = **radiation**

Person on the beach = **receptor**

Sunburn on skin = **dose**

TLDs of the above types are placed at 98 locations around the Laboratory, near known sources of radiation and at each AIRNET station, and are also worn by many Laboratory employees. They are analyzed quarterly for dose measurements.



Breakdown of radiation doses and their effects in mrem.

How does LANL monitor radiation?

To monitor gamma photons and neutrons, the Laboratory established the Direct-Penetrating Radiation Monitoring Network (DPRNET). DPRNET uses a series of detectors called thermoluminescent dosimeters (TLDs) to distinguish Laboratory radiation from natural radiation.

TLDs are placed at 98 locations around the Laboratory, near known sources of radiation, and are also worn by many employees. They are analyzed quarterly for dose measurements.

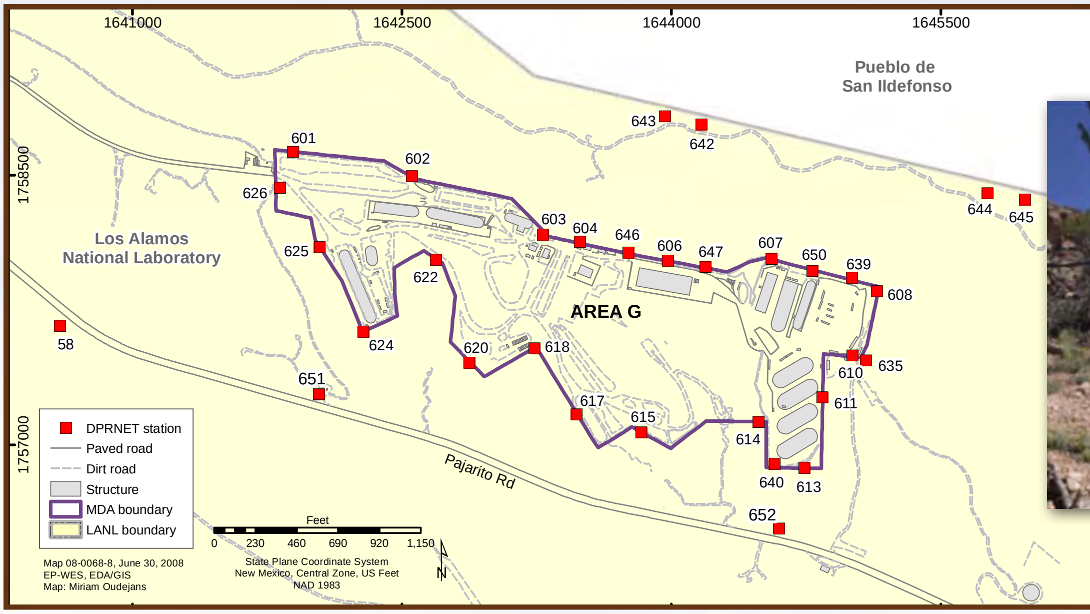
Why do LANL workers wear TLDs and the public does not?

Natural radiation is much larger than the radiation from the Laboratory and is quite variable. A TLD would not be able to distinguish between the small amount from the Laboratory from the large natural variations. Depending on work locations and work activities, some workers may work near large sources of radiation that are inaccessible to the public. Such workers could expect to receive a dose from the Laboratory.

How can we distinguish LANL radiation from natural radiation?

In the case of DPRNET, we measure the dose close to the source, in addition to calculating the dose to the public. If the amount of radiation is large, we can measure it where the people are; if it is a small amount, we calculate how much gets to the public.

Some of the Laboratory radiation is from radioactive material in the air, water, and other media. If we measure the amount of these materials, in units of picocuries (pCi), we can then calculate the amount of radiation, in units of mrem, that affects humans, animals, or plants.



TLD stations around Area G.

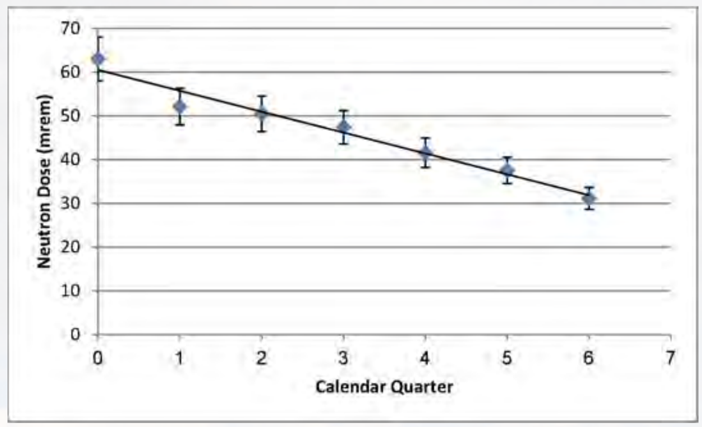
A TLD dosimeter attached to the fence on the border between TA-54 and San Ildefonso Pueblo.

Area G and ship to WIPP

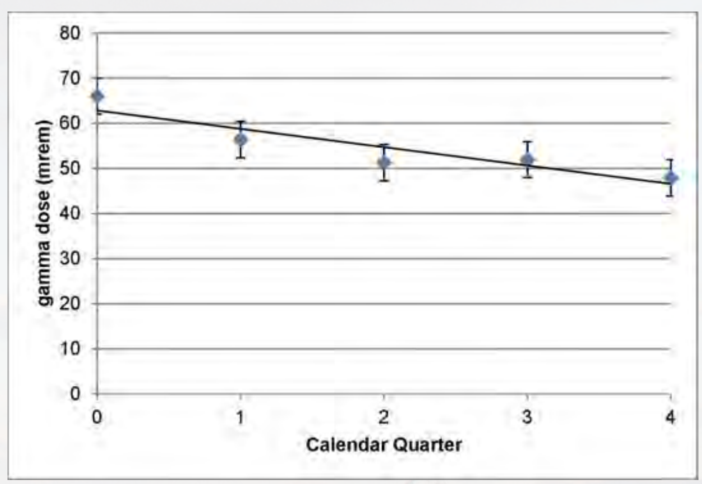
Area G is the Laboratory's primary radioactive waste storage and disposal facility. Waste is contained in pits or shafts or is stored in drums awaiting shipment off-site. In 2011, the Laboratory shipped more than 500 cubic meters of TRU waste to the Waste Isolation Pilot Plant (WIPP), located east of Carlsbad, New Mexico, thus reducing the amount of radioactive material stored at Area G and the gamma and neutron dose rates around the perimeter of Area G, as shown in the figures.

Results

For 2011, the maximum public dose from direct penetrating radiation was 0.5 mrem/yr, which is far below the DOE dose constraint of 25 mrem/yr.



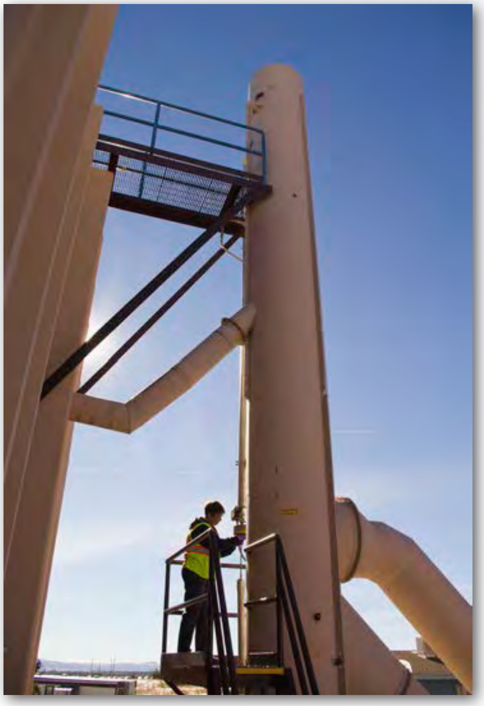
The figure shows the decreasing average quarterly neutron doses (mrem) around the perimeter of Area G for the last two quarters of 2010 and the four quarters of 2011. The first point is the average dose of the previous years.



The figure shows the decreasing average quarterly gamma doses (mrem) around the perimeter of Area G for calendar quarters 1, 2, 3, and 4 of 2011. The first point is the average dose of the previous years.

What is in air?

The air we breathe is primarily made up of nitrogen (78%) and oxygen (21%). Other gases, including carbon dioxide, argon, and water vapor, make up the remaining 1%. Human activities can also release substances into the air, such as particulate matter (smoke/exhaust from burning fuels) and noxious gases (poisonous gases such as carbon monoxide). Both particulate matter and noxious gases can be harmful if they are inhaled.



A Laboratory worker checks the monitoring system on a stack.

A filter used in a stack monitoring system.

Why does LANL monitor air?

Of the different monitoring that takes place at the Laboratory, air is the most significant. Air monitoring is of great importance because

- it is impossible to contain harmful material released in air,
- material released in air has the potential to move rapidly and to great distances, and
- once material is inhaled into the lungs, it is difficult to remove.

How does LANL monitor the air?

Stack Monitoring

Stack monitoring measures the amount of radioactive material at the source of the emission (i.e., the stack, to calculate the dose at the location of the receptor).

The Laboratory monitors four different types of emissions:

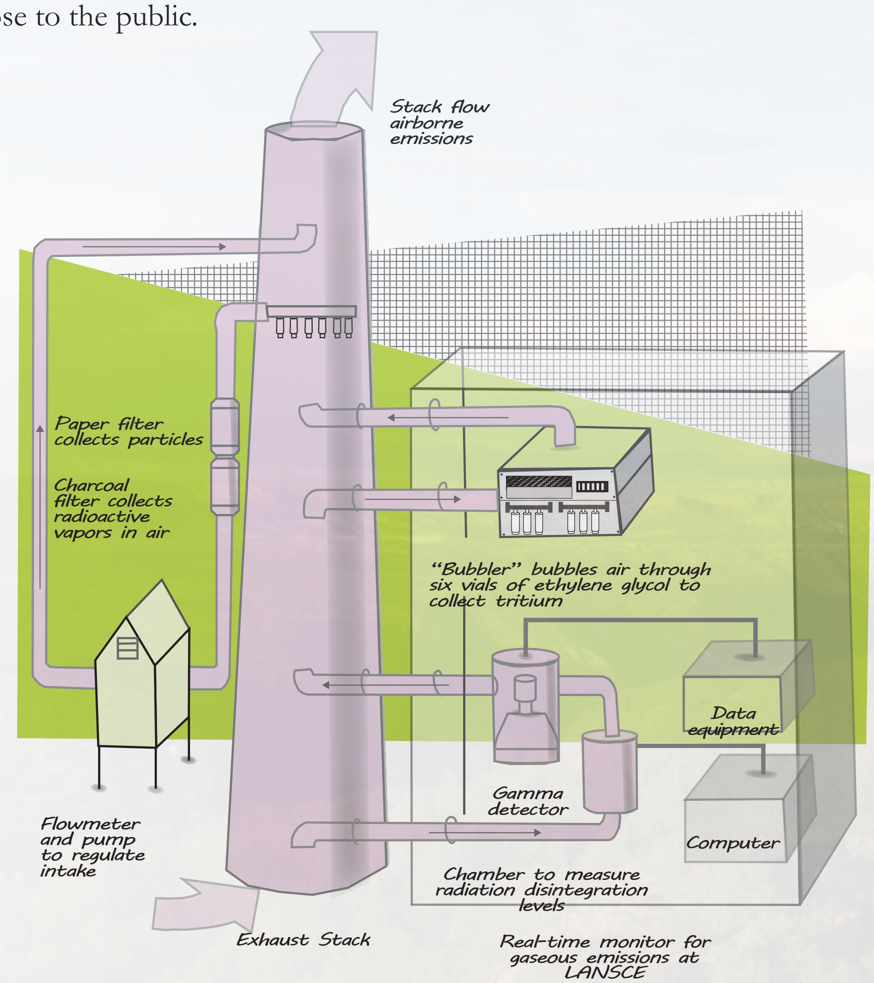
(1) Particulate matter, such as plutonium and uranium particles

(2) Radioactive vapors, such as iodine-131

(3) Tritium, an isotope of hydrogen

(4) Radioactive gases, such as oxygen-15, nitrogen-13, and carbon-11

Samples are collected from air in the stack and analyzed. The computer model CAP88 then uses the emission data to calculate the dose to the public.

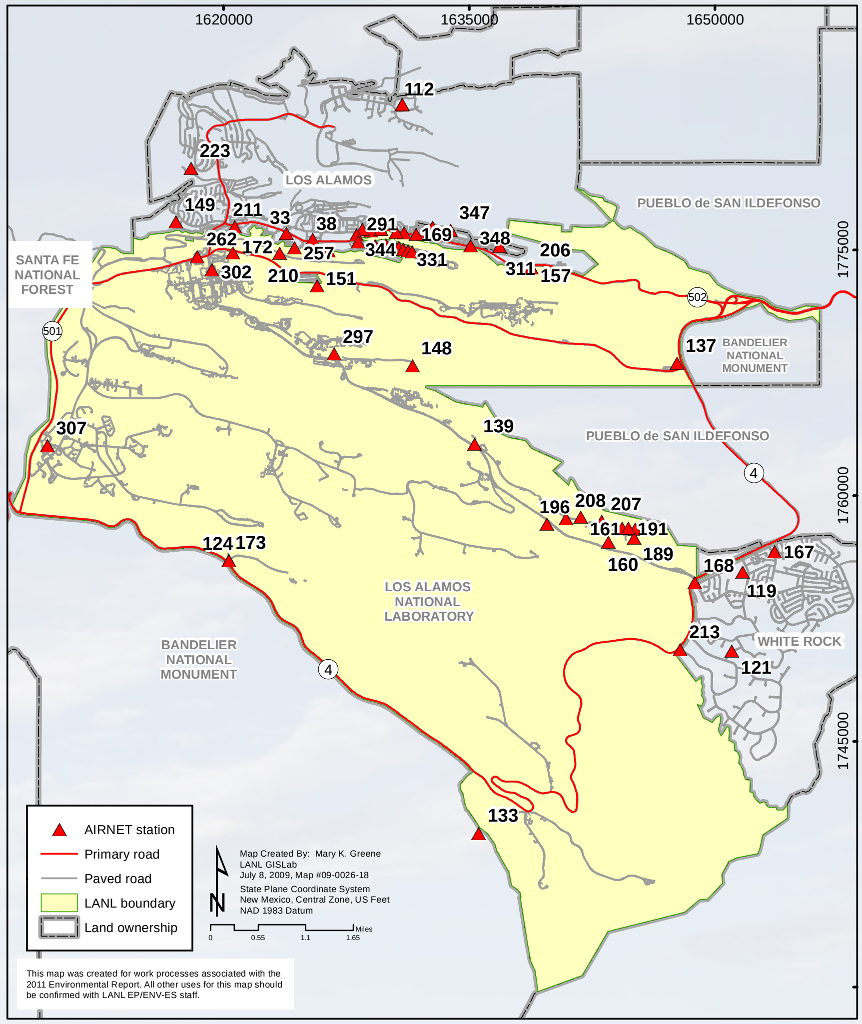


AIRNET

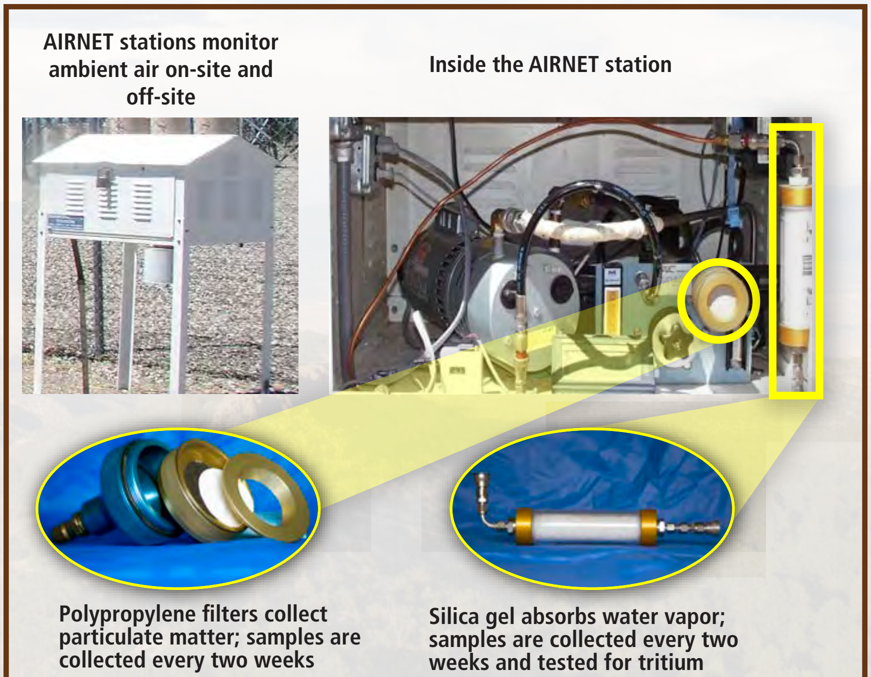
The Los Alamos townsite is downwind of the Laboratory, so many air-monitoring stations are located in and around the town. In 2011, the Laboratory operated 59 air-monitoring network (AIRNET) stations to sample for radionuclides. AIRNET stations monitor for 24 hours a day, 365 days of the year.

The monitoring stations take in air at 4 cubic feet per minute, which is approximately 10 times the rate at which humans breathe. Because the AIRNET stations are able to sample a large amount of air, the data the Laboratory produces are more accurate.

The Laboratory expects to produce certain analytes based on the materials that are used at each facility. The materials used include tritium, americium, uranium, and plutonium. Tritium is collected in the form of water vapor, while americium, uranium, and plutonium are found in the air as particulate matter. The samples are collected and analyzed every 2 weeks for identification of analytes and assessment of the potential impact on the public.



Locations of AIRNET stations.

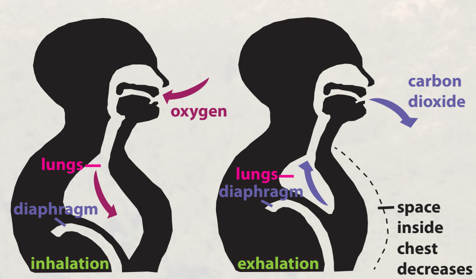


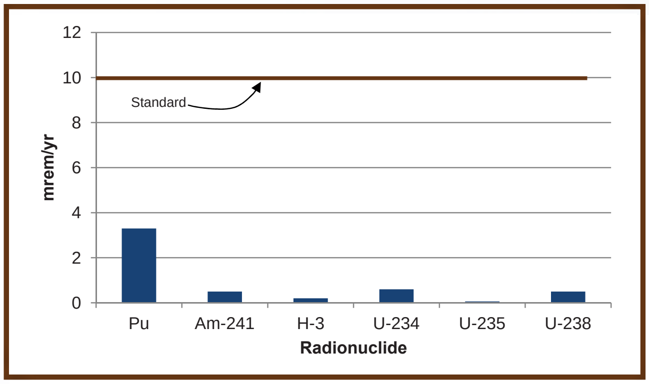
How an AIRNET station works.

How much air do we breathe?

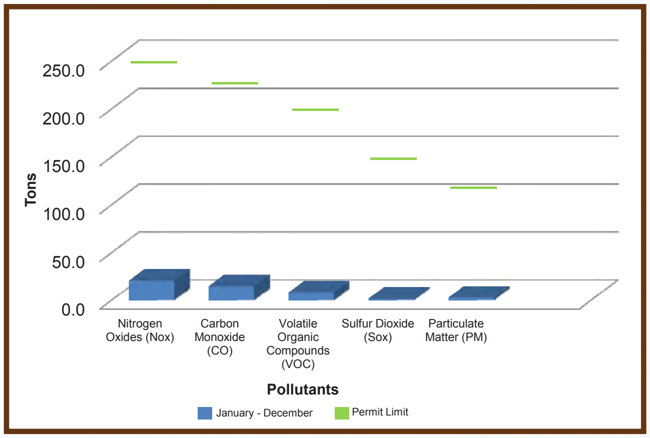
- *Tidal volume* refers to the volume of air in the lungs when a person takes a normal breath, or a breath requiring no extra effort.
- The tidal volume for an average person is approximately 1 L.
- The average person breathes about 20 L/min.

The Mechanics of Breathing





2011 dose by airborne analyte



2011 Semi-Annual Emissions

Results

In 2011, the Laboratory detected no airborne radioactivity that exceeded the U.S. Environmental Protection Agency (EPA) standard of 10 mrem/yr, with the largest dose to the public being 3.53 mrem. All tritium activities were far below EPA standards, with the highest activity occurring at a known source near Area G. Americium levels were similar to those in previous years and remained well below EPA standards. The Laboratory monitoring detected no enriched or depleted uranium in 2011. Plutonium levels (plutonium-239) were higher than usual because of cleanup at Material Disposal Area (MDA) B but remained below EPA standards.

Non-Rad Air Emissions Monitoring

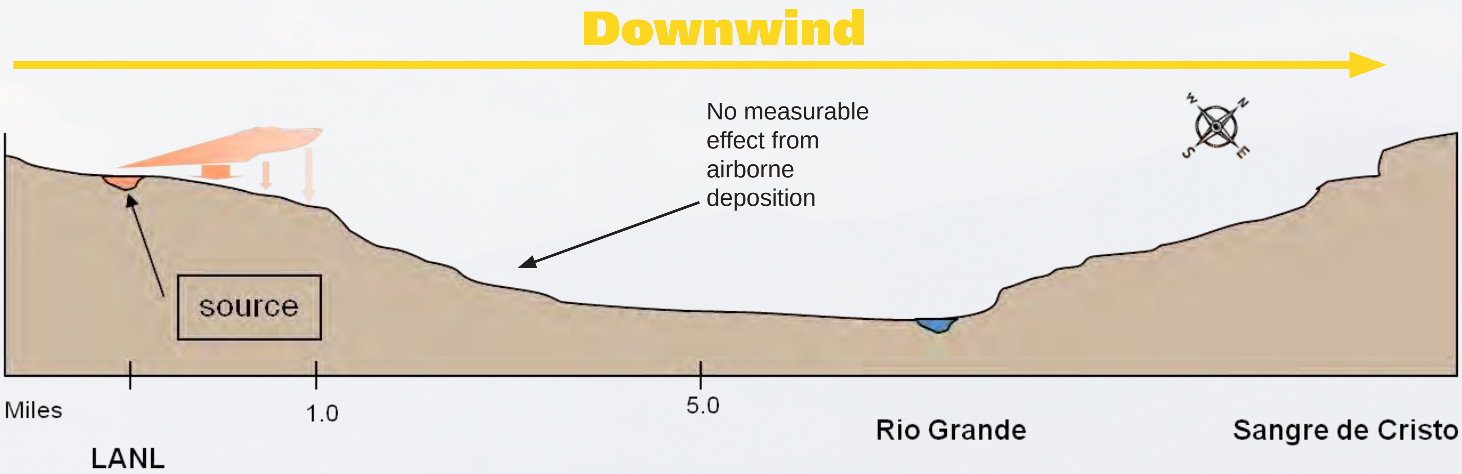
In compliance with the Clean Air Act (CAA), the Laboratory also monitors nonradiological pollutants, such as carbon monoxide (CO), sulfur oxides (SOx), nitrogen oxides (NOx), volatile organic compounds (VOCs), and particulate matter (PM).

- CO is the product of inefficient burning, such as from a motor vehicle.
- SOx, including sulfur dioxide, is the result of burning coal, which contains sulfur. When sulfur dioxide mixes with water, sulfurous acid is created. Sulfurous acid causes respiratory damage to humans and animals and damages the vegetation in the environment.
- NOx, including nitrogen dioxide, is the result of burning coal, oil, or gasoline at high temperatures. When nitrogen dioxide mixes with water, nitric acid is created. Nitric acid is harmful in similar ways to sulfurous acid.
- VOCs are chemical compounds that vaporize when they are exposed to the air. When VOCs evaporate, they are able to enter the lungs and cause damage. VOCs are produced by motor vehicles.
- PM is a hazard to human health when the particle size becomes small enough to enter the lungs, for example, smoke.

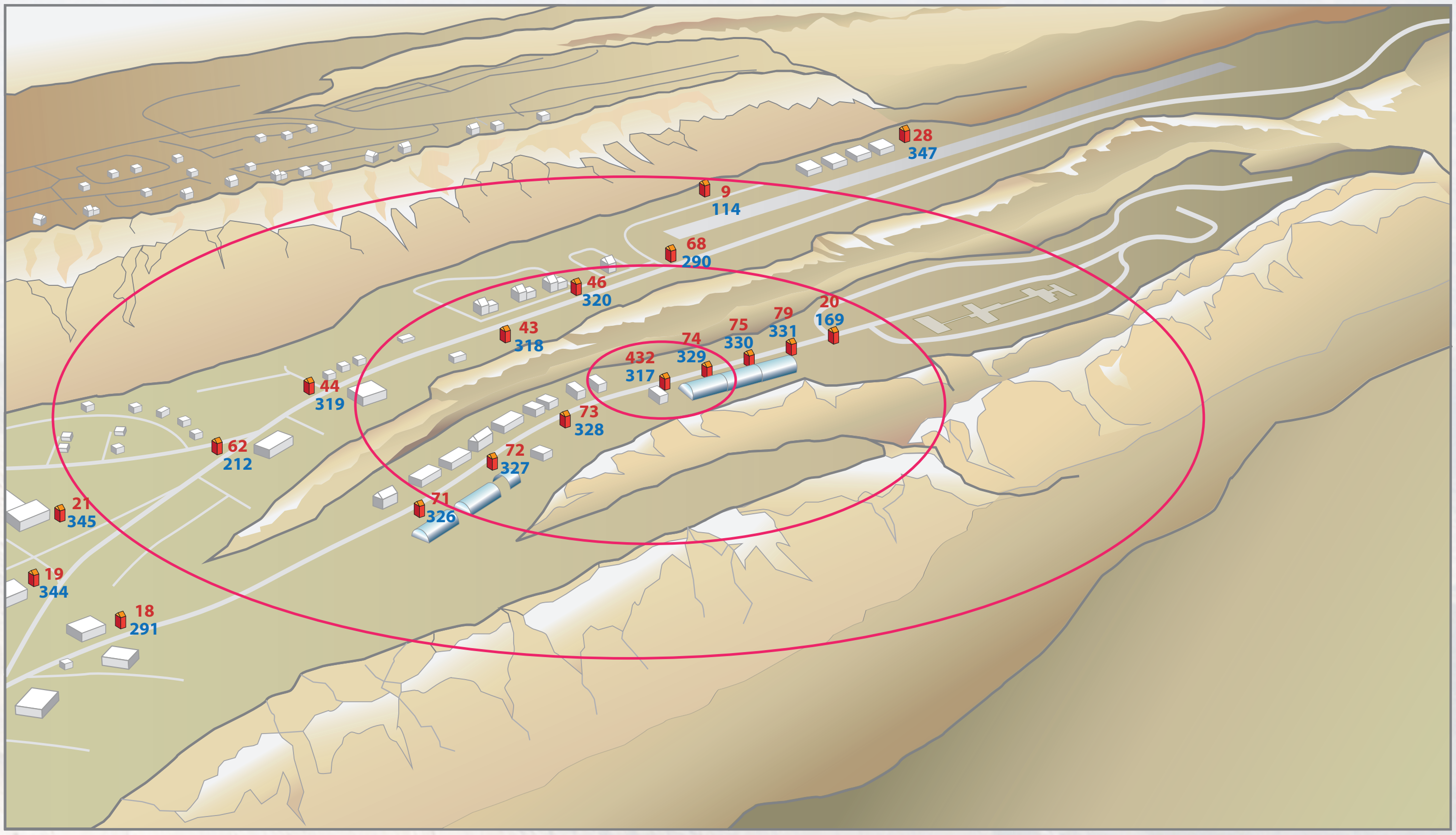
Results

Emissions of these pollutants from 2007 to 2011 are relatively constant and remain far below permit limits. Meeting the permit limits ensures that the Laboratory meets the EPA's National Ambient Air Quality Standards.

How far have LANL contaminants traveled in air?



Downwind concentrations depend on distance. Calculations and observations show deposition (in soil and sediment) of airborne radioactive material is too small to measure beyond 1 mile.



In 2011, the annual air emissions from MDA B resulted in 3.53 mrem at AIRNET station 317, less than 100 yards from the source. However, the airborne material did not travel far. The inner circle corresponds to 1 mrem at a distance of 100 yards; the next circle corresponds to 0.1 mrem at a quarter mile; and the outer circle corresponds to 0.01 mrem at half a mile. Beyond half a mile, the dose was less than 0.01 mrem and was too small to measure.

From March 19-21, NEWNET detected an increase of 0.2microR/h and then an additional increase of 0.1microR/h on March 24.

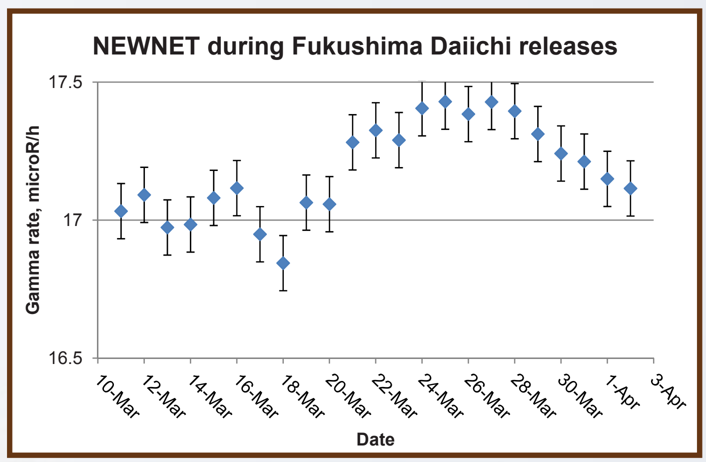
Does LANL do any special monitoring?

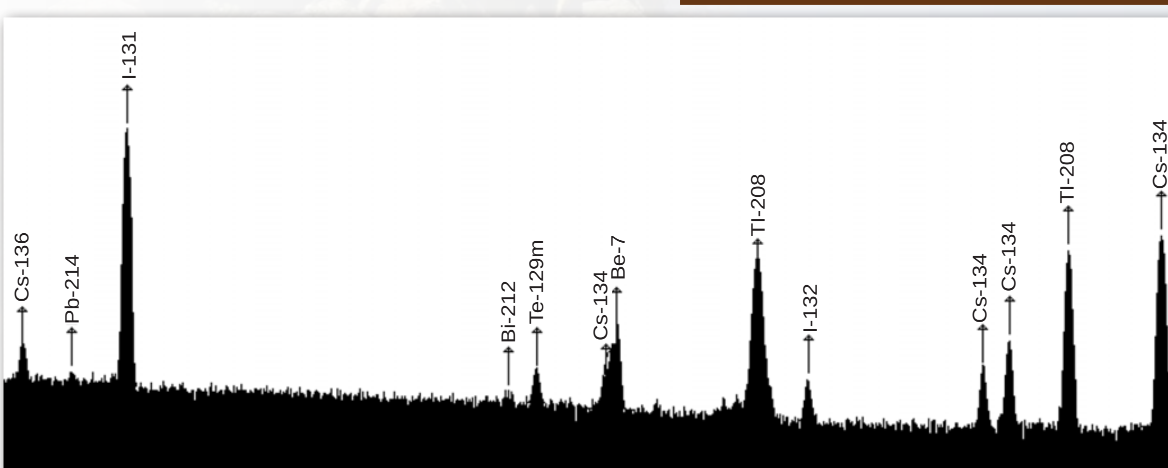
Fukushima Daiichi

Following the March 11, 2011, earthquake and tsunami that damaged the Fukushima Daiichi nuclear plant in Japan, the Laboratory implemented special air monitoring to assess the impact. Models predicted that a radioactive plume from the reactor would arrive in the U.S. on March 18, so the Laboratory supplemented the routine air samplers using three high-volume samplers. The samplers have an air intake about 100 times the human breathing rate, and the filters are changed every 3 days.

The first signs that the plume had arrived in the U.S. were detected by the monitoring program known as the Neighborhood Environmental Watch Network (NEWNET). NEWNET is valuable because it updates every 15 minutes and is able to give early indications of increases in radiation from radioactive particulates in the air. However, NEWNET only measures gamma photons and cannot identify specific isotopes.

Though the plume was measurable in New Mexico, radiation levels were far below any regulatory limit.





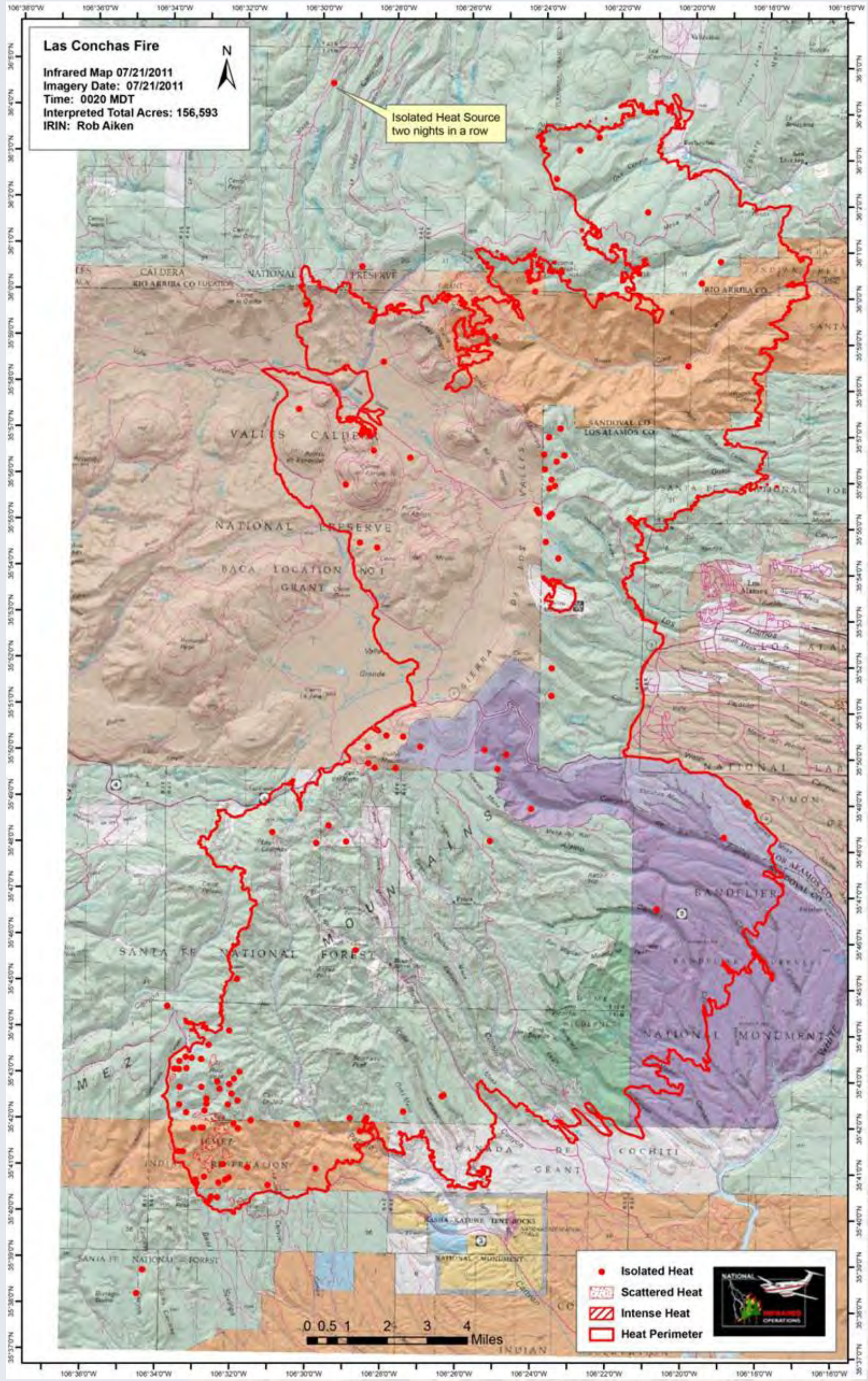
This spectrum uses specific gamma energies to identify the analytes detected by NEWNET.

Las Conchas Fire

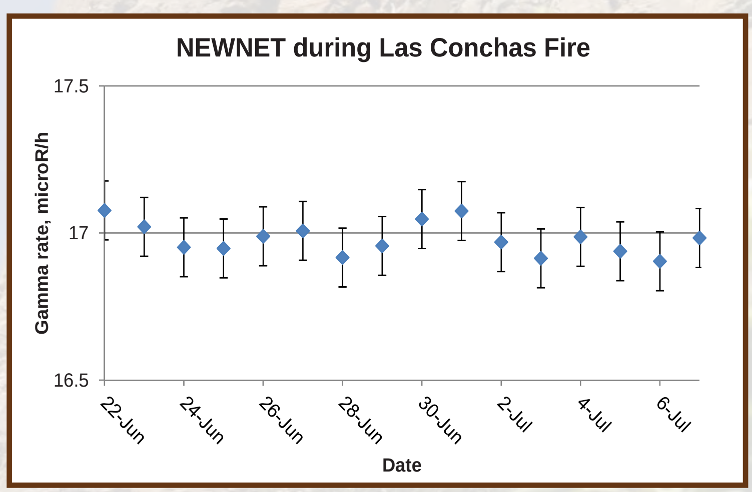
The Las Conchas fire started on June 26, 2011, in the Jemez Mountains west of the Laboratory. The fire burned to the west, south, and northwest of the Laboratory but did not cross over NM 501 near the western boundary. A 1-acre spot fire next to NM 4 was quickly extinguished.

Air monitoring used several independent systems. The standard AIRNET system was supplemented by high-volume samplers operated by the AIRNET team, by the Laboratory's Field Monitoring team, and by the Radiological Assistance Program team. The results indicated no measurable Laboratory radioactivity. Unlike the Fukushima Daiichi release, no measurable increase in radioactive material was detected by NEWNET during the Las Conchas fire.

No measurable health effects are expected from any of the radioactive emissions during 2011.



Las Conchas fire, July 15, 2011.



Types of Surface Water

Base flow—continual stream flow but not necessarily present year round.

Snowmelt runoff—flowing water present because of melting snow.

Storm water runoff—flowing water present in response to rainfall.

A Laboratory worker uses grab sampling to collect a surface water and sediment sample.

Laboratory workers inspect an automated storm water sampler in Acid Canyon.

Why does LANL monitor surface water?

The Laboratory monitors surface water, including storm water and canyon sediment, to

- evaluate the transport of legacy contamination,
- evaluate potential changes in dose as a result of the transport of contaminants,
- confirm that concentrations are not increasing due to ongoing operations, and
- evaluate the effectiveness of sediment transport mitigation in Los Alamos and Pueblo Canyons.

The flow of surface water on the Pajarito Plateau is limited, and no drinking water systems rely on surface water supplies, so it is not considered a drinking water source for humans. However, because wildlife may use surface waters within and around the Laboratory, standards are set to protect wildlife.

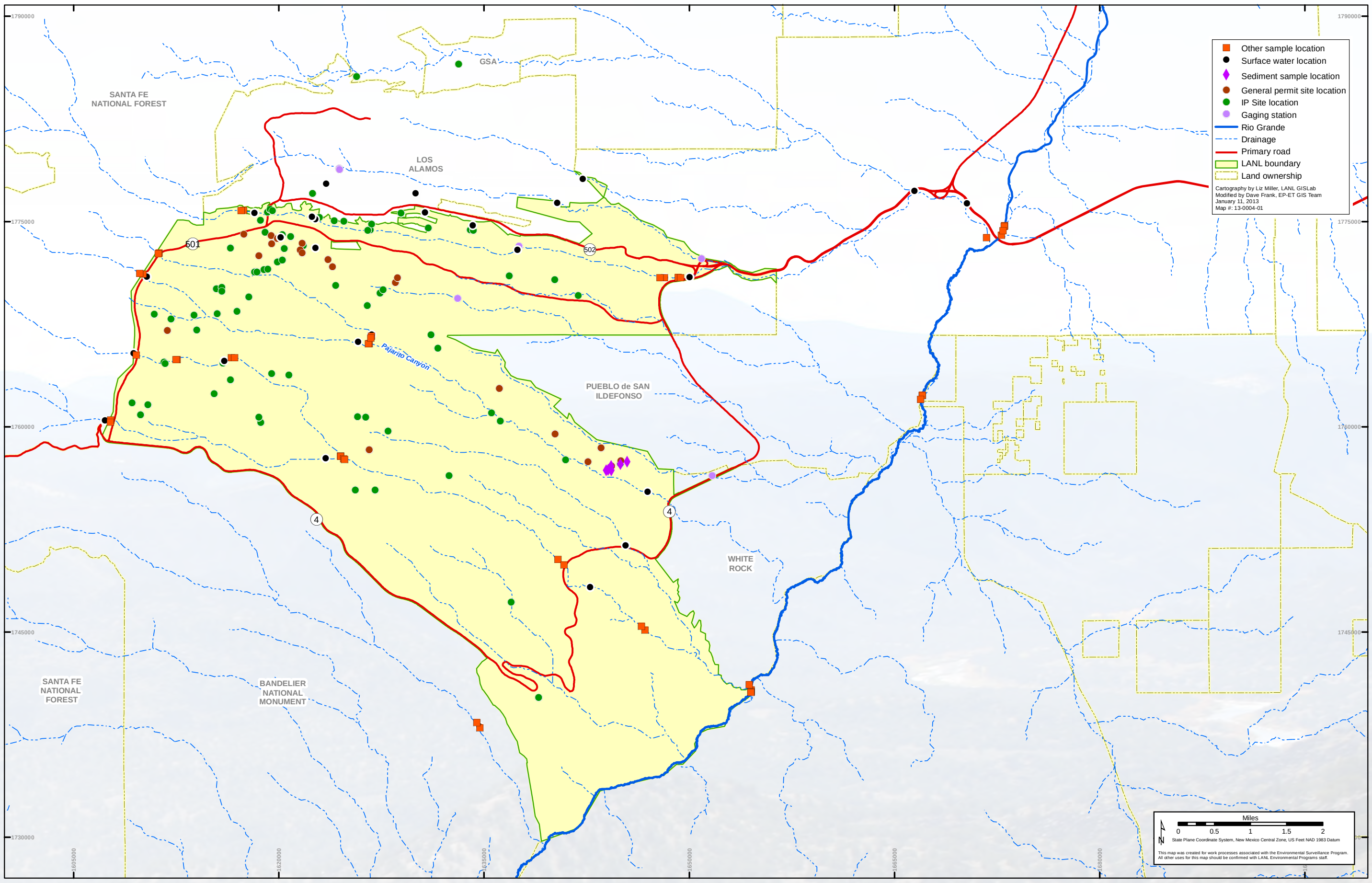
How does LANL monitor surface water?

Laboratory property encompasses seven primary watersheds, each of which drains directly into the Rio Grande. The watersheds are defined by seven major canyons: Los Alamos, Sandia, Mortandad, Pajarito, Water, Ancho, and Chaquehui.

Surface water and sediment samples are collected in the canyons, with extra monitoring conducted near and downstream of potential sources of Laboratory-produced substances. The samples are collected either manually (grab sampling) or by automated samplers that are activated during periods of high storm water runoff. All surface water and sediment samples are then analyzed for radionuclides and chemicals.

Results

During 2011, the Laboratory saw an increase in the amount of sediment and ash transported by storm water. Samples contained greater amounts of radioactivity and chemicals than previous years. The increase was the direct result of the Las Conchas fire, which burned areas upgradient of the Laboratory in the Santa Fe National Forest. Though the sediment and ash contained increased concentrations of radioactive materials and chemicals, the highest levels were measured upstream of the Laboratory, indicating the materials were natural and from residual fallout from the 1950s and 1960s, not a product of the Laboratory.



Surface water sampling locations.

Does LANL impact the Rio Grande?

To assess the Laboratory's impact on the river, samples of water, sediment, and foodstuffs are collected both upstream and downstream of the Laboratory. Samples are analyzed for radionuclides and chemicals. The same concentrations of radionuclides and chemicals exist downstream as they do upstream, indicating the radionuclides are natural or from fallout and the Laboratory is not a major contributor to the chemical contamination of the Rio Grande.

Crews float down on rafts for the annual sampling campaign on the Rio Grande in White Rock Canyon.

The Rio Grande, looking east from Overlook.


Reroute storm water
Monitor storm water
Install check dams
Pueblo Canyon
Remove contaminants
Remove waste

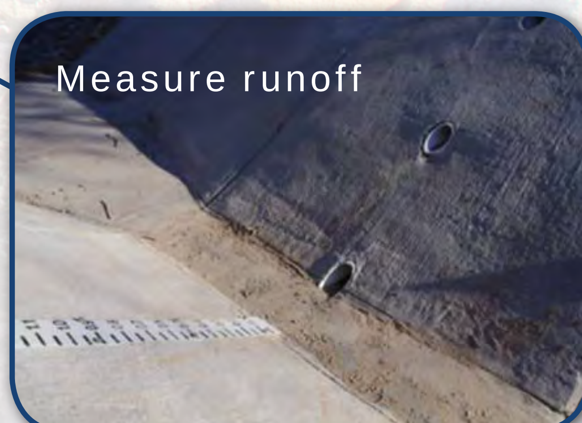
Defenses in depth: Nested controls to stabilize sediments

As part of the EPA Clean Water Act, the Laboratory operates under the National Pollutant Discharge Elimination System permit program. The permit program serves to monitor and control surface water releases associated with industrial activities at the Laboratory to minimize the discharge of pollutants.

Surface water monitoring leads to actions with two main objectives:

1. Divert and minimize water flowing onto areas with known contamination
2. Restrict and slow the water flowing off Laboratory property to allow deposition of sediments.

The Laboratory has installed sediment-control structures at 405 sites to minimize erosion and reroute storm water away from areas of known contamination. The structures also enhance the deposition of sediment to prevent the movement of contaminants off Laboratory property.



Types of Groundwater

Alluvial – Water that occupies sediment in canyon bottoms.

Intermediate – Water found at various depths, settled on rocks that it cannot easily travel through.

Regional Aquifer – Water located 600-1200 feet below the surface, separated from alluvial and intermediate groundwater by several layers of rock and dry tuff, source of public drinking water.

A shallow alluvial well used to sample groundwater within alluvial sediments.

Why does LANL monitor groundwater?

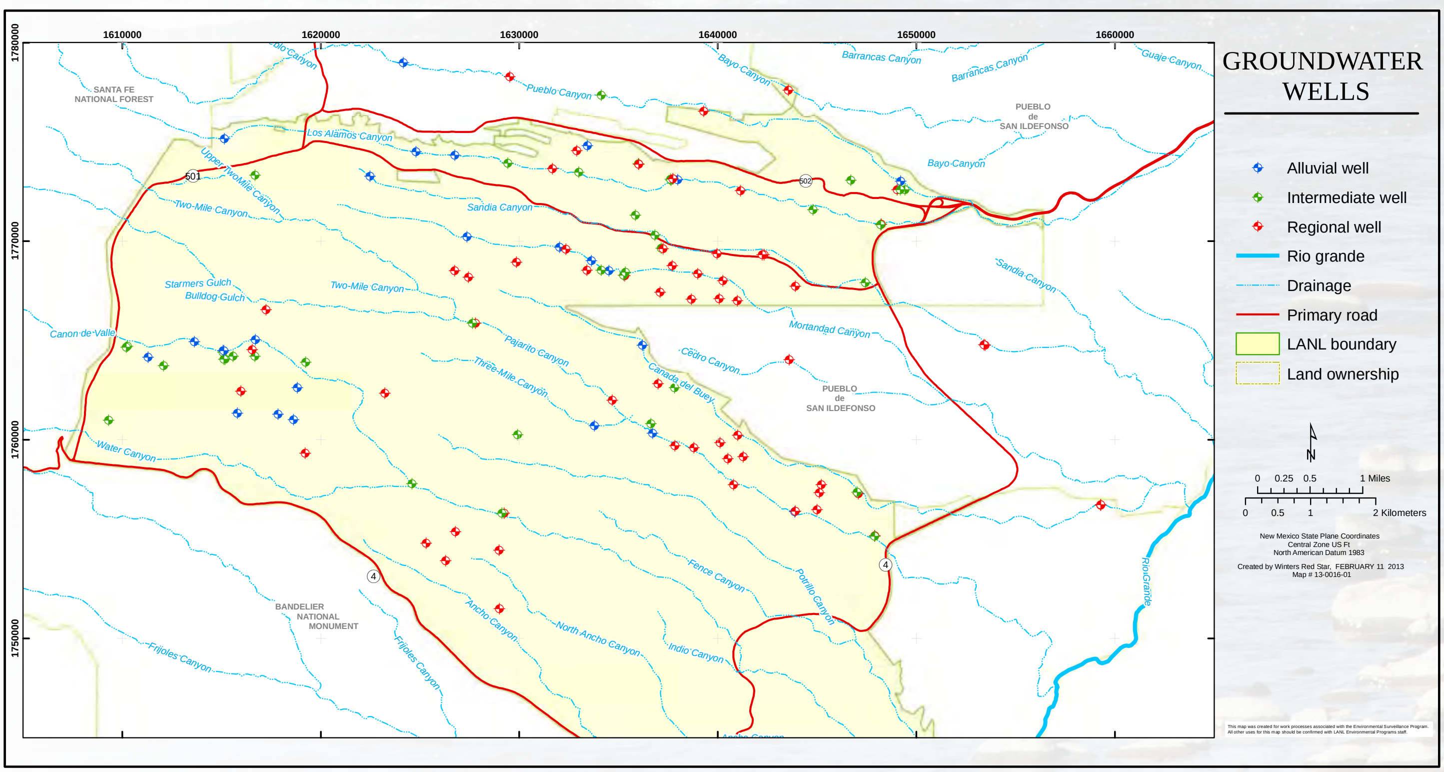
There are three different forms of groundwater beneath the Pajarito Plateau: alluvial groundwater, intermediate groundwater, and the regional aquifer. Los Alamos County's drinking water supply consists of water pumped from the regional aquifer.

To determine the impact of past and present liquid waste discharge from the Laboratory facilities on groundwater quality, the Laboratory collects and analyzes samples from the three different modes of groundwater.

How does LANL monitor groundwater?

In 2011, the Laboratory used a total of 215 wells and springs to collect groundwater samples. Deep wells, such as monitoring and drinking water supply wells, were used to collect water from the regional aquifer and intermediate groundwater, while alluvial groundwater samples were taken from shallow wells and springs. Because groundwater is monitored at various depths, the Laboratory is able to track the movement of materials through each of the levels of groundwater. This monitoring system allows the Laboratory to prepare for and minimize any potential impact to public drinking water.

For example, the movement of chromium has been tracked from the alluvial groundwater in Sandia Canyon to the intermediate groundwater that extends from Sandia Canyon to Mortandad Canyon and from there to the regional aquifer beneath Mortandad Canyon. The concentrations are monitored closely, and treatment options are being evaluated if the chromium reaches the public drinking water supply.



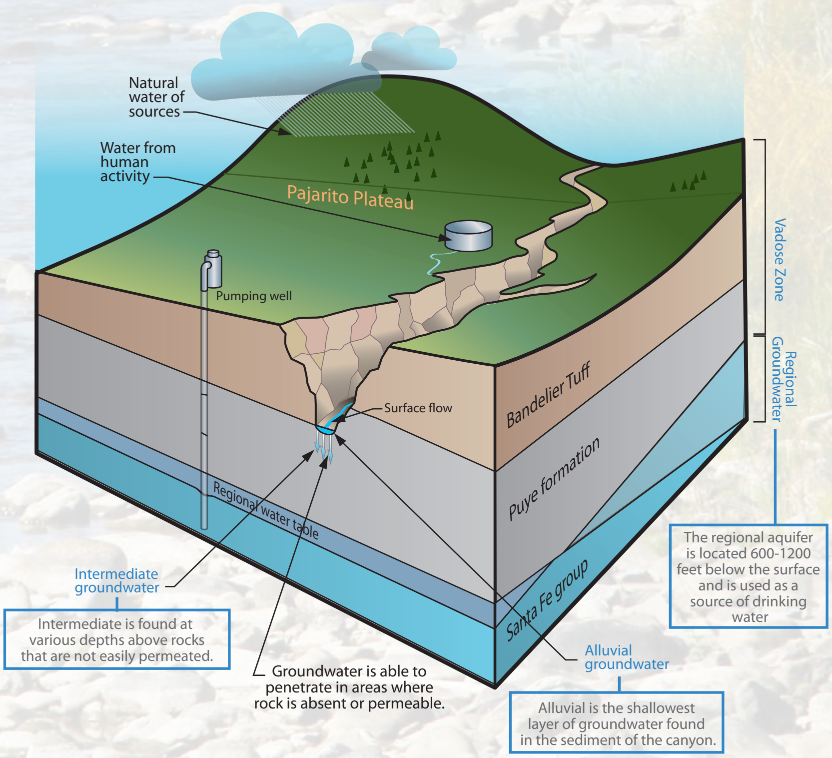
Groundwater monitoring well locations.

Results

In 2011, the water samples collected from the Los Alamos County water supply wells were in compliance with both federal and state standards.

A groundwater well used to sample water from the regional aquifer.

Crews float in rafts down the Rio Grande to remote springs to collect samples for groundwater analysis.



Water Flow Model on the Pajaritio Plateau Groundwater Zones

What materials are of interest?

The Laboratory expects to see certain materials, based on the work being done at each facility.

Research Department Explosive (RDX) – RDX was widely used during World War II (WWII). At the Laboratory, RDX has been used as part of explosives research and development.

Perchlorate – Perchlorates are salts that are derived from perchloric acid. They are produced through both natural and artificial processes. Perchlorate-based materials are often used in explosives, solid fuel for rockets, and batteries.

Chromium – Chromium is widely used as a corrosion inhibitor. Until 1972, the Laboratory used potassium dichromate in a cooling tower at Technical Area 03 (TA-03). The water was discharged into Sandia Canyon after use.

What materials are mobile?

Materials that are soluble in water are the most mobile and move readily with the groundwater. Materials that are not soluble in water are usually bound to soil particles, and only move if the sediment moves.

RDX – RDX is soluble in water, and so it moves easily in groundwater. From 1951–1996, the Laboratory discharged RDX into Cañon de Valle. As a result, low levels of RDX have been detected in the groundwater under Cañon de Valle at TA-16. The Laboratory is currently working on the removal of contaminated soil and sediment in this area to reduce the impact to groundwater.

Perchlorate – Most perchlorates are soluble in water, and thus they travel easily in groundwater. Perchlorate has been detected in groundwater in Mortandad Canyon, but concentrations are decreasing as a result of reduced discharges from TA-50.

Chromium – Most of the chromium discharged by the Laboratory before 1972 is in the form of relatively immobile trivalent chromium and remains in the wetlands of upper Sandia Canyon. However, some of the chromium has migrated downstream, converted into soluble hexavalent chromium, and infiltrated the intermediate and deep groundwater under Mortandad Canyon.

Why does LANL monitor foodstuffs?

Foodstuffs are products edible to humans such as fruits, vegetables, and various animal tissues. To assess the potential impact of Laboratory operations on human health via the food chain, foodstuffs are collected within and around the Laboratory perimeter every 3 years and analyzed for radionuclides and chemicals.

The last foodstuffs sampling was conducted in 2010. The Laboratory collected more than 100 fruit and vegetable samples from locations on and surrounding Laboratory property, goat's milk and chicken eggs from noncommercial farms in White Rock and surrounding communities, and honey from hives located at TA-54, east of Area G, Los Alamos townsite, and Pojoaque, New Mexico. In 2011, the Laboratory also collected and analyzed samples from two road-killed elk and two road-killed deer found on the Laboratory property as well as samples of fish and crayfish taken from the Rio Grande.

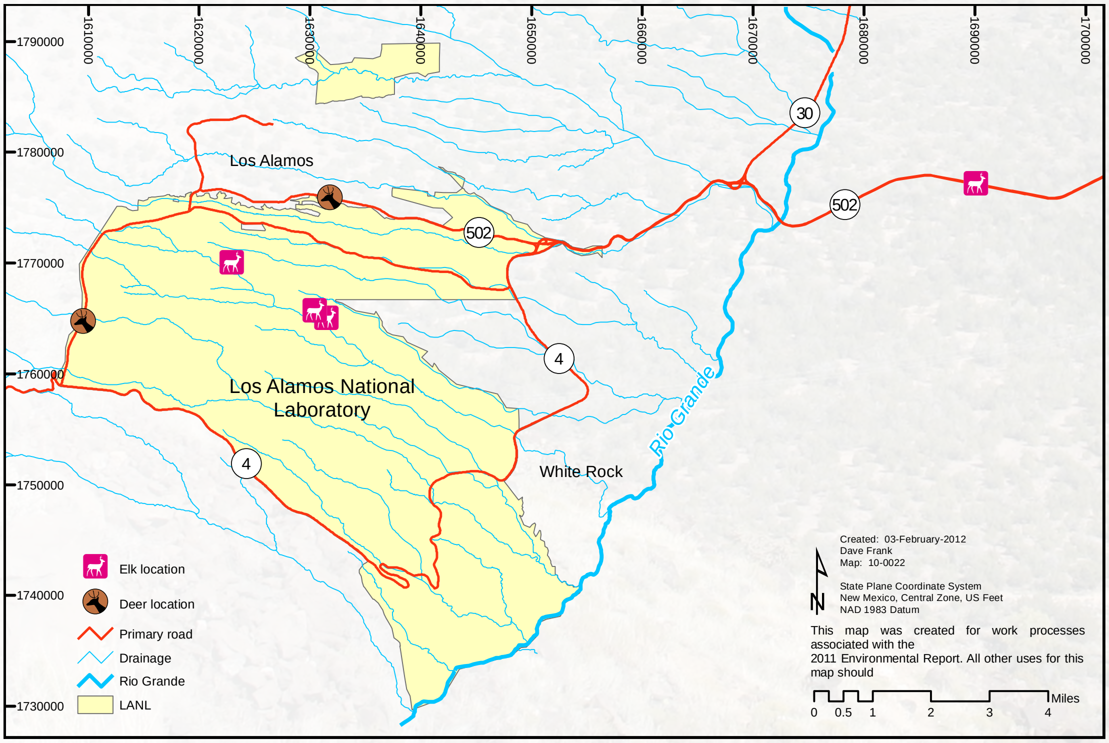
Results

All foodstuffs samples collected in 2010 and 2011 contained concentrations of radionuclides and chemicals far below screening levels.

Fish sampling in Rio Grande.

Crayfish taken from Rio Grande for sampling.

Sampling fish in July of 2011 at Cochiti Reservoir.



Location of deer and elk collected as road kill from within and around the perimeter of the Laboratory in 2011.

Why does LANL monitor biota?

The Laboratory monitors potential impact to the surrounding ecosystems by sampling and analyzing biota. Biota are organisms not normally eaten by humans and include native vegetation, small mammals, reptiles, birds, and bees. Like soil and foodstuffs, biota samples are taken every 3 years, with the last sampling occurring in 2009. Samples are analyzed for radionuclides and chemicals. The Laboratory also looks for changes in population and diversity of biota species.

Because the results are consistently low, the Laboratory rotates sampling biota, soils, and foodstuffs every 3 years.

Mexican spotted owl (*Strix occidentalis*)

Results

All biota samples collected in 2009 contained concentrations of radionuclides and chemicals far below screening levels. The population or diversity of biota species has not been impacted.

Williamson's sapsucker (*Sphyrapicus thyroideus*)

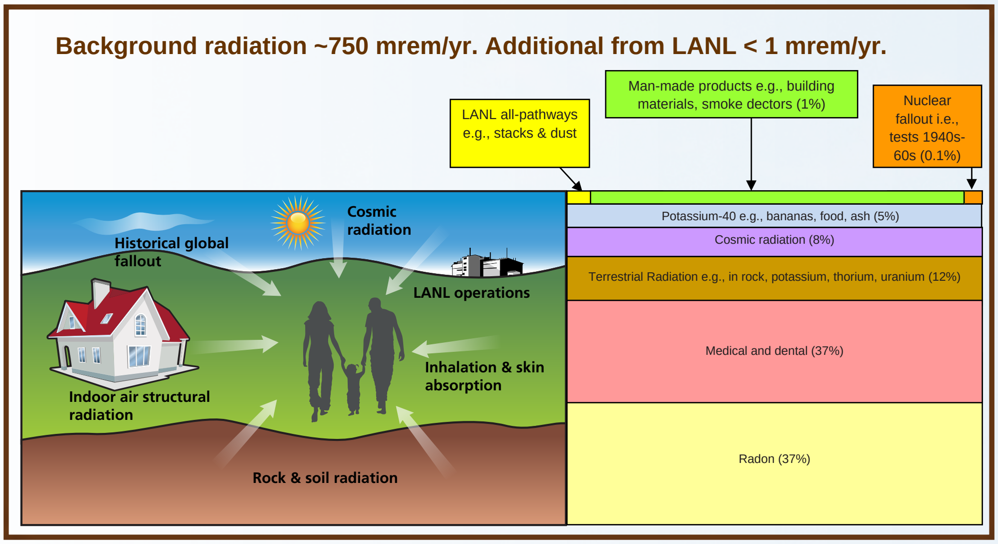
Mesa Verde Cactus (*Sclerocactus mesae-verdae*)

Ponderosa Pine (*Pinus ponderosa*)

Sampling of Benthic Macroinvertebrates.*

* Benthic macroinvertebrates are animals that are found at the bottom of a stream, sea, or lake, large enough to see with the naked eye and have no backbone.

What is dose?



You can calculate the dose you receive in your daily life at http://newnet.lanl.gov/info/dosecalc.asp

Dose is a measure of harm or risk. A large dose of any sort has the potential to be harmful. The doses presented in this report are so small that the harm or risk is essentially zero. Radiation dose, measured in mrem, is the amount of energy per gram of living tissue a person receives from a radioactive source. The primary risk of radiation dose is cancer. For low doses of radiation, the risk of cancer is 0.0000008 per mrem received or 8/10,000,000.

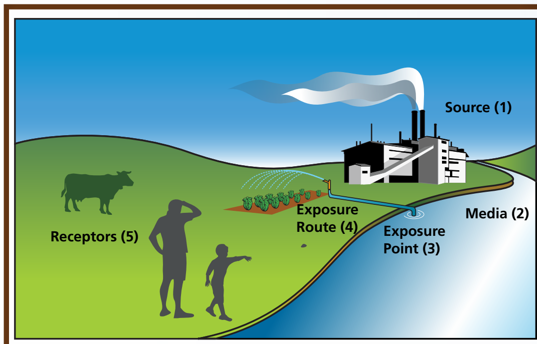
For chemicals, dose is a measure of the amount of a chemical per gram of living tissue.

How does LANL determine the dose to the public and the environment?

The Laboratory uses DPRNET to make direct measurements of radiation dose near radioactive sources, such as Area G.

For air, water, and food, the dose is not measured directly but instead is calculated based on the amount that gets into the body and the given pathway.

What are pathways?



(1) **Source** – the point of origin of the contamination

(2) **Media or Medium** – the means of transportation for contamination

(3) **Exposure Point** – the location of potential contact between a person/animal and contamination

(4) **Exposure Route or Pathway** – the means by which the contamination enters the body

(5) **Receptor** – the exposed individual, plant, or animal

A “pathway” is a way that a material can get into the body, for example, breathing air, drinking water, or eating food. A pathway may involve several steps.

For the direct exposure pathway, radiation directly penetrates the body.

For the airborne pathway, a material is inhaled directly into the lungs, and then moves into the bloodstream.

For the ingestion pathway, there are several different possibilities:

- An animal drinks surface water, a human then eats the animal.
- Crops are irrigated with surface water, a human then eats the crops.
- A contaminant gets into the aquifer, the aquifer supplies the public drinking water system, and the water is consumed.
- A contaminant gets into the aquifer, the aquifer supplies a natural spring, and the spring water is consumed.

A pathway may be interrupted or incomplete. For example, water from the aquifer is treated before it reaches the public drinking water system, and thus contaminants are not ingested by the public.

What is the MEI?

The Laboratory monitors the potential radiation dose to the public by calculating the dose to the maximally exposed individual (MEI). The MEI is a hypothetical person located off-site of Laboratory property, such as at a residence or place of business, who receives the greatest radiation dose from Laboratory operations. The dose to the MEI is calculated assuming the hypothetical person spends 24 hours of every day of the year at the location. The hypothetical person is also assumed to eat food grown at the location and drink water found at the location.

The MEI considers every possible way the radiation from the Laboratory might affect a human. To determine the dose to the MEI, the potential dose to each pathway is calculated. The doses are then added together for a total all-pathways dose.

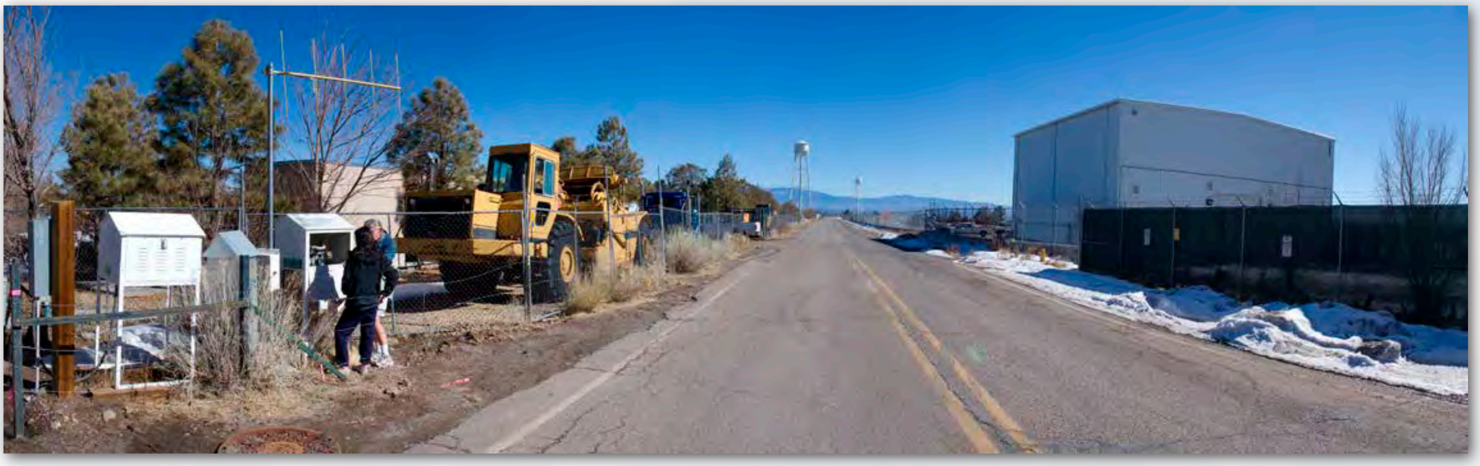
1. The direct exposure dose is measured and calculated using DPRNET.
2. The airborne pathway dose is calculated using AIRNET data, stack sampling, and computer models.
3. The ingestion pathway dose is calculated using data from food/water samples and computer models.

AIRNET station 317, with MDA B cleanup site in the background.

Results

For 2011, the largest dose to any member of the public located offsite of Laboratory property was 3.53 mrem. The dose was the result of cleanup work performed at MDA B, located on DP Road. An AIRNET station near the site measured the 3.53 mrem dose. Therefore, the business next to the station became the location for the 2011 MEI. The primary contributor to the radiation dose at this location was plutonium-239.

AIRNET station 317 and businesses along DP Road. A fence surrounds the MDA B cleanup site.



A view of the MEI location looking east towards TA-21. MDA B (left) is fenced off, and a rigid structure covering an excavation site can be seen. Across the street is AIRNET station 317, which detected the 3.53 mrem dose.

Construction at TA-21.

Workers at TA-21.

Work at TA-21.

TA-21 historical aerial.

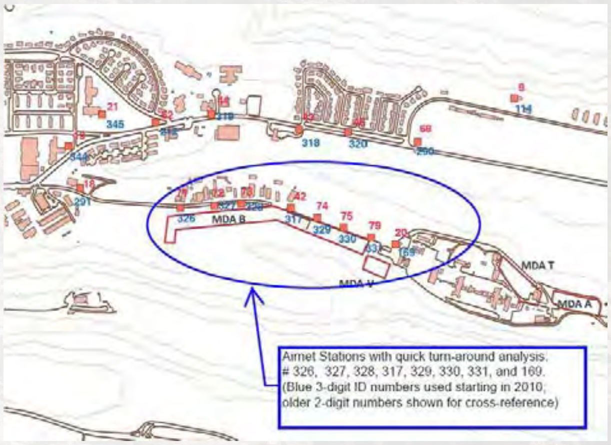
MDA B and TA-21, then and now

The original plutonium facility, D building, was constructed hurriedly during WWII and was clearly an inadequate location for processing large quantities of plutonium. The building was built of wood and in close proximity to both the hospital and residences, making the possibility of a fire catastrophic. Construction of TA-21 was completed in late 1945, and the site became the new location of plutonium processing following the end of WWII.

MDA B served as the primary dump site for all hazardous materials during and briefly following the war. Little thought was given to the implementation of any standards for dumping materials during the race to end WWII. No records were kept of the materials dumped, and materials were not packaged or labeled. No effort was made to prevent the mixing of chemical and radioactive waste, and the waste was not immediately buried. As a result, several spontaneous fires started. Because of the mixing of radioactive and chemical wastes, the smoke from the chemical fires most likely contained radioactive material. The scientists knew the dangers this could pose to those living in the town, and in 1948 MDA B was closed. A new material disposal area, MDA C, was opened in that same year along what is now Pajarito Road, and standards were put in place to ensure the proper disposal of hazardous materials.

Managing emissions from MDA B

As part of the EPA Clean Air Act the Laboratory complies with an off-site dose limit of 10 mrem/year for the airborne pathway. In 2011, the Laboratory allocated half of the 10 mrem/ year dose limit to the MDA B cleanup project and reserved the remaining half for all other Laboratory operations. Several AIRNET stations located between MDA B and the townsite as well as stations located near residences downwind of MDA B were in operation at the time of the cleanup. Filters from the stations were collected every two weeks and sent out for analysis. The AIRNET stations nearest MDA B were analyzed with an expedited turn-around time of 2 to 3 weeks between sample collection and data delivery. Data from the stations were tracked and trended. The 3.53 mrem dose to the airborne pathway was measured over the span of 2011 and was lower than the 5 mrem/year dose limit allocated to the MDA B cleanup project. The map shows the MDA B cleanup site in close proximity to the public as well as the many air monitoring stations.



In 2010, the demolition of TA-21 and excavation of MDA B began. Because of the lack of records of materials disposed of in MDA B, Laboratory workers were unsure of what they would find in the disposal area. It was believed by many that plutonium-contaminated material had been disposed of in the area, so structures were put in place over the excavation sites to better protect the public from radioactive dust and material.

Enclosures were constructed at MDA B to protect the public from airborne radioactive dust and material.

An excavation site at MDA B. The dig took place inside an enclosure.

Items found during the excavation of MDA B.

A Laboratory worker stands next to a mixing tank found during the excavation of MDA B.

A Coca-Cola bottle is one of the waste items recovered from the MDA B excavation.

Any waste from MDA B that could not be recycled was sorted by waste type and then shipped to repositories.

Western Tiger Swallowtail (*Papilio rutulus*)

Fall migratory bird monitoring location at Pajarito Wetland.

Blue Grosbeak (*Passerina caerulea*)

Biota Dose

Biota are the plant and animal life that inhabit a region. They are not usually eaten by humans and include native vegetation, small mammals, birds, and bees.

The Laboratory uses data from soil and water samples along with the computer program RESRAD-BIOTA to monitor dose to various species of biota. Dose limits are applied to whole biota populations, rather than an MEI.

The DOE dose limits for biota are

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

Results

For 2011, the biota doses at the Laboratory were far below DOE dose limits. There was no measurable impact to populations of biota species.

Horned lizard (Phrynosoma modestum)

Deer mouse (*Peromyscus maniculatus*) commonly trapped in the small mammal monitoring project.

Tree mortality and climate change

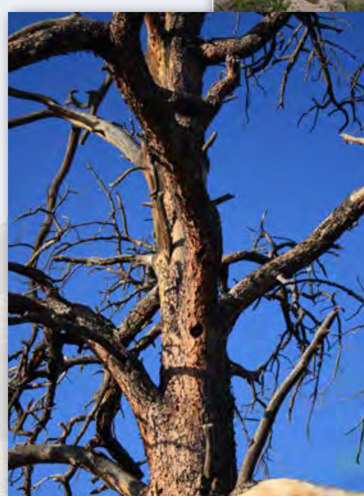
Tree ring data from 1000 to 2007 indicate the drought starting in the 1990s could be the most severe "mega drought," yet even more severe that the mega droughts in the 1200s and 1500s, when Puebloan cultures abandoned cultural centers throughout the Southwest. Increasing temperatures and evaporation stimulate processes that are the final cause of death for trees.

- Dry hillsides increase susceptibility to forest fires such as the Cerro Grande fire in 2000, which burned 48,000 acres, and the Las Conchas fire in 2011, which burned 156,000 acres.
- Trees without enough moisture to fill holes with sap die off from infestations of bark beetles.
- As the soil dries, trees have to draw harder to conduct water all the way into needles and leaves, picking up air bubbles that block the flow and eventually kill the trees.

These factors will cause the retreat of ponderosas to higher elevations and could cause the disappearance of piñons from the plateaus and high mesas of the region.

Large-scale forest changes (ecotone shifts) can impact soil erosion, biota, and potentially contaminant transport and accessibility. Consideration of climate change impacts is an important part of environmental surveillance planning at Los Alamos.

Thriving ponderosas in a canyon of the Pajarito Plateau circa 1995



Ponderosa tree in 2013

Piñon tree on high mesa circa 1995

Dead piñon tree in 2010

Environmental remediation programs

Aerial view of TA-21 on DP Mesa.

Demolition of buildings at TA-21.

After TA-21 demolition was completed, only waste bins remained. The bins were sorted and shipped to repositories by waste type.

Sampling at MDA C.

TA-21 Closure

TA-21 is located on DP Mesa on the northern boundary of the Laboratory and is immediately east-southeast of the Los Alamos town site. The facilities at TA-21 were the site for plutonium processing and research at the Laboratory from 1945–1972.

The cleanup of TA-21 was funded by the American Recovery and Reinvestment Act. By the end of the project, the Laboratory had successfully completed the

- decontamination and demolition of 24 buildings at TA-21,
- removal and remediation of early Laboratory waste from MDA B, and
- installation of 16 groundwater monitoring wells.

MDA C

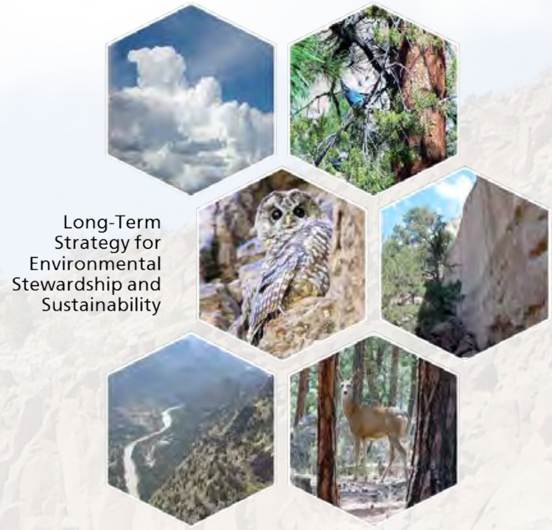
Following the closure of MDA B in 1948, MDA C became the site for material disposal. MDA C is located along Pajarito Road and was in operation from 1948 to 1968. It was used intermittently from 1968 until its closure in 1974. Waste disposed of at MDA C consisted of liquids, solids, and containerized gases generated from nuclear energy research and development activities at the Laboratory. The wastes included metals, hazardous materials, and radioactively contaminated materials. Samples collected from around and beneath MDA C have shown no significant releases. At this time, the Laboratory's goal is to avert water from flowing on to the area to prevent the movement of contaminants into groundwater. No plans are in place to dig up the material disposal site, and the likely path forward is to cap the area to keep it dry.

Polychlorinated biphenyls (PCBs) in Los Alamos Canyon below TA-01

PCB contamination from TA-01 can be found on the edge of Los Alamos Canyon near the Los Alamos townsite. The contamination is the result of many leaks at the old TA-01 facility during WWII. The Laboratory removed much of the PCB-contaminated soil, and two detention basins have been put in place to capture any remaining PCBs flowing in storm-water runoff.

Installing piping to vacuum PCB-contaminated sediments from the drainage.

What exactly is LANL's long-term strategy for the environment?



The Laboratory's Long-Term Strategy for Environmental Stewardship and Sustainability is to be the sound environmental stewards required to accomplish our national security mission. The strategy is to protect human and environmental health by

- cleaning up or stabilizing historical releases to the environment;
- controlling current programs to ensure an impact to the environment, which is as low as reasonably achievable; and
- creating a sustainable future through pollution prevention, waste elimination, energy and water conservation, and fostering resilient ecosystems.

The strategy looks from two linked perspectives:

- A broad-reaching vision to set long-term environmental goals.
- A day-to-day examination of decisions to choose those actions that are most protective.

Water studies on the Rio Grande.

How will LANL implement the strategy?

- Through open communication and consultation with our stakeholders resulting in overarching strategies to guide decisions over the long-term.
- Through deployment programs and software applications that support protective, proactive decision-making to create a sustainable future beyond ordinary compliance requirements.

Public tour of sediment control structures in Pueblo Canyon.

Environmental grand challenges—live a sustainable future

Grand challenges cause actions to address difficult issues:

- Consult with tribal governments and collaborate with our stakeholders to ensure the Laboratory's impact on the environment is as low as reasonably achievable.
- Remove or stabilize pollutants from the Manhattan Project and Cold War eras.
- Protect water resource quality and reduce water use.
- Eliminate industrial emissions, discharges, and releases to the environment.
- Protect human and environmental health by managing and restoring lands.
- Produce zero radioactive, hazardous, liquid, or solid wastes.
- Use energy efficiently while creating sustainable energy sources.

1000th shipment of TRU waste from Area G.

A message from Burgandy Brock

For the last three years, I have had the opportunity to work as a student in Environmental Stewardship at the Laboratory. When I first began my journey, I was completely unfamiliar with many of the ideas and tools the Laboratory uses to meet its commitment to environmental stewardship. Over the years, my mentor has been exceedingly successful in not only broadening my understanding of and maintaining my interest in the different aspects of environmental science at the Laboratory but also in awakening my curiosity and strengthening my desire to learn. Throughout the process of writing this report, I have held on to these ideals as my major goals. I hope that I have been successful in presenting to you the information you deserve to know about our environment in a way that is both stimulating and comprehensible. My dream is that this report will be helpful in motivating you to ask even more questions, and improve your appetite for knowledge.

A message from Michael McNaughton

Mentoring an excellent student such as Burgandy is exceptionally rewarding. For both the student and the mentor, curiosity and a desire to learn are essential, and both of us have learned a lot. Especially, I have learned, and am still learning, how to take the 400-page Environmental Report and distill the essence into 32 pages of interesting information. This summary report is Burgandy's perspective, presented her way. I hope you find it as interesting as I do.

We have also both benefited greatly from the knowledge, skills, and insights of those who mentored both of us through this process: Lorrie Bonds Lopez, Jeanne Fair, Elaine Forbes, and Tanner Johnson, whose advice and contributions were invaluable at every step.

Michael explains the workings of an AIRNET station to Burgandy during one of their field trips.

Sandia Canyon, downstream from the wetlands.

Valle Caldera

Mortandad Canyon

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Visit the Laboratory's environmental website: www.lanl.gov/environment and sign up for e-mail notification

Explore Long-Term Strategy for Environmental Stewardship and Sustainability: www.lanl.gov/projects/envplan

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