Community Summary

of

CDC's Los Alamos Historical Document Retrieval and Assessment (LAHDRA) Project

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Introduction to Community Summary of CDC's LAHDRA Project

"Knowing our past helps to understand our present. Understanding our present helps to choose the necessary steps for the path to our future." *– Marian Naranjo, Santa Clara Pueblo*

Las Mujeres Hablan (The Women Speak), our colleagues, and community members are honored to present this Introduction to the *Community Summary of CDC's Los Alamos Historical Document Retrieval and Assessment (LAHDRA) Project.* Las Mujeres Hablan is a network of women leaders from community organizations in Northern New Mexico. We came together in 2007 to address our common concerns about the environmental and health effects from the nuclear weapons industry at Los Alamos National Laboratory (LANL) on downwind and downstream communities. Our shared values and beliefs are based on the truth that all people are inherently inter-connected with the land. Our mountains, valleys, and river ecosystems must be respected and cared for so that our communities are healthy now and into the future.

As land-based Peoples, we see how industry and technology developed by the modernized world have changed our present and future relationship to the land. The Peoples of this area have always understood their responsibility in a relational co-existence as the caretakers of this *Place*, because we are this *Place*. For this reason, we must first speak of the Pajarito Plateau and the Jemez Mountains. This area is a dormant volcanic plateau located in north central New Mexico, the ancestral homelands of the Pueblo Peoples. This sacred plateau is bounded by the Valles Caldera to the west and consists of nineteen finger-like mesas with cliffs and canyons that flow into the life-giving Rio Grande to the east.

All discussion of the Pajarito Plateau and the Jemez Mountains must acknowledge that places have the ability to record multiple worldviews. These ancient mountains are a place that continues to nurture life as they have throughout millennia, recording cycles that are held in the sacred dimensions of time immemorial. We must listen to the stories of the Peoples and read the ageless recordings imprinted on the canyon walls. When the United States Government and the military began its operations at LANL in 1943, the land was seized under a set of values that separated the Peoples from the land. The sole purpose was to develop weapons of mass destruction. It was an unnatural occurrence that changed life as we know it. This culture of violence was forcibly incorporated into our story. The rocks recorded it. The water and air recorded it. Our DNA recorded it to be forever held by our children.

Of gravest concern is the LAHDRA documentation of past releases of man-made radioactive materials, heavy metals, and toxic chemicals into the environment by LANL. For example, between 1948 and 1955 releases of airborne plutonium from twelve industrial stacks at LANL exceeded the routine releases from the Hanford, Rocky Flats, and Savannah River Sites since the beginning of their combined operations.

Our communities continue to be exposed to toxic chemical, heavy metals and radioactive by-products released by the nuclear weapons industry. These toxic substances settle on the mesas, are re-suspended to be blown downwind, are rained onto the mountaintops, dispersed into canyon bottoms and then, washed into the waters of the Rio Grande. Over the last decade many of our organizations have been involved in investigations examining environmental releases from LANL. The LAHDRA Project is vitally important because it parallels and reinforces other scientific studies that examine the on-going life threatening effects. Through our work with the LAHDRA Project, Las Mujeres Hablan confirms our long-term commitment to protecting the vitality of our communities and our land.

The human health impacts of the Nuclear Age reach back to the beginning with the detonation of the first atomic bomb, on July 16, 1945, at the Trinity Test Site at Jornado Del Muerte. In 1945, approximately 38,000 people lived in the counties of Lincoln, Otero, Socorro and Sierra adjacent to the Trinity Test Site in south central New Mexico. At this time, people residing in New Mexico grew their own fruits and vegetables; raised animals for meat, eggs and milk; hunted year round to supplement their food sources, and collected water in cisterns for bathing, drinking, and cooking. For days, fallout from the detonation settled on everything in close proximity contaminating people, animals, crops, soil, and water. Livestock were exposed and reported to have turned white or half white depending on how they were positioned to the blast. The people living in the area were not given notice either before or after the test to alter their lifestyles in order to protect them from the radioactivity and toxins. The plume from the detonation was tracked by the military across the Mid-west reaching as far as the Atlantic Ocean.

The LAHDRA Project is the first scientific report to document exposure of area residents to very high levels of internal and external radiation from the radioactive fallout. The Tularosa Basin Downwinders Consortium, working with Las Mujeres Hablan, call attention to the fact that the only documentation of environmental sampling was published in 1978. Of most serious concern, is that neither epidemiological nor dose reconstruction studies of the populations living adjacent to either the Trinity Test Site, where cancer rates in adjacent counties have been recorded at four times the national average, or LANL have been conducted.

As we continue to speak, we are also engaged in integrating the scientific findings with what we know in our hearts. We feel the on-going acute and chronic harm. For decades the Peoples living in the shadows of the nuclear weapons industry have been told that there is not enough evidence to prove that the industry's development and manufacturing has caused significant damage. In our holistic worldview, if harm is caused to our kidneys, does that not affect our whole body? If the bees are harmed, does that not change the plants, the water, and the soil? We know that our cultural perspectives and interpretative abilities are valid tools in healing our homelands.

We would like to acknowledge the work everyone has contributed. We are grateful to the CDC's Branch Chief, Dr. Charles Miller, and to Project Director, Phil Green for their persistence and years of dedication. We wish to recognize the late Tom Widner, ChemRisk Project Director and Principal Investigator for his invaluable contributions throughout this eleven-year journey of discovery. All have shown

professionalism and an abiding respect to our Peoples. We also thank our Congressmen, notably U.S. Senator Jeff Bingaman and U.S. Senator Tom Udall, for ensuring continued annual funding for the LAHDRA Project.

Las Mujeres Hablan looks forward to the continuation of the LAHDRA Project, recognizing that damage to *Place* requires that the voices of New Mexico be heard and valued. This endeavor will help us to further understand our past and present in order to make decisions for our future.

Kuu Da, Muchas Gracias, Thank you.

Las Mujeres Hablan
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Marian Naranjo – Director, Honor Our Pueblo Existence
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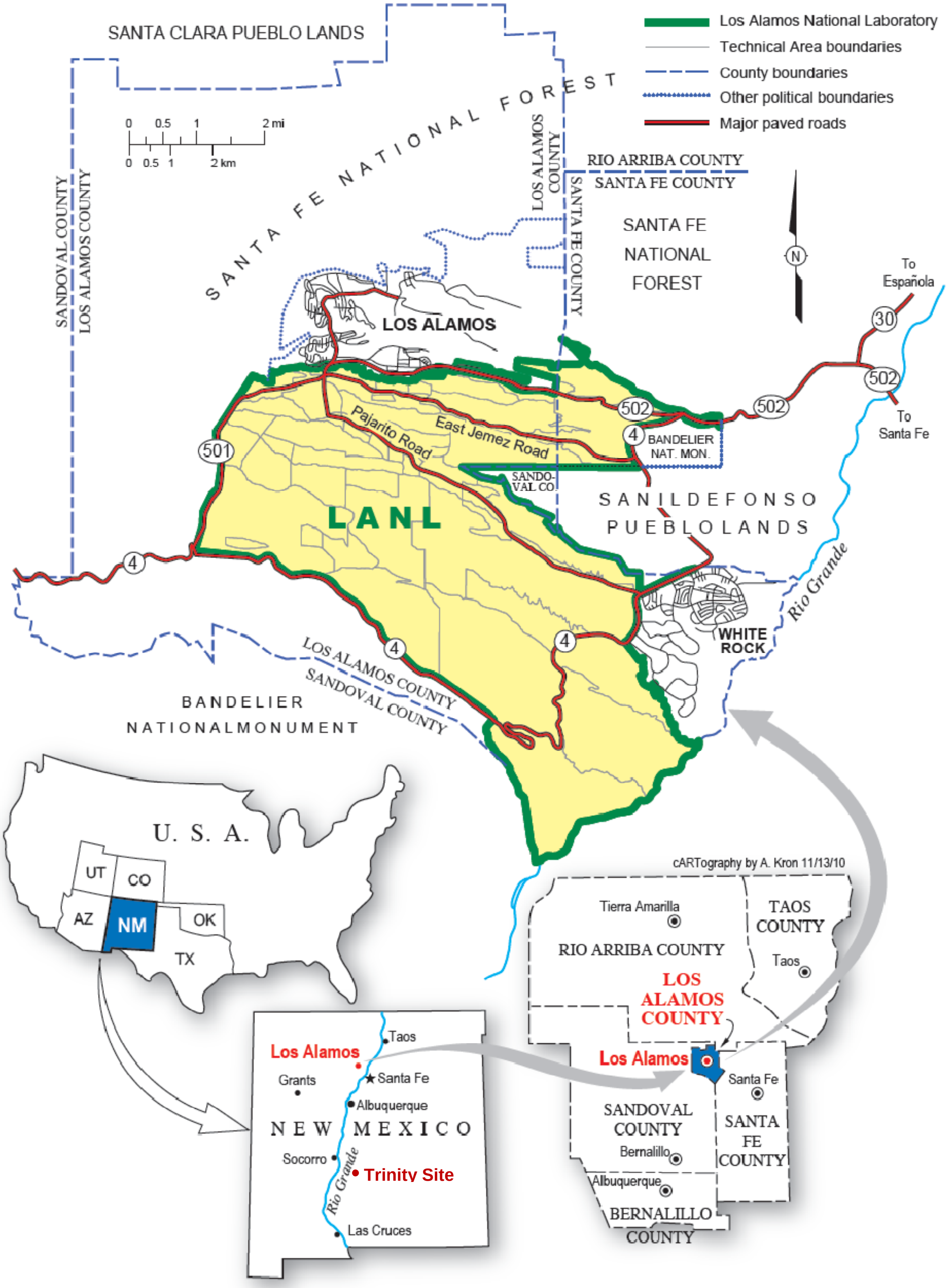
We dedicate this INTRODUCTION to future generations.

The Community Introduction was prepared by Las Mujeres Hablan, a network of women leaders from community organizations in Northern New Mexico. The perspectives and opinions expressed within the Community Introduction do not necessarily state or reflect the views of the Centers for Disease Control and Prevention or the authors of this report.



The setting of Los Alamos National Laboratory

What types of activities have been conducted at Los Alamos National Laboratory?

In 1942, the Manhattan Engineering District (MED) was created to develop the world's first atomic bombs. Research and production facility production began at secret areas in Tennessee, New Mexico, and Washington. Originally referred to as "Site Y," the New Mexico facility in Los Alamos was opened in 1943 with a single mission – to design, perfect, and manufacture the world's first atomic weapons. During World War II, two types of atomic weapons were produced at the Los Alamos facility: a plutonium gun device and a uranium implosion device. One of these, called the "Fat Man" device, was tested at the Trinity Site near Socorro, New Mexico on July 16, 1945, and another was dropped on Japan 24 days later.

Early chemical plutonium processing in D- Building in wartime Los Alamos Laboratory.

After World War II, Los Alamos Lab scientists and engineers developed and tested nuclear devices that were more powerful, compact, reliable, and suitable for a variety of combat objectives than their pre-war devices had been. Los Alamos Lab scientists were involved with nuclear device testing within the continental U.S., the Pacific Ocean, and Alaska. Some of these tests were part of the Plowshare program, which aimed to develop peaceful uses for nuclear explosives.

Los Alamos Scientific Laboratory was the lead site for U.S. nuclear component manufacture until 1949, after which time it served as a backup production facility at which nuclear components for test devices were designed, developed, and built. From time to time, the Los Alamos National Laboratory (as "Site Y" was renamed in 1981; we will refer to it as "LANL" or sometimes as "the Lab") performed special functions in its backup role.

LANL's responsibilities expanded to include thermonuclear ("Super") weapon design and testing, high explosives and weapon development and testing, weapons safety, nuclear reactor and accelerator research, radioactive material production and processing, waste treatment and disposal, and chemistry, biology, and biophysics projects.

How did the LAHDRA project come about?

Between 1979 and 1992, studies of potential off-site health risks were initiated for each major early MED/ Atomic Energy Commission (AEC) site except for LANL. In 1990, a Memorandum of Understanding (MOU) was signed by the Departments of Energy (DOE) and Health and Human Services (HHS). Under that MOU, HHS became responsible for all public health effects research related to DOE sites. The LAHDRA project work is funded by DOE and conducted by the Centers for Disease Control and Prevention (CDC), the designated lead agency for HHS.

In response to requests from elected officials, CDC began initial exploratory investigations at LANL in 1994. CDC staff found large collections of documents, including many that were classified, and some that described off-site chemical and radionuclide releases that had occurred. The number of documents needing to be reviewed and the ability of independent investigators to access them were largely unknown. After competitive bidding, CDC awarded a contract that allowed work on the LAHDRA project to begin in 1999.

What was the purpose of the LAHDRA project?

The purpose of the LAHDRA project was to identify and collect all available information concerning off-site releases or health effects from LANL activities. The goals of the LAHDRA project were to:

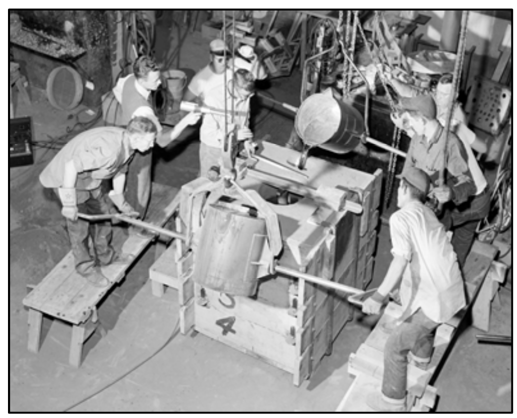
- retrieve historical documents and evaluate their usefulness for off-site dose assessment;
- declassify (as necessary) relevant documents and release them to the public;
- enter relevant documents into a project information database; and
- develop a prioritized list of contaminant releases from the LANL site.

What types of releases did the study team consider, and over what periods?

The project team focused on the radioactive materials (radionuclides) and toxic chemicals that were released from LANL in the past and traveled via the air, water, or soil to areas where the general public lived. The LAHDRA team studied releases that may have occurred since 1943, when the Los Alamos facility first opened, to the present. Environment controls and regulations increased significantly in the 1970s, and the LAHDRA team found that the documented chemical and radionuclide releases of most concern likely occurred beginning in 1945 and continued into the 1960s; less information was available for years prior to 1945. Because the LAHDRA project's scope of study included all LANL operations within New Mexico, the team also collected information about the Trinity test (conducted by LANL, the MED, and the Army approximately 150 miles south of Los Alamos) and the underground Plowshare detonations that were conducted near Farmington and Carlsbad.

Did the team evaluate exposures to LANL workers?

The LAHDRA team did not focus on chemical or radionuclide exposures to LANL workers, except to the extent that workers may have also been Los Alamos town residents. LAHDRA document analysts spent relatively little time reviewing documents about operations or events that resulted in only worker exposures or local contamination. Under the MOU mentioned earlier, the National Institute of Occupational Safety and Health (NIOSH) has responsibility for studies involving energy-related worker health concerns. Much of the information that the LAHDRA team collected, however, was also relevant to worker chemical and radionuclide exposures, so the LAHDRA team shared that information with NIOSH staff.



Foundry workers in the original Technical Area.

How was information gathered at LANL?

The LAHDRA team had unprecedented access for an independent study team reviewing historical documents at LANL. A core group of approximately

15 analysts, most of whom held DOE Q-level security clearances, worked on the project on a part-time basis. These analysts had advanced training in health physics, nuclear and chemical engineering, toxicology, industrial hygiene, environmental health, and other relevant fields of study. The team's initial review efforts focused on the centralized document collections, the largest of which was the LANL Records Center, followed by any collections held by individual LANL divisions and groups. Examples of these include the records centers for the environmental health and safety division and the environmental stewardship program.

LAHDRA document analyst Bob Burns at work in the LANL Records Center in 2005.

The LAHDRA team focused on documents that discussed historical operations, airborne chemical and radionuclide releases from stacks or building exhaust systems, accidents and incidents, as well as any that discussed chemicals or radionuclides in effluents or waste streams that could have contaminated surface water or ground water. The LAHDRA team also interviewed more than 50 current and former LANL workers to help fill in gaps in the team's knowledge regarding historical operations, materials used by the Lab, and chemical and radionuclide releases that may have resulted.

LAHDRA team members completed a Document Summary Form (DSF) for each document or set of documents that they selected as relevant. The DSF captured bibliographic data (such as title, authors, date, document location, and a short summary), as well as project-specific keywords and analyst comments. The information from each DSF was entered into a project information database.

Documents requested for public release by the LAHDRA team were processed by LANL reviewers who removed any classified information, information protected under the Privacy Act, and proprietary or legally privileged information.

Copies of nearly 10,000 documents were obtained by the LAHDRA team, many of which had never been publicly released. These documents included data sheets, letters and memos, drawings and photographs, laboratory notebooks, and technical reports. The document collection compiled by the LAHDRA team includes over 300,000 pages of historical information.

Did the LAHDRA team have full access to documents at LANL, including those that were classified?

In the first several years of information gathering, LAHDRA analysts with DOE Q-Level clearances had unescorted, unrestricted access to classified and unclassified record collections. However, in 2004, following some highly-publicized security incidents at LANL unrelated to LAHDRA, LANL put new security procedure into place. These procedures required that LAHDRA analysts be escorted when working with classified documents, and denied LAHDRA analyst

The LANL Reports Collection contains many thousands of classified and unclassified technical reports.

access to several specific types of information. These categories included nuclear weapons design information, information concerning the vulnerability of nuclear weapons to unauthorized detonation, information concerning the design and function of use control systems for nuclear weapons, and secret information provided to the U.S. by foreign governments. While documents in these categories would not be expected to have any relevance to off-site releases or health effects from LANL operations, an appeal process was created for documents withheld from the LAHDRA team that the team thought may potentially contain relevant information.

LAHDRA team member Joe Shonka interviewing former D-Building worker Helen Cowan.

Is the team confident that all operations with important off-site releases have been identified?

Yes. LAHDRA analysts literally reviewed millions of documents, including many types of informal and formal documents within many different types of collections. In addition, the analysts, based on their extensive experience reviewing documents at U.S. nuclear weapons plants, have found that when an operation was significant in terms of off-site releases, it was not discussed in only one or two documents, but rather in quite a few documents scattered across multiple locations. While the team did not review every single document ever issued at LANL, the team is confident that it identified all significant documents pertaining to important operations.

The LAHDRA team believes that LANL's denial of access to several very specific categories of classified information for a portion of the project had no real impact on the team's ability to identify operations that were important in terms of potential public exposure. A very small fraction of the documents at LANL fell into the special categories of classified information that were withheld from the team; however, because those restrictions were not in place for the first several years of document review, LAHDRA analysts did actually see some documents from those categories. The LAHDRA team verified that those documents, as a rule, contained no information relevant to assessing potential public chemical and radionuclide exposures.

How was the public involved in the LAHDRA project?

The CDC and the LAHDRA team hosted public meetings once or twice each year during the project. The meetings were held at various locations in the Los Alamos-Española-Taos-Santa Fe-Pojoaque region. The meetings included presentations and discussions concerning the team's information gathering progress, knowledge gained about historical activities of relevance to off-site releases, problems encountered with accessing and obtaining relevant documents, plans for completing information gathering, and progress towards prioritizing historical releases. In total, 18 public meetings and several workshops were held. In addition to those meetings, CDC and LAHDRA team members met with, and offered briefings to, representatives of the Eight Northern Indian Pueblo Council and many of the individual Northern New Mexico pueblos.

Updates on noteworthy aspects of the project were presented at conferences of relevant professional societies. In addition, in the spring of 2003, a poster session was conducted at a local community college. At that session, interested citizens prepared and presented posters that focused on selected topics of relevance to LAHDRA.

The LAHDRA team invited representatives of local community advocacy groups to workshops and project meetings with LANL staff that dealt with unclassified topics. As an example, a technical work session held with LANL staff in 2007 included the CDC project team, as well as representatives of the DOE, the New Mexico Environment Department, and the executive director of Concerned Citizens for Nuclear Safety.

Members of the public participated in a number of interviews with LAHDRA team members. Some of the interviewees were current or former Lab workers, but many were not. For example, the LAHDRA team interviewed many members of the public who lived near the Trinity Site. These residents shared valuable information about experiences following the bomb blast, and about local people, housing, and lifestyles.

The project also provided some support to Chimayo resident Peter Malmgren, who, in his "Los Alamos Revisited" oral history program, interviewed 145 of the people who built Los Alamos and/or worked in or near LANL. These histories, which have been placed in the State Archives, include the testimony of people ranging from janitors and housekeepers to senior nuclear weapons specialists.

After the draft final report of the LAHDRA project was issued in 2009, CDC worked with *Las Mujeres Hablan*, a network of local community groups, to host a special session at Ohkay Owingeh (formerly San Juan Pueblo). The purposes of the day-long meeting, which was held in January, 2010, was to provide an opportunity for local residents to learn more about the methods and findings of the LAHDRA project, to present community perspectives regarding LANL's operations and health and emotional effects that could have resulted, and to comment on the LAHDRA study and any follow-up work that could be undertaken.

The June 2009 LAHDRA public meeting

Is the information gathered by the LAHDRA team available to the public?

The information gathered by the LAHDRA team has been made available to the public throughout the entire project. A set of paper copies of the documents obtained from LANL was maintained by the project team near Atlanta, and another set is available to the public at the University of New Mexico's Zimmerman Library in Albuquerque.

Document reading rooms were set up at four locations, including the Zimmerman Library at the University of New Mexico, Mesa Public Library, Northern New Mexico College, and the Santa Fe Community College. These reading rooms hold electronic copies of all documents obtained during the LAHDRA project.

Early in the project, a Web site was developed to provide project related information to the public. Postings on the LAHDRA Web site include summaries of all public meeting presentations and associated public comments and discussion, summaries of workshops conducted to offer more detailed overviews of project-related topics for interested parties from LANL and the public, downloadable copies of interim project reports, video clip excerpts of public meeting presentations, and instructions for contacting LAHDRA team members. Eight interim versions of the LAHDRA project report were issued as information gathering progressed.

Dan Barkley of the University of New Mexico's Zimmerman Library shows CDC members of the LAHDRA team the project documents available to the public there.

Several years into the project, the LAHDRA team began scanning the documents that they had been collecting. An electronic database using Microsoft Access was created to describe and catalogue the information reviewed and collected during the project. This database has been made available for public review at the University of New Mexico's Zimmerman Library.

How did the LAHDRA team identify the materials that were released off-site?

During their document reviews, LAHDRA analysts looked for information that described materials that were used at LANL, how these materials were used and possibly released, and measurements or estimates of the quantities of radionuclides and/or chemicals that were released with potential to travel off-site.

The first priority for the LAHDRA team was to locate information needed in order to estimate off-site releases or health effects from operations at LANL or other LANL-sponsored operations within New Mexico. Examples of such information include effluent monitoring data, accident reports with estimates of releases, descriptions of release points, toxic material inventories, and results of environmental monitoring performed near locations where people lived or recreated. LAHDRA analysts also captured documents that contained supporting or confirmatory information that could be useful in estimating off-site releases or health effects. Examples of such documents include historical site activity descriptions, operation log books for important facilities, and process flow sheets.

How did the team identify the releases that were likely most important in terms of potential health effects?

The LAHDRA project was, by design, almost exclusively an information gathering effort. The project team was only able to scratch the surface of evaluating and interpreting the extensive body of information that it assembled. The prioritization analyses that were performed, while quite simple, established relative rankings of the radionuclides and chemicals documented to have been used at LANL.

Prioritization was made difficult by the fact that many historical releases were not monitored, sampled, or otherwise quantified over significant periods of time. Prioritization was, however, conducted for three classes of materials— airborne radionuclides, waterborne radionuclides, and toxic chemicals.

Airborne Radionuclides

The LAHDRA team prioritized radionuclide releases by calculating the volume of air required to dilute the reported annual quantity of the material released to equal the maximum effluent concentration stated in federal regulations. Those "dilution volume required" values served as a guide for judging the relative importance of one radionuclide compared to others.


The original Technical Area housed operations that used a wide variety of radionuclides and chemicals in close proximity to residential areas.

The LAHDRA team could not independently estimate past releases to the environment during the project's information gathering phase. Therefore, the team used release quantities reported by LANL staff to help prioritize releases. To account for inaccuracies or uncertainties, several adjustments had to be made to the data (These adjustments were required because of the changes in sampling systems and analytical capabilities over time at LANL; several studies were conducted using the old and new methodology side-by-side to understand the limitations of the older technology, and how they impacted the measured concentrations. Information gained from these studies was used to develop the adjustment factors).

The LAHDRA team also estimated radionuclide and chemical releases resulting from explosive testing by using reported quantities of materials used in these tests, such as lanthanum or uranium. Estimates of the fraction (or percentage) of material released were based on calculations performed by LANL staff at the time that the data were collected.

Waterborne Radionuclides

The project team ranked waterborne radionuclides in a similar manner, by calculating the volume of water required to dilute the reported annual quantity of each radionuclide released to equal the maximum effluent concentration stated in federal regulations.


Untreated radioactive wastes were released to Acid/Pueblo Canyon through this pipe from 1945 to 1951.

Toxic Chemicals

Many chemicals have been used at LANL since 1943; the project team was able to identify nearly 100 of them. These toxic materials were used in explosives, as solvents, in water treatment, and for chemical analyses, among other uses. Prior to the 1970s, chemical use and their ultimate fate and transport in the environment were poorly tracked and documented compared to radionuclides.

To prioritize toxic chemicals, the project team used data from chemical inventories and LANL documents. This information described the chemicals used, why they were used, and provided rough estimates of quantities used. The ranking scheme for these toxic chemicals had three primary features:

1. estimates of the quantity of each chemical used annually at LANL;
2. toxicity values, such as factors that determine the likelihood of developing cancer. These are often called "cancer potency factors" or "cancer slope factors"; and
3. estimates of lifetime exposure to a chemical likely to be without appreciable health risk, called the "reference dose." The lower the reference dose, the more toxic the chemical. The U.S. Environmental Protection Agency publishes reference doses for many chemicals.

The project team ranked each chemical that causes cancer by multiplying its estimated annual usage by the chemical's cancer potency factor.

In this DP West Site solutions preparation room, chemicals were mixed in large vats and fed by gravity to operations below.

The team ranked each chemical known to cause health effects other than cancer by dividing its estimated annual usage by its reference dose.

As an example of this method, consider two chemicals used in the same amounts each year. The chemical that is more toxic (that is, it has the lower reference dose) would be ranked higher than the other.

What materials appear to have been most significant in terms of potential off-site exposures?

The LAHDRA team found that the materials listed in Table 1 warrant highest priority for radionuclides and toxic chemicals.

Table 1: Ranking of Highest Priority Materials

Airborne Radionuclides	Waterborne Radionuclides	Chemicals
Plutonium	Plutonium	Trichloroethylene ("TCE")
Uranium	Strontium-90	Uranium (as a heavy metal)
Mixed Activation Products		2,4,6-trinitrotoluene ("TNT")
Radioactive Lanthanum		Tetrachloroethylene ("PERC")
Mixed Fission Products		Carbon tetrachloride

Mixed activation products are radionuclides that are most often produced by the exposure of air and other materials to radiation in or near reactors and large accelerators. These products commonly decay quite quickly, with half-lives often less than 30 minutes.

Mixed fission products are radionuclides such as cesium-137 and strontium-90 that are formed in the fission process in nuclear reactors and atomic weapon detonations. Table 2 presents brief summaries of how some of the key materials used at LANL can affect the human body.

D-Building in the original Technical Area was the first facility in the world in which plutonium was processed in visible quantities and used to make atomic weapon parts.

Table 2: How can the materials that were released affect the human body?

Materials of Concern	Potential Health Effects
Radionuclides – All radionuclides emit radiation. Radiation exposure can increase the chances of experiencing cancer, genetic effects, and/or effects in unborn children.	
Plutonium (Pu-239/240 and Pu-238)	Inhalation is a concern for plutonium because plutonium particles can imbed in the lungs and emit alpha and gamma radiation for many years. When ingested, plutonium enters the bloodstream, and most of it deposits in the liver and skeleton; increased risk of cancer results from irradiation of cells.
Uranium (U-233, U-235, U-238)	For uranium containing over 8% U-235 or that has been irradiated in a reactor, radiation hazard is of primary concern. When uranium is ingested, little is absorbed, and then most is excreted in the urine. Low solubility uranium affects bone most, or the lung when inhaled [See also chemicals].
Tritium (H-3)	Tritium in either gaseous or tritiated water (HTO) form penetrates the skin, lungs, and gastro-intestinal tract. Tritium gas is not significantly absorbed into the body. As HTO, tritium that is breathed or eaten is completely absorbed and is rapidly dispersed throughout the body.
Radioactive Lanthanum (La-140,"RaLa")	La-140 is a source of high-energy gamma radiation. It is most often an external radiation hazard. Impurities that were present in the RaLa used at LANL are important when assessing exposures; they include strontium-90, which has a 29-year half-life. Ingested La-140 delivers the highest doses to the intestines. Inhaled La-140 delivers the highest doses to the large intestines and the lungs.
Iodine (I-131, I-133)	Radioactive iodine can be concentrated in the thyroid gland and cause that tissue to be irradiated. Thyroid cancer can result.
Mixed Activation Products	Activation products are radionuclides that are made by bombarding a stable element with neutrons, protons, or other types of radiation. As with any radionuclide, activation products emit radiation.
Strontium (Sr-90)	Radioactive strontium emits beta radiation. As mentioned, exposure can increase the chances of experiencing cancer, genetic effects, and/or effects in unborn children.
Mixed Fission Products	Also referred to as fission fragments, fission products are the products of a nuclear fission reaction. Fission products are radioactive and usually have a short radioactive decay half-life. As with any radionuclide, fission products emit radiation.
Chemicals	
Beryllium	Inhaling beryllium can cause acute beryllium disease. Some people become sensitive to beryllium, and may develop a reaction in the lungs called chronic beryllium disease (CBD). CBD can occur many years after beryllium exposure, and can cause weakness, fatigue, difficulty breathing, anorexia, weight loss, and possibly heart disease. There are some people who are sensitized to beryllium, and they may not experience any of these symptoms. Prolonged beryllium exposure can increase the risk of lung cancer.
Trichloroethylene ("TCE")	TCE vapors may cause headaches, lung irritation, dizziness, poor coordination, and difficulty concentrating. Breathing it over a prolonged period of time may cause nerve, kidney, and liver damage. Drinking TCE for long periods may cause liver and kidney damage, impair the immune system, and impair fetal development in pregnant women. TCE is a probable human carcinogen.
Uranium (as a heavy metal)	All forms of uranium (natural, depleted, and enriched) have the same chemical effect on the body. Large amounts of uranium can react with the tissues in the body and damage the kidneys. Uranium can decay into other radioactive substances, such as radium, that can cause cancer to people exposed to these substances for a prolonged period of time [See also radionuclides].
2,4,6-trinitrotoluene ("TNT")	Workers who breathed high levels of TNT experienced low red blood cell counts and abnormal liver function. Spleen enlargement and other immune system effects have also been seen in animals that ate or breathed TNT. Skin irritation can occur after prolonged skin contact, and cataracts can develop after exposure for a year or more. TNT is a possible human carcinogen.
Tetrachloroethylene ("PERC")	Effects of low levels of PERC in air or water are not well known. High exposures can cause dizziness, headache, sleepiness, confusion, nausea, difficulty speaking and walking, unconsciousness, and death. High exposures have caused liver and kidney damage in animals, and could be toxic to the unborn. PERC is thought to be a carcinogen.
Chloroform	Breathing air, eating food, or drinking water containing high levels of chloroform may damage the liver and kidneys. It is unknown whether chloroform causes reproductive effects or birth defects in people, but these effects have been seen in animals. Chloroform is thought to cause cancer.
Carbon tetrachloride	Inhalation or ingestion can cause liver, kidney, and nervous system damage. Kidney damage can lead to a buildup of wastes in the blood. The liver and kidneys can often mend after low, brief exposure. Effects are more severe in people who drink large amounts of alcohol. The USEPA has determined that carbon tetrachloride is a probable human carcinogen.

Information about potential health effects for these and other materials can be found at: http://www.atsdr.cdc.gov/toxfaqs/index.asp

What characteristics of operations and life in Los Alamos are important when assessing public exposures?

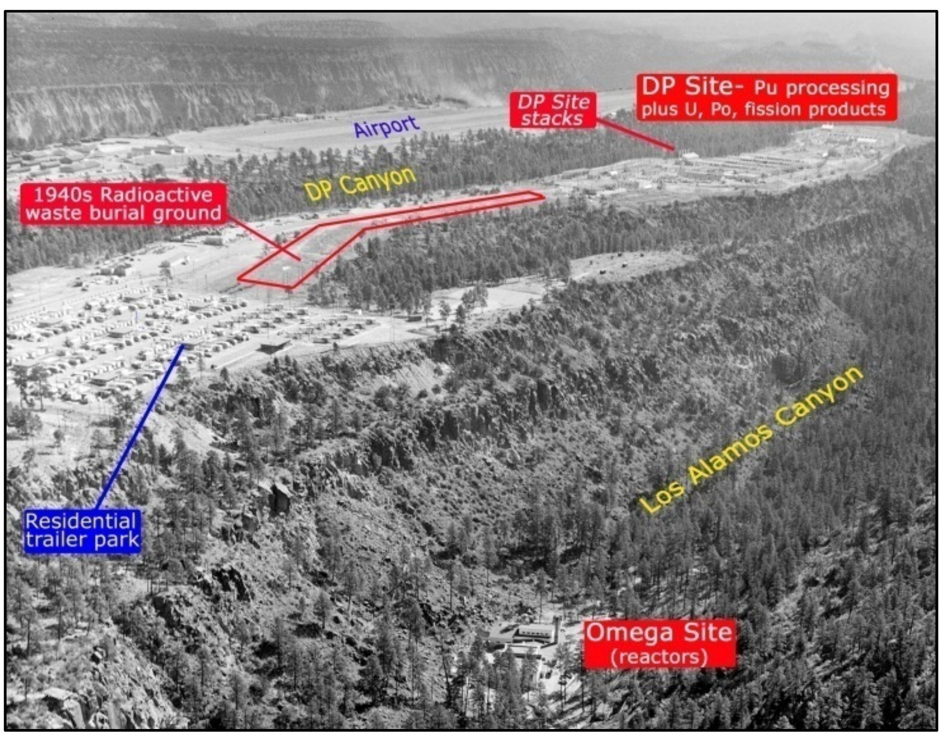
From the beginning, residential areas at Los Alamos were built unusually close to key operational areas. The Sundt apartments, for example, are directly across the street from the original Technical Area, and a trailer park is located along DP Road, just west of the DP West plutonium facility. This trailer park was located right next to a radioactive waste burial ground, and also directly above the Omega Site reactors in Los Alamos Canyon. Today we wonder why key facilities at LANL were placed so close to residential areas. Such decisions were likely influenced by a mindset often voiced by Lab employees: "LANL has never been a production facility."

Familiar hazards, such as explosive testing, were confined to remote areas north and south of the town. Potential hazards from nuclear reactors were kept in mind when locating Omega Site on the floor of Los Alamos Canyon; the thinking was that the steep canyon walls would offer some protection if a catastrophic failure occurred.

Facilities that involved the more "exotic" materials– such as plutonium and beryllium – were placed among residential areas, apparently out of convenience for the workers in the Technical Area. This practice differed from the other major MED/AEC nuclear facilities; those facilities were often assigned sizable buffer zones, and were located 14 miles or more from the closest residents.

Early facilities for processing plutonium, uranium, and beryllium had no filters or sampling systems on their exhaust systems. As time passed, nuclear material containment and effluent treatment systems were upgraded in the U.S. based on lessons learned at LANL, experience at other sites, and on the expanding knowledge of associated health hazards.

As facilities changed over time, however, LANL was unusually slow in implementing the use of high efficiency particulate air (HEPA) filters on the exhaust systems of plutonium facilities. For this reason, releases of airborne plutonium from the DP West Site in the late 1940s and the 1950s were likely significantly higher than they otherwise would have been.



The trailer park along DP Road was near DP West Site, Omega Site, and a radioactive waste burial ground.

Were there historical releases that the study team believes were particularly important?

Six historical operations particularly caught the LAHDRA team's attention because of potential releases, and the team felt these areas may warrant more detailed study. These areas are briefly described below.

Airborne Plutonium Releases 1943-1959

D-Building in LANL's original Technical Area was the first site in the world in which plutonium was handled in visible quantities, purified, converted to metal, and used to make atomic weapon parts. Starting in 1943, scientists and engineers in D-Building used equipment and procedures that would be considered extremely crude by modern-day standards to process this new and largely unknown element, under demanding schedules and extreme wartime pressures.

D-Building and its roof became highly contaminated, and about 85 rooftop vents released contaminated air without monitoring, and, for the most part, with no filtration.

There are no records or LANL estimates of airborne plutonium releases from D-Building, which no longer served as the main plutonium production facility when DP West Site became operational in late 1945; D-Building, however, remained a significant unmonitored release point until after 1953.

DP West Site facilities included exhaust filters, but they were considerably less effective than modern-day filters, even when all components were functioning. Airborne radioactivity was sampled from four central "Building 12" stacks and analyzed to quantify releases, but not all stacks were sampled over all periods of operation. In its 1979 Final Environmental Impact Statement, LANL reported that 1.2 curies (1.2 Ci) of ^{239}Pu had been released from site activities through 1972.

Based on documents that it reviewed, the LAHDRA team estimated that airborne plutonium releases from DP West central stacks alone between 1948 and 1959 totaled about 17 curies. That estimate does not include contributions from D-Building or from DP West operations before 1948. During those years, LANL was the nation's sole producer of plutonium cores for atomic weapons. That total

DP West Site (later called TA-21) took over main plutonium production operations late in 1945.

does not include any contributions from DP West release points other than the central stacks, from waste disposal operation, from burial ground fires, or from other accidents and incidents.

The DP West Site "Building 12" central exhaust treatment facility and stacks.

Airborne Beryllium Releases

LANL used significant quantities of beryllium before the health hazards of this material were fully understood. Soon after Site Y became operational, beryllium oxide powder was hot pressed to make components for the "Water Boiler" reactor that was built in Los Alamos Canyon late in 1943.

Beryllium was first machined in a shop located in V Building in the original Technical Area. In 1953, operations moved to new shops located at Technical Area 3 (TA-3) on South Mesa. The beryllium shops had no exhaust filters at first, crude filters starting in 1948, and high efficiency filters starting in 1964.

Beryllium was also used in explosive testing at the Lab. LANL personnel have estimated that about 2,700 pounds of beryllium were expended in this testing through 1997, peaking at over 220 pounds used in 1964.

In an annex to B-Building in the original Technical Area, just across the street from residential apartments, an anti-aircraft cannon was used to test scaled-down versions of atomic weapon components. That testing was an unmonitored release point for beryllium and polonium.

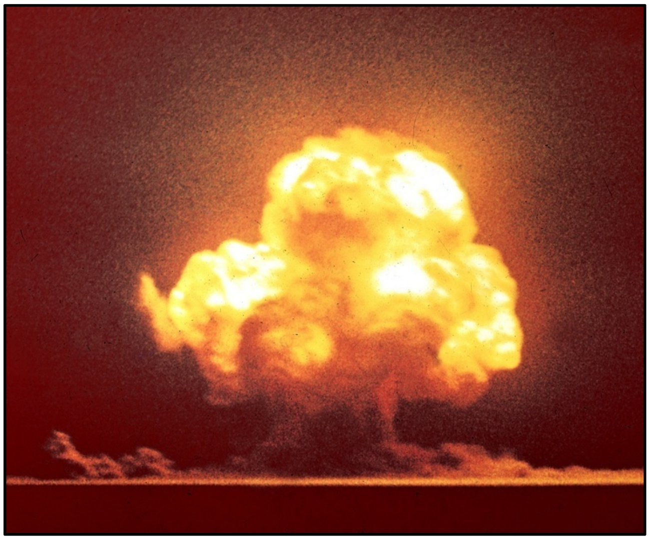
The Trinity Test

The Trinity test was the world's first atomic bomb test. It was conducted on July 16, 1945 at a site near Socorro in south-central New Mexico. The implosion-style device designed and built at LANL contained about 13 pounds of plutonium. Because the device was detonated atop a relatively short, 100-foot tower, much sand and soil were drawn into the fireball. The radioactive cloud that was formed dropped radioactive fallout over a large area.

The local terrain and wind patterns caused "hot spots" of deposition in public areas to the northeast of the shot tower that was located at "ground zero." Several ranchers reported that material resembling flour fell to the ground for four to five days after the blast, and residents living as close as 12 miles from ground zero commonly collected rain water from metal roofs into cisterns for drinking.

Pressures to maintain secrecy and avoid legal claims against the Army led to decisions that were not made in later weapon tests. Local residents were not warned before the test, nor informed about potential protective actions that could have been taken. Plans and resources were in place to support evacuation of residents, but no evacuations were conducted.

Machining of beryllium in V-Shop, the "old beryllium shop."



The Trinity blast as photographed by LANL scientist Jack Aeby from a distance of about 10 miles.

A number of field monitoring teams traveled across the countryside downwind of the blast to measure radiation levels in public areas, but some occupied homes were overlooked on the day of the test.

Radiation levels near some homes approached 10,000 times what is currently allowed in public areas. The monitoring teams used instruments that were crude and poorly suited to field use. The teams were unable to measure contamination from about 11 pounds of plutonium that was not consumed in the atomic chain reaction, but was dispersed by the blast.

Evaluations of Trinity fallout published to date have not addressed the internal radiation doses that members of the public received after they breathed contaminated air and consumed contaminated water and food.

Tritium Releases before 1967

Tritium has been used at LANL to "boost" weapons (increase the power obtained from a given amount of fissionable material), and as "fuel" to support fusion in hydrogen bombs. It has also been used in fusion research and accelerator neutron production.

LANL personnel requested tritium from Oak Ridge, Tennessee as early as the spring of 1944. While LANL continued to receive tritium in increasing quantities for use at 10 or more areas of the Lab, the LAHDRA team found no airborne tritium effluent data for years prior to 1967. Between 1967 and 1995, annual airborne tritium releases reported by LANL were never lower than 3,000 Ci, and peaked at 35,600 Ci in 1977. Scattered incident reports located by LAHDRA analysts describe accidental tritium releases that totaled as much as 64,890 Ci in 1965 and 39,000 Ci as early as 1958. These releases were all within the 22-year period of tritium usage, for which official reports of LANL releases include no data for this radionuclide.

Airborne Uranium Releases

Uranium in various forms has been used in a wide variety of applications at LANL. Uranium was used as a fissionable material in atomic weapons, and to make other weapon parts. It was also used in liquid and solid forms as fuel in various nuclear reactors and test devices. Some of these test devices, called critical assemblies, studied nuclear materials near the point where the fission chain reaction starts.

The "Water Boiler" reactor (shown here partially disassembled) used enriched uranium fuel in liquid form and was surrounded in part by beryllium oxide blocks.

Uranium was purified, converted to metal, cast, heat treated, machined, and recovered from wastes in various facilities at LANL. Some Lab facilities produced fuel for reactors operated elsewhere, such as for the Rover nuclear rocket program. Other buildings had special facilities for handling irradiated uranium and plutonium from nuclear reactors.

The LAHDRA team located documents containing release estimates for uranium operations beginning in 1952, and documents indicating quantities of uranium used in explosive testing at LANL as far back as 1949. Before the 1970s, effluent monitoring programs were considerably less developed than they were in the 1970s and beyond.

Airborne Iodine Releases

In 1996, an epidemiologist from the New Mexico Department of Health reported that the thyroid cancer incidence rate in Los Alamos County from 1986 to 1990 was nearly four times the rate for New Mexico as a whole. That elevated rate was found to be statistically significant, but surrounding counties did not show a similar rise. Because it is known that radioactive iodine taken into the body can accumulate in the thyroid gland and increase the risk of thyroid cancer, there was heightened interest in identifying any historical operations at LANL that could have released radioactive iodine to the environment.

It has been shown that a delay, called a "latency period," normally passes between exposure to radiation and diagnosis of the thyroid cancer that results in some cases. With that in mind, some scientists have tried to estimate the period when releases that could have led to the rise in thyroid cancer incidence in Los Alamos County most likely would have occurred. The period between the mid-1960s and late 1970s appears to be a reasonable window of interest for examining potential radioiodine sources.

The LAHDRA team kept the need for that type of information in mind while reviewing historical documents. They collected information pertaining to a number of operations that resulted in radioactive iodine production. These operations included those involving nuclear reactors, accelerators, criticality test devices, and irradiated reactor fuels.

No source of radioiodine emissions stands out at LANL like the "Green Run" releases that occurred at Hanford in 1949, or the radioactive lanthanum production that occurred at the Oak Ridge X-10 Site from 1944 to 1956. The LAHDRA team expanded the project report to include more discussion of recognized sources of radioiodine at LANL and summaries of the information collected that could support an assessment of potential off-site radioiodine releases. It was not possible to develop that portion of the LAHDRA assessment to include the types of preliminary screening that were performed for plutonium, beryllium, and several other materials.

Explosive testing was a source of releases of uranium, beryllium, tritium, TNT, and other materials.

What did the team do to estimate how high public exposures from key operations could have been?

The prioritization steps that the LAHDRA team completed yielded information about how each contaminant ranked in terms of the *relative priority* that it might warrant compared to other contaminants in the same category (that is, airborne radionuclides, waterborne radionuclides, toxic chemicals). So that it could put some of the historical releases of most interest in perspective in more absolute terms (that is, in relationship to doses that could have been received by members of the public), the LAHDRA team received approval from the CDC to perform preliminary, screening-level assessments of potential public exposures for a handful of releases. These releases included airborne releases of plutonium, beryllium, tritium, and uranium.

The preliminary screening performed in each case used methods from the National Council on Radiation Protection and Measurements (NCRP) published in their Report No. 123, *Screening Models for Releases of Radionuclides to the Atmosphere, Surface Water, and Ground.*

Screening Methods

Up to three levels of screening can be performed using the NCRP method. The Level I screening uses some assumptions that ensure that exposures are not underestimated, such as that wind will blow from the release point to the residential area 25% of the time, and that an area will experience 25% of the contaminant concentration from an exhaust vent or stack. Some might call these "conservative" assumptions.

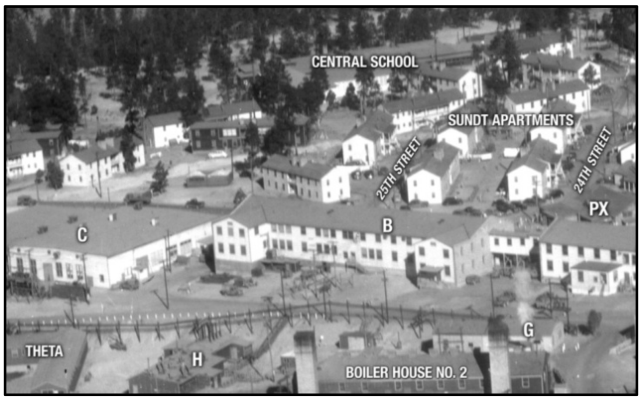
If the results of the Level I screening exceeded a "limiting value," the evaluation proceeded to Level II. Level II screening more realistically represents dispersion between the release point and the residential area, considering factors such as the height of the release point and the size of the source building. The most realistic screening, called Level III, includes more specific analysis of all existing exposure pathways, such as consuming homegrown vegetables.

The trailer park on DP Road and Group 18 housing by the airport were the closest residential areas for preliminary screening of airborne plutonium releases in 1949 and 1959, respectively.

For the preliminary screening performed by the LAHDRA team, the limiting value was set equal to the dose rate that corresponds to a 1 in 100,000 added risk of fatal or non-fatal cancer.

Results of the Preliminary Screening

The results of the preliminary screening evaluations performed for airborne releases of plutonium, beryllium, tritium, and uranium are summarized in Table 3. For more details, please refer to the LAHDRA project final report.



Residential areas (top) immediately across Trinity Drive from Buildings A, B, and C in the original Technical Area (bottom).

What are the possible next steps for investigating off-site releases or health effects from LANL activities?

As the CDC outlined during the January, 2010 meeting held just after the draft final report of the LAHDRA project was issued, potential next steps include:

- Finalize the LAHDRA report and complete the project; or
- Proceed to some form of more detailed dose reconstruction for all releases and locations identified in the report; or
- Proceed to some form of more detailed dose reconstruction for selected releases and locations identified in the report.

The CDC made it clear at the time that there was no funding in place to support any detailed dose reconstruction work for LANL releases. If the CDC decides to recommend that more detailed dose reconstruction be done, it will have to work with the DOE and Congress to determine if such work can be financially supported.

If more detailed dose reconstruction is undertaken for historical releases from LANL operations, it will most likely follow a process similar to the one that the CDC has applied in other nuclear weapon complex site studies. The components of that process are depicted in Table 4. Not all of the steps shown in Table 4 need be performed for a given site, depending on what is learned in the early stages of a project. Some steps might overlap, be combined, or possibly be performed in a different order.

The work performed under the LAHDRA project was almost exclusively information gathering in nature (Step 1 in Table 4), with side activity focusing on identifying off-site releases, prioritizing those releases, and preliminary screening of four materials. Several activities that the team completed approached source term analysis and screening-level assessment of doses, but only in very simple forms, and only for a small number of operations.

If more detailed dose reconstruction is undertaken, source term and transport pathway analyses would be more rigorously and thoroughly developed for the operations of interest. The thousands of documents that the LAHDRA team assembled contain much information that would support those analyses, but such information has not yet been fully "mined" from the document collection and carefully analyzed or evaluated.

Once the relevant sources and transport pathways have been characterized for the releases of interest, screening-level dose assessments would likely be expanded to identify any releases that warrant more detailed investigation in terms of potential off-site health effects.

Table 3: Results of Preliminary Screening Assessments for Airborne Releases Performed under the LAHDRA Project

Material	Source of Releases	Timing	Results	Implications*
Plutonium	DP West Building 12 stacks	1949	Limiting value exceeded by factors of 137 or more at each level of screening.	Releases warrant more detailed evaluation.
	DP West Building 12 stacks	1959	Limiting value exceeded by factors of 335 or more at each level of screening.	Releases warrant more detailed evaluation.
Beryllium	Machining in "old" V Shop	1943-1953	Concentrations exceed USEPA limit.	Releases warrant more detailed evaluation.
	Machining in "new" SM-39 shops	1953-present	No limits exceeded.	Releases do not appear to warrant high priority.
	Cannon testing of weapon initiators	1944	Concentrations exceed OSHA, AEC, USEPA, and National Emission Standard limits.	Releases warrant more detailed evaluation.
	Pressing of beryllium oxide powder	1943	Concentrations exceed USEPA and National Emission Standard limits.	Releases warrant more detailed evaluation.
	Explosive testing at TA-15	1964	Concentrations exceed USEPA limit.	Releases warrant more detailed evaluation.
Tritium	Six Technical Areas with highest releases	1968-1977	Limiting value was not exceeded for any Technical Area releases in 1970.	Releases do not appear to warrant high priority.
Uranium	TA-21 enriched uranium operations	1972	Limiting value exceeded.	Releases warrant more detailed evaluation.
	TA-3 depleted uranium operations	1973	Limiting value exceeded.	Releases warrant more detailed evaluation.

*Implications are limited to results from preliminary screening assessments, which can only be conducted using available data. Data gaps exist for plutonium, tritium, and beryllium (See Chapter 17 of the LAHDRA Technical Report for a more detailed discussion).

Table 4: Components of the process that CDC has used for dose reconstruction at other DOE sites

1	**Retrieval and assessment of data–** *- What do we know about off-site releases?* *- What will available data allow us to do?*
2	**Source term and transport pathway analysis–** *- What materials were released?* *- How much was released?* *- How did release rates vary over time?* *- In what form(s) was the material released?* *- How did the material travel from where it was released to where exposure occurred?*
3	**Screening-level dose assessment–** *- Using relatively simple methods, determine possible magnitude of public doses*
4	**Development of methods for assessing environmental doses–** *- More realistically represent how a material was released, traveled through the environment, and caused public exposure*
5	**Calculation of environmental exposures, doses, and risks–** *- To how much of the contaminant were people exposed?* *- How much dose did their bodies receive?* *- What are the risks that added cancer or non-cancer health effects will occur?*

One element that could reasonably be included in those assessments would be a more complete analysis of the sets of available environmental monitoring data that have been collected on and near LANL property. While most environmental measurements were performed after 1970, the LAHDRA project was unable to make full use of those data for possibly placing bounds on the potential magnitudes of releases to the environment. The assessments that LAHDRA began, which incorporate using historical soil and human tissue sample analyses, hold considerable promise for evaluating the potential significance of past releases.

In the types of evaluations that would likely be included in more detailed dose reconstruction, assessments are often done in an iterative manner, meaning that calculations start out relatively simple, and elements contributing most to the uncertainty of the results are identified. This process is called "sensitivity analysis." More work is then done to improve the assessments in those critical areas, and refined calculations are made. The process is repeated until the uncertainty of the results either is acceptable or cannot be further reduced.

For off-site releases that warrant more detailed evaluation, methods would be developed (or possibly adapted from those used with success elsewhere) to assess how the materials released were transported to public areas and resulted in exposures to residents. Performing these steps for releases from LANL facilities could be quite challenging due to the complex terrain of the Pajarito Plateau, the close proximity of residential areas, and the intermittent nature of the transport of waterborne materials released into the canyons. That being said, though, much work has been done to apply air dispersion models to complex terrain in general, and in the Los Alamos area specifically.

Based on final dose assessments, results would be translated to estimates of the probability that health effects, such as cancer, will occur. These evaluations would consider the latest information available concerning dose-response relationships in exposed populations, as well as factors often found to be important, such as gender and age at an individual's time of exposure to the contaminant of interest.

Based on the number of people estimated to have been exposed to contaminants of interest, and on estimates of how much health effect risks might increase, health professionals would be better equipped with the information needed to judge if epidemiologic studies of any populations are warranted.

As a potential alternative or companion to proceeding with more detailed dose reconstruction, any information that is gained regarding potential public exposures could also guide community health monitoring initiatives that could include additional monitoring for expected health effects. Others have advocated initiating epidemiologic investigations soon, based on what is known now, without first conducting more detailed dose reconstruction.

Discussions at LAHDRA public meetings have included proponents of more detailed dose reconstruction and proponents of expanded community health initiatives. Because any resources made available to further study potential health effects from LANL operations would certainly be limited, the challenge would be to choose the most appropriate method, or an optimal combination of methods, for any follow-up work.