6. Watershed Monitoring

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A. INTRODUCTION

Los Alamos National Laboratory (LANL or the Laboratory) monitors the quality of surface water, including storm water, and stream sediment in northern New Mexico to evaluate the potential environmental effects of Laboratory operations on affected watersheds. The Laboratory analyzes samples for a variety of parameters, including radionuclides, inorganic and organic chemicals, and general chemistry of surface water. In this chapter, the effects of Laboratory operations on surface water and stream sediment are evaluated geographically and over time. Additionally, the sampling results are compared with criteria established to protect human health and the aquatic environment.

Surface water monitoring and assessments at the Laboratory increased substantially after 2005 following agreements with federal and state regulatory agencies that require widespread monitoring of both perennial and ephemeral stream flows for an extensive list of constituents. As a result, increased sampling of base flow has resulted from the Compliance Order on Consent (the Consent Order) with the New Mexico Environment Department (NMED), discussed in Chapter 2. Additionally, increased sampling of storm water and snowmelt runoff has resulted from the Federal Facility Compliance Agreement (FFCA) and Administrative Order with the US Environmental Protection Agency (EPA) (EPA 2005a, b). In 2007, surface water sampling was conducted at over 160 different locations, yielding a substantial amount of water quality data.

B. HYDROLOGIC SETTING

The Laboratory includes parts or all of seven primary watersheds that drain directly into the Rio Grande, each defined by a master canyon (Figure 6-1). Listed from north to south, the master canyons for these watersheds are Los Alamos, Sandia, Mortandad, Pajarito, Water, Ancho, and Chaquehui Canyons. Each of these canyons includes tributary canyons of various sizes. Three of the primary watersheds have their headwaters west of the Laboratory in the eastern Jemez Mountains (the Sierra de los Valles), mostly within the Santa Fe National Forest (Los Alamos, Pajarito, and Water Canyons), and the remainder head on the Pajarito Plateau. Only the Ancho Canyon watershed is entirely located on Laboratory land. Canyons draining Laboratory property are dry for most of the year, and no perennial surface water extends completely across Laboratory land in any canyon. Approximately two miles of canyon on the Laboratory land have naturally perennial streams fed by springs and approximately three miles have perennial streams created by effluent discharges.

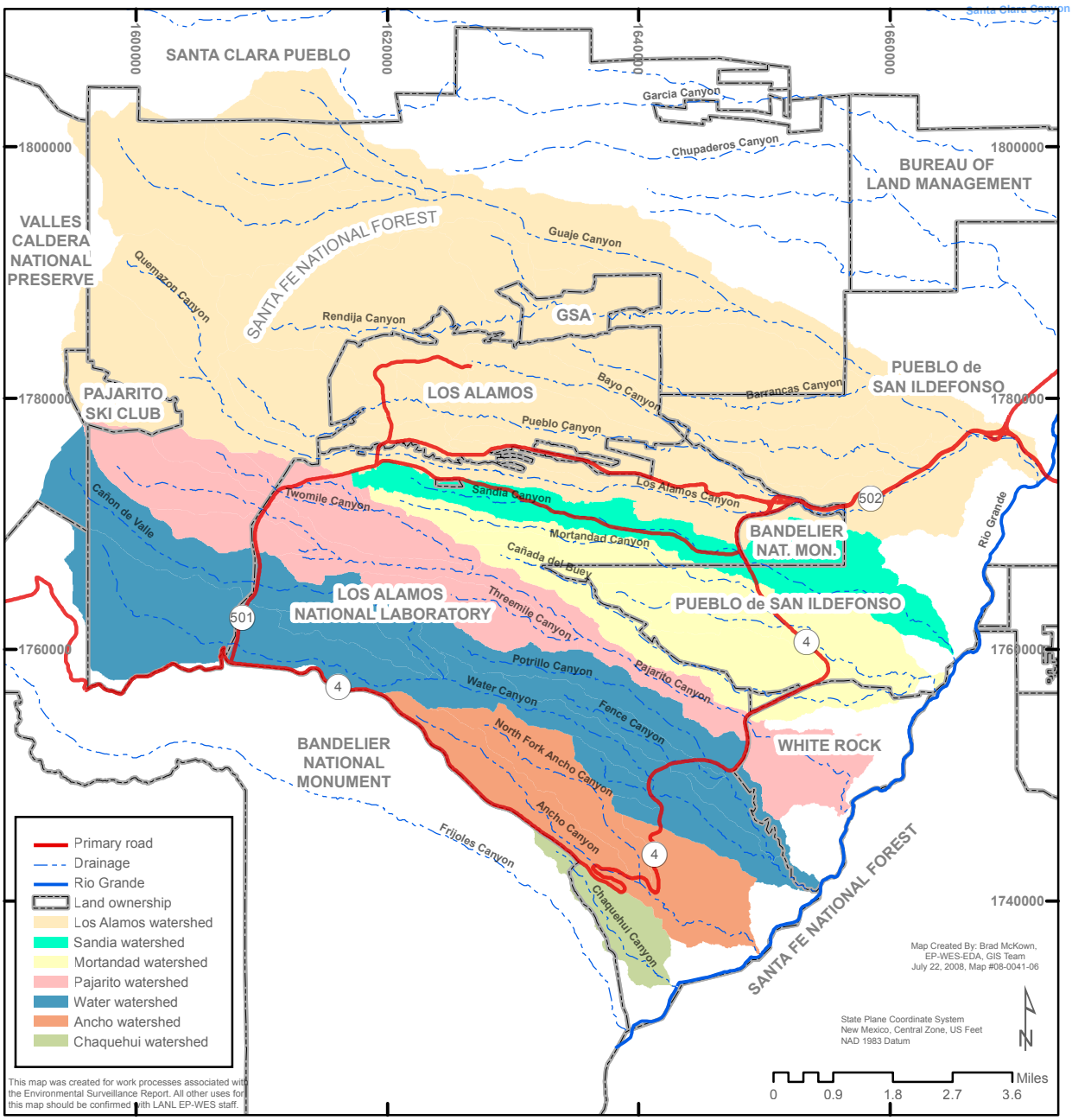


Figure 6-1. Primary watersheds at Los Alamos National Laboratory.

The remaining stream channels are dry for varying lengths of time. The driest segments flow only as runoff from local precipitation or snowmelt, and the stream bed is always above the water table. The flow in these streams is ephemeral. Other streams sometimes have the water table higher than the stream bed and/or experience extensive snowmelt runoff and are considered intermittent. Intermittent streams may flow for several weeks to a year or longer. To aid in water quality interpretation, stream flow is divided into three types. Each of the three flow types might be sampled at a single location within a time span of as little as a week, depending on weather conditions. At times, the flow might represent a combination of several of these flow types.

The three types of stream flow are:

- Base flow—persistent stream flow, but not necessarily perennial water. (This type of flow is generally present for periods of weeks or longer. The water source may be springs, effluent discharge, or alluvial groundwater that emerges along stream beds.)

- Snowmelt runoff—flowing water present because of melting snow. (This type of water may be present for up to a month or more and in some years may not be present at all.)
- Storm water runoff—flowing water present in response to rainfall. (These flow events are generally very short lived, with flows lasting from less than an hour to—rarely—several days.)

Because base flow and snowmelt runoff can be present for extended periods of time, they may be available for potentially longer-term exposures, such as wildlife watering. Storm water runoff may provide a short-term water source for wildlife, particularly when it collects in bedrock pools or other local depressions, although water quality will improve at these locations over time as the suspended sediment settles out. Storm water runoff in particular is capable of transporting Laboratory-derived constituents associated with sediment particles off-site and possibly into the Rio Grande.

None of the streams within the Laboratory boundary average more than one cubic ft per second (cfs) of flow annually. It is unusual for the combined mean daily flow from all LANL canyons to be greater than 10 cfs, although one storm event in late fall of 2007 (November 30 to December 2, 2007) resulted in an estimated combined mean daily runoff from LANL of about 22 cfs on December 1. By comparison, the average daily flow in the Rio Grande at Otowi Bridge during that event was 800 cfs, or approximately 35 times higher. Although most of the streams at LANL are dry throughout the year, occasional floods can redistribute sediment downstream. Stream flow in 2007 on the Pajarito Plateau was dominated by snowmelt runoff from March through May in the larger canyons that head in the Sierra de los Valles, with relatively minor storm water runoff events in the summer and a larger event in late fall. Total runoff measured at downstream gages in the canyons leaving the Laboratory is estimated at about 205 acre-feet (ac-ft), about 91 ac-ft from snowmelt runoff, 70 ac-ft from storm water runoff in the summer, and 44 ac-ft from the late fall event. The volume of storm water runoff in 2007 was the least since the Cerro Grande fire in 2000 and similar to pre-fire runoff volumes. Figure 6-2 shows the estimated storm water runoff at LANL from June through October, and the seasonal precipitation since 1995.

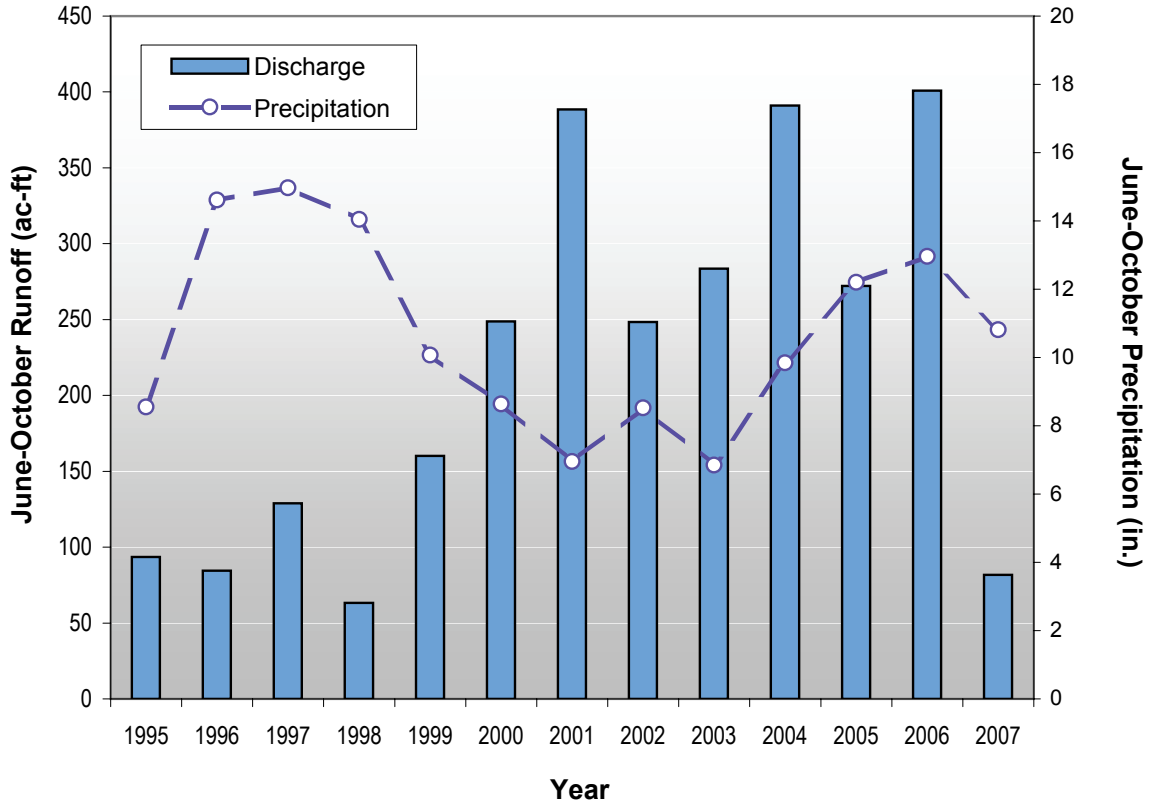


Figure 6-2. Estimated June through October storm water runoff in LANL canyons (Pueblo Canyon to Ancho Canyon) and precipitation at TA-6, 1995-2007.

The snowmelt in 2007 caused continuous stream flow in Los Alamos Canyon, extending from the Jemez Mountains (the Sierra de los Valles), across LANL, and into the Rio Grande for approximately 2.5 months, from mid-March to early June. The estimated total volume of snowmelt runoff measured in Los Alamos Canyon at the Laboratory's eastern boundary was about 91 ac-ft, decreasing to about 29 ac-ft in lower Los Alamos Canyon near the confluence with the Rio Grande. Snowmelt runoff was not recorded in other canyons in 2007 on the eastern Pajarito Plateau.

C. SURFACE WATER AND SEDIMENT SCREENING LEVELS

Table 6-1 summarizes the standards, screening levels, and guides used to evaluate the monitoring data and evaluate potential Laboratory impacts. For brevity, they are all commonly referred to as "screening levels" in this chapter. The surface water screening levels include biota concentration guides (BCGs), water quality standards, maximum contaminant levels (MCLs), risk based screening levels, and water screening action levels (wSALs). The wSALs are established under the FFCA and presented in the Laboratory's annual Storm Water Pollution Prevention Plan (SWPPP; e.g., Veenis et al. 2007). The suite of screening levels for surface water varies, depending on the stream flow conditions and established or potential uses, as discussed further in Section C.1. Results for sediment are compared with background concentrations, human health screening levels, and BCGs. Because some of the criteria are not for current uses, actual impacts can be less than indicated by these comparisons. For example, use of livestock watering standards is required by New Mexico regulations, although there are no livestock at the Laboratory except for some trespassing cows grazing at low elevations near the west bank of the Rio Grande. In addition, comparison of surface water data with groundwater standards and drinking water MCLs is useful as a screening tool to indicate potential impacts to water supply wells, although surface water at the Laboratory is not used as a drinking water supply.

1. New Mexico Surface Water Standards

The New Mexico Water Quality Control Commission (NMWQCC) establishes surface water standards for New Mexico in Standards for Interstate and Intrastate Surface Waters (NMWQCC 2005). Certain watercourses may be 'classified' and have segment-specific designated uses. A designated use may be an attainable or an existing use (e.g., wildlife watering, aquatic life) for the surface water. Nonclassified surface water may be described as ephemeral, intermittent, or perennial, each of which also has corresponding designated uses. The designated uses for surface water are associated with use-specific water quality criteria, including numeric criteria. Some of the standards are for total concentrations and some are for dissolved concentrations; data from non-filtered surface water samples are compared to the former, and data from filtered samples are compared to the latter.

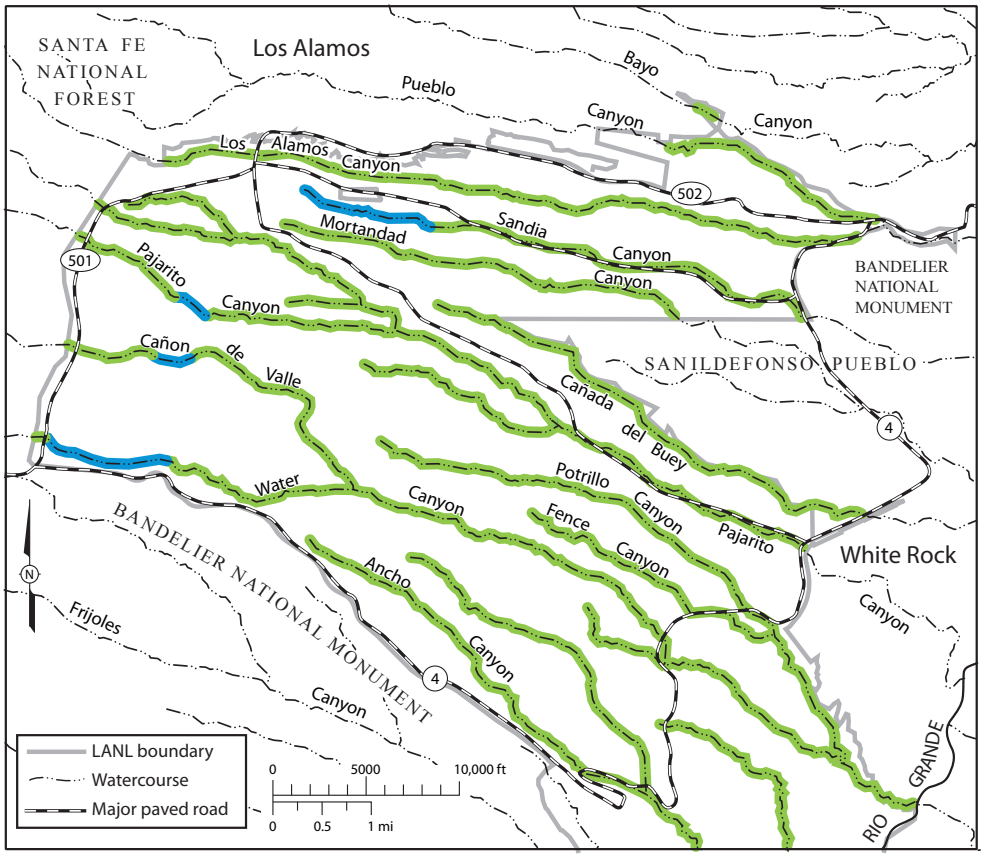
Significant changes were made in the NMWQCC stream standards, effective July 17, 2005. The most significant change, with respect to surface water monitoring at the Laboratory, is the classification of all surface water with segment-specific designated uses within the Laboratory boundary. Four stream segments, with designated uses of coldwater aquatic life, livestock watering, wildlife habitat, and secondary contact, are classified as perennial (Figure 6-3). The remaining stream segments, with designated uses of limited aquatic life, livestock watering, wildlife habitat, and secondary contact, are classified as ephemeral or intermittent.

Table 6-1
Application of Surface Water and Sediment Screening Levels to Monitoring Data

Medium	Standard	Risk- or Dose-Based Screening Level	Reference	Location	Notes
Surface water					
	State gross alpha water quality standard for surface water (NMWQCC, 2005)	Biota concentration guides (BCGs)	DOE (2002)	On-site and off-site	Surface water is generally present sporadically or is not available for long-term access and does not provide persistent drinking water. The actual exposure pathway is to plants and animals, and not to humans. BCGs are based on 1 rad/day exposure limit for aquatic animals and terrestrial plants, and 0.1 rad/day for terrestrial animals. Comparison with radionuclide criteria is based on time-weighted average over the year per DOE guidance (DOE 2003) and Section 20.3.4 of New Mexico Administrative Code (NMAC).
Radionuclides and Radioactivity			20.6.4 NMAC	On-site and off-site	Based on the protection of livestock watering for radium-226 + radium-228, tritium, and gross alpha radiation. NMWQCC standards are not specific about exposure frequency or duration; for screening purposes, we compare single sample results with numeric criteria. The gross alpha standard excludes alpha radiation from source, special nuclear, and byproduct material regulated by the Atomic Energy Act.
	State water quality standards for surface water	Water screening action levels (wSALs)	20.6.4 NMAC FFCA SWPPP	On-site and off-site	Single sample results are compared with screening levels based on water quality standards, risk based standards, and wSALs.
Nonradionuclides					
	State water quality standards for groundwater	EPA drinking water MCLs	20.6.2 NMAC EPA (2007)	On-site and off-site	Single sample result comparisons with groundwater quality criteria and MCLs are used to determine potential for stream flows to impact underlying groundwater bodies.

Table 6-1 (continued)

Medium	Standard	Risk- or Dose-Based Screening Level	Reference	Location	Notes
	None	Human health screening levels	LANL (2005a)	On-site and off-site	Screening levels derived to determine if more detailed assessment is needed to evaluate impacts to the public; comparisons are made for recreational or industrial exposure parameters; based on a dose rate limit of 15 mrem/year (LANL 2005a). Recreational levels are appropriate for Laboratory lands because of public access. There are no residential uses of LANL lands and residential use is impractical at many locations (e.g., active floodplains in canyon bottoms).
Radionuclides		Biota concentration guides	DOE (2002)	On-site and off-site	Dose limit to biota same as for surface water. Individual results compared to BCGs.
		Background	Ryti et al. (1998) or McLin and Lyons (2002)		Results from Pajarito Plateau stations are compared to plateau-specific background levels (Ryti et al. 1998). Results from regional stations are compared to background levels specific to major rivers and reservoirs within the Rio Grande drainage system (McLin and Lyons 2002).
	None	Human health screening levels	NMED, EPA Region 6, or LANL	On-site and off-site	Recreational or industrial screening levels derived to determine if more detailed assessment is needed to evaluate impacts to the public.
Nonradionuclides		Background	Ryti et al. (1998) or McLin and Lyons (2002)		Results from Pajarito Plateau stations are compared to plateau-specific background levels (Ryti et al. 1998). Results from regional stations are compared to background levels specific to major rivers within the Rio Grande drainage system (McLin and Lyons 2002).



Stream Type Designated Uses

Perennial (NM 20.6.4.126): Coldwater Aquatic Life, Livestock Watering, Wildlife Habitat, Secondary Contact

Ephemeral and Intermittent (20.6.4.128): Limited Aquatic Life, Livestock Watering, Wildlife Habitat, Secondary Contact

Perennial

Ephemeral and Intermittent

Figure 6-3. Designated stream segments and uses at Los Alamos National Laboratory.

The surface water within the Laboratory is not a source of municipal, industrial, or irrigation water, though wildlife does use the water. While direct use of the surface water is minimal within the Laboratory, stream flow may extend beyond the LANL boundary where the potential is greater for more direct use of the water. Stream flows sometimes extend onto Pueblo de San Ildefonso land, particularly flows in Pueblo Canyon derived from treated sanitary effluent discharged from the Los Alamos County Wastewater Treatment Plant (WWTP). Spring water may be used traditionally and ceremonially by Pueblo de San Ildefonso members, and may include ingestion or direct contact.

2. Radionuclides in Surface Water

US Department of Energy (DOE) Order 5400.5 prescribes total dose limits associated with exposure to radionuclides in environmental media. Because of the limited extent of stream flow, there are no drinking water systems on the Pajarito Plateau that rely on surface water supplies. The emphasis of the radiological assessment of surface water is, therefore, on potential exposures to aquatic organisms and terrestrial plants and animals, rather than to humans. For protection of biota, concentrations of radionuclides in surface water are compared with the DOE BCGs (DOE 2002), with site-specific modifications by McNaughton (2005). For screening purposes, single sample results are first compared with BCGs to identify if radionuclides at a location pose a

potential risk to biota. Following DOE guidance (DOE 2003), final evaluations of potential risk at these locations use annual time-weighted radionuclide content of the water rather than individual sample results. Surface water analytical results for gross alpha radiation, radium isotopes, and tritium are also compared with the NMWQCC water quality standard for protection of livestock watering use, which is a designated use for surface water within the Laboratory boundary (NMWQCC 2005). NMWQCC standards are not specific about exposure frequency or duration. Therefore, for screening purposes, single sample results are compared with numeric criteria for these analytes, as discussed in Section C.3. It should be noted that the gross alpha standard does not apply to source, special nuclear, or byproduct material regulated under the Atomic Energy Act, and the gross alpha radiation data discussed in this chapter were not adjusted to remove these sources of radioactivity.

3. Nonradioactive Constituents in Surface Water

Surface water concentrations of nonradioactive constituents are compared with screening levels that correspond to the designated uses for the stream, as discussed in Section C.1. Hardness-dependent aquatic life numeric criteria from NMWQCC (2005) are calculated using a water hardness value of 100 mg $CaCO_3$/L (EPA 2006). For evaluating the potential impact of chronic exposure to surface water constituents on aquatic life in perennial stream segments, the Laboratory uses the protocol employed by NMED for assessing standards attainment in New Mexico (NMED 2006a). For designated perennial stream segments, single sample results are compared with the chronic screening level which is 1.5 times the chronic aquatic life criterion (NMWQCC 2005).

Surface water results are also compared with the NMWQCC groundwater standards for screening purposes to evaluate the potential for stream flows to impact underlying groundwater bodies (NMWQCC 2002). Similarly, for screening purposes results are also compared with EPA MCLs for drinking water or tap water screening levels (EPA 2007) for analytes without an MCL, although surface water at the Laboratory is not a source of drinking water. For comparisons with MCLs or tap water screening levels, data from filtered surface water samples are used because contaminants adsorbed to sediment particles would be naturally filtered out as water infiltrates from stream channels to deeper groundwater bodies.

Surface water results are also compared with the NMWQCC groundwater standards for screening purposes to evaluate the potential for stream flows to impact underlying groundwater bodies (NMWQCC 2002). Similarly, for screening purposes results are also compared with EPA MCLs for drinking water or tap water screening levels (EPA 2007) for analytes without an MCL, although surface water at the Laboratory is not a source of drinking water. For comparisons with MCLs or tap water screening levels, data from filtered surface water samples are used because contaminants adsorbed to sediment particles would be naturally filtered out as water infiltrates from stream channels to deeper groundwater bodies.

4. Sediment

Sediment analytical results are compared to screening levels to identify concentrations that may require further assessment. The Laboratory's Waste and Environmental Services Division uses screening action levels (SALs) to identify radionuclide concentrations of interest (LANL 2005a). Comparisons with SALs are used to readily distinguish the areas with the most potential concern: concentrations below the SALs are not of concern to public health, whereas concentrations greater than the SALs would trigger more detailed evaluations. Recreation is the dominant use in most canyon bottoms along streams at the Laboratory, and recreational SALS provide the most appropriate comparison to sediment data. Concentrations of nonradioactive compounds in sediment are compared with recreational or industrial soil-screening levels (SSLs) developed by NMED (2006b), EPA Region 6 (EPA 2007), or LANL (2007c). All of these screening levels are protective because they are calculated based on the assumption that humans will be exposed to the chemicals or radionuclides for extended periods of time, which is not the case on LANL property. Sediment data from the Pajarito Plateau are also compared with established plateau-specific background concentrations of metals or radionuclides that are naturally occurring or result from atmospheric fallout (Ryti et al. 1998; McDonald et al. 2003) and sources other than LANL. Data from regional sediment stations are compared to background levels established for the major drainages of the area, the Rio Grande, Rio Chama, and Jemez River (McLin and Lyons 2002; McLin 2004).

D. SAMPLING LOCATIONS AND DATA ANALYSIS METHODS

1. Regional Monitoring Locations

Regional base flow and sediment sampling stations (Figure 6-4) are located in northern New Mexico. Samples from upriver regional stations reflect baseline concentrations and provide a basis for evaluating Laboratory impacts to the Rio Grande drainage system. Regional sediment samples were obtained in 2007 from stations on the Rio Grande, from Abiquiu Reservoir on the Rio Chama, and from Cochiti Reservoir on the Rio Grande. Sampling stations in the Rio Grande drainage system are located up to approximately 37 mi (60 km) upriver of the Laboratory.

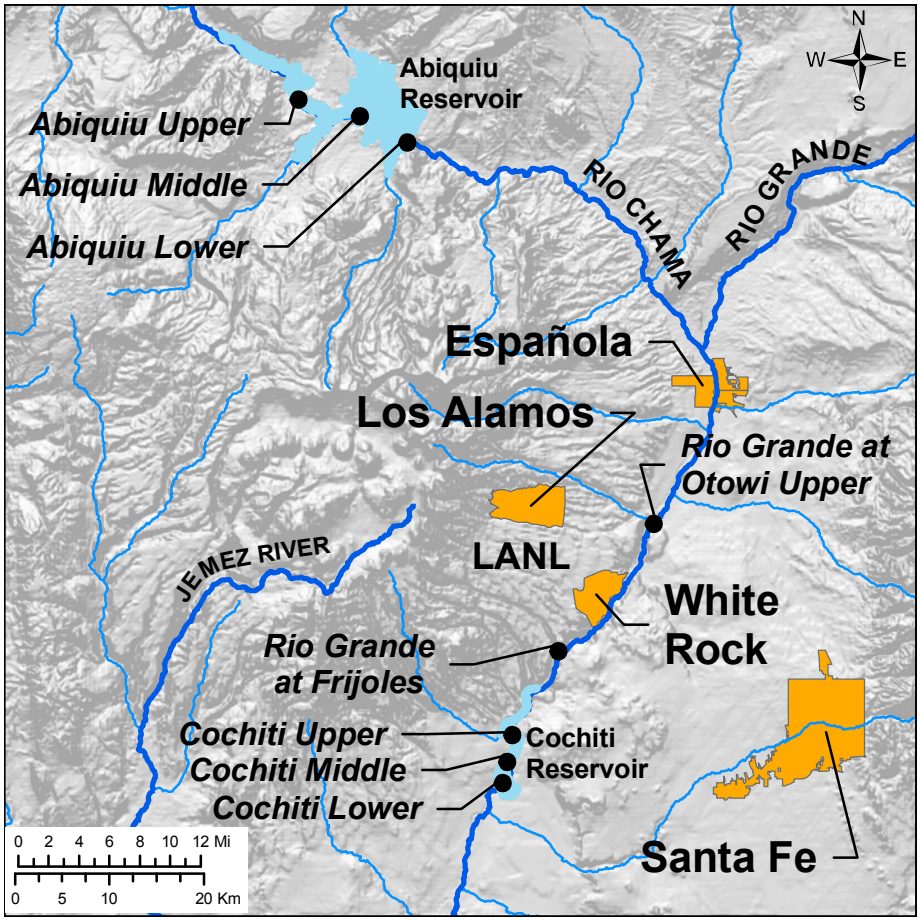


Figure 6-4. Regional base flow and sediment sampling locations.

2. On-Site and Perimeter Monitoring Locations

Surface water and sediment are sampled in all major canyons crossing current or former Laboratory lands. Stream channel sediment is sampled to evaluate the accumulation of potential contaminants in the aquatic environment (DOE 1991). Surface water samples are collected across the Pajarito Plateau within and near the Laboratory, with particular emphasis placed on monitoring downstream of potential Laboratory contaminant sources, such as at the downstream Laboratory boundary. The Laboratory collects base flow grab samples from locations where effluent discharges or natural springs maintain stream flow.

Storm water runoff samples in streams are collected at stream-gaging stations using automated samplers (Figure 6-5). Many gaging stations are located near where drainages cross the Laboratory's boundary or New Mexico State Highway 4 (NM 4). Baseflow, snowmelt runoff, or persistent surface water are also sampled at some gaging stations and at other locations along stream channels (Figure 6-6). Storm water runoff is also sampled at many mesa-top and hillside sites ("site monitoring areas" or "SMAs") which allows the Laboratory to evaluate runoff from specific Laboratory sites (Figure 6-7). The SMAs usually have negligible runoff from other sources, although some receive runoff from paved areas in the Los Alamos town site and may include non-LANL contaminants.

Sediment stations on the Pajarito Plateau and vicinity (Figure 6-8) are located within approximately 2.5 mi (4 km) of the Laboratory's boundary, with the majority located within the Laboratory's boundary. Many of the annual sediment-sampling stations on the Pajarito Plateau are located within canyons to monitor sediment in the active channel related to past and/or present effluent discharges. More extensive evaluations of sediment, both active channel and floodplain sediment deposits, have been completed or are in progress in several canyons (LANL 2004a, 2006c, 2007d, 2007e, 2007f; Reneau et al. 2004), and complement the active channel sampling at these annual sediment stations.

Sediment was also collected in 2007 from short tributary drainages to Cañada del Buey and Pajarito Canyon below Material Disposal Area (MDA) G at Technical Area (TA)-54 (Figure 6-9), which is an active waste storage and disposal area. Sampling stations were established outside its perimeter fence in 1982 to monitor possible transport of radionuclides from the area.

Additionally, surface water and sediment were sampled at several locations on Pueblo de San Ildefonso lands. DOE entered into a Memorandum of Understanding with Pueblo de San Ildefonso and the Bureau of Indian Affairs in 1987 to conduct environmental sampling on pueblo land. The drainages passing from LANL onto pueblo lands are Bayo, Los Alamos, Mortandad, and Sandia Canyons and Cañada del Buey.

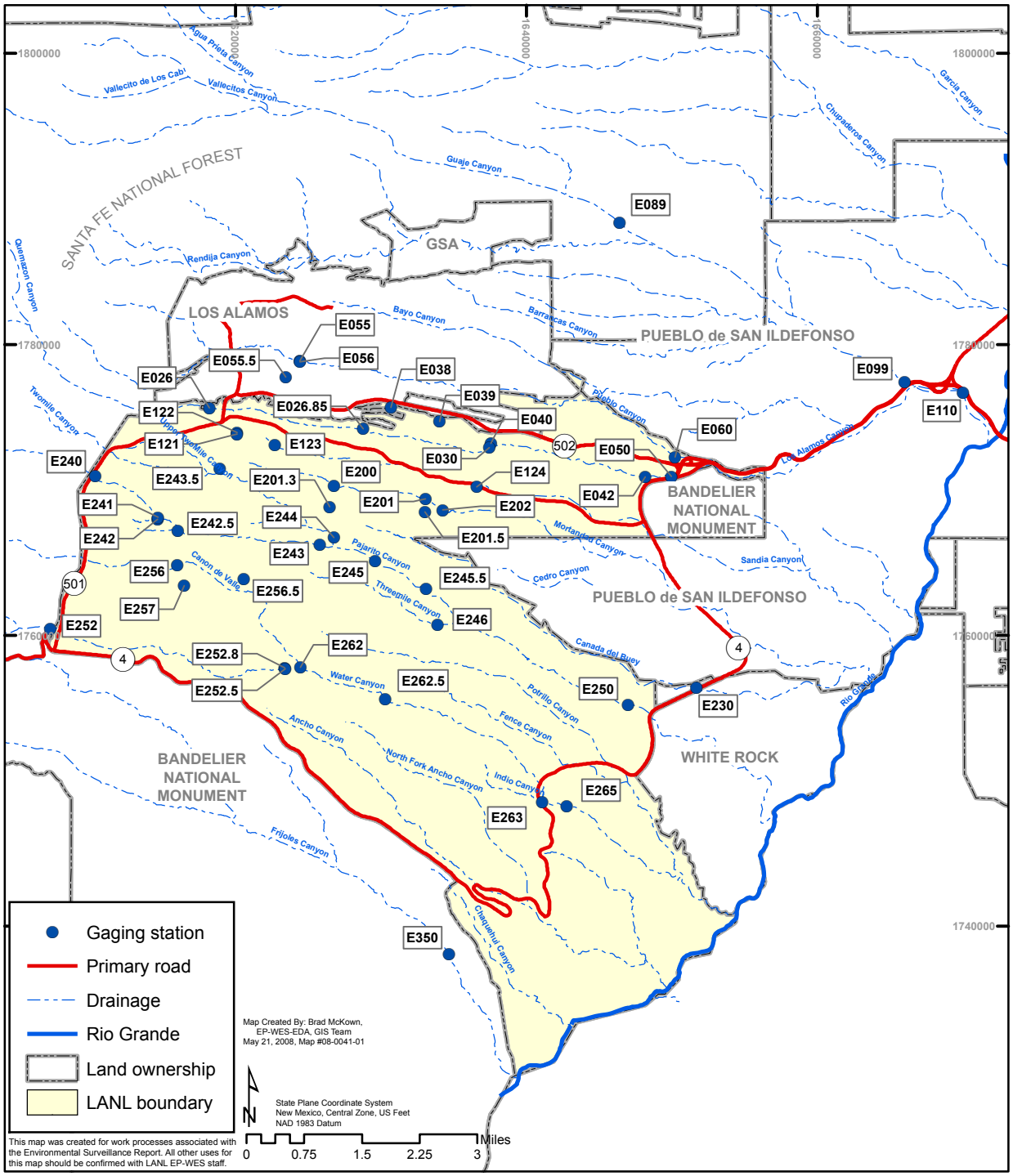


Figure 6-5. Gaging stations sampled in 2007 within and in the vicinity of Los Alamos National Laboratory.

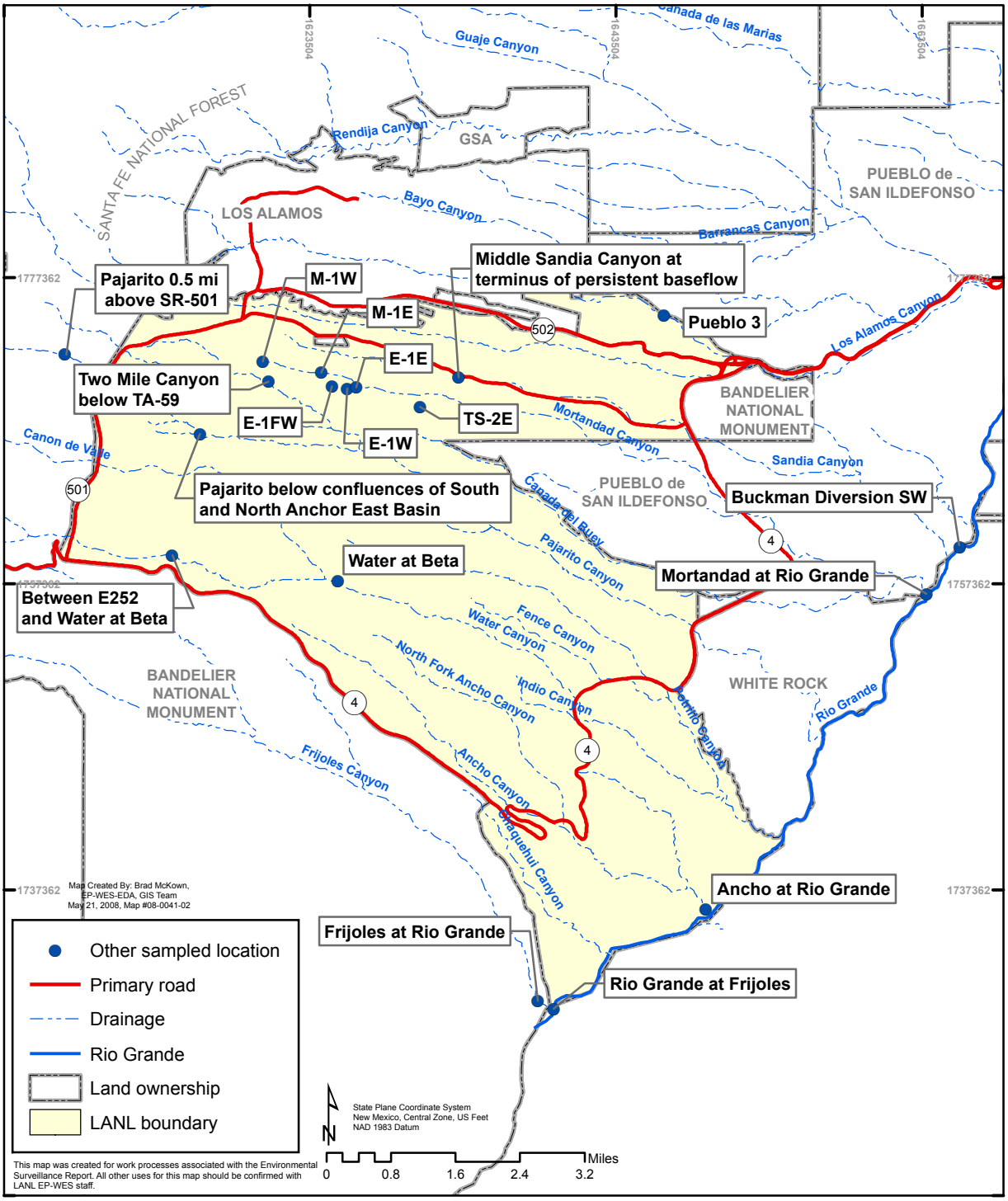


Figure 6-6. Other surface water locations sampled in 2007 within and in the vicinity of Los Alamos National Laboratory.

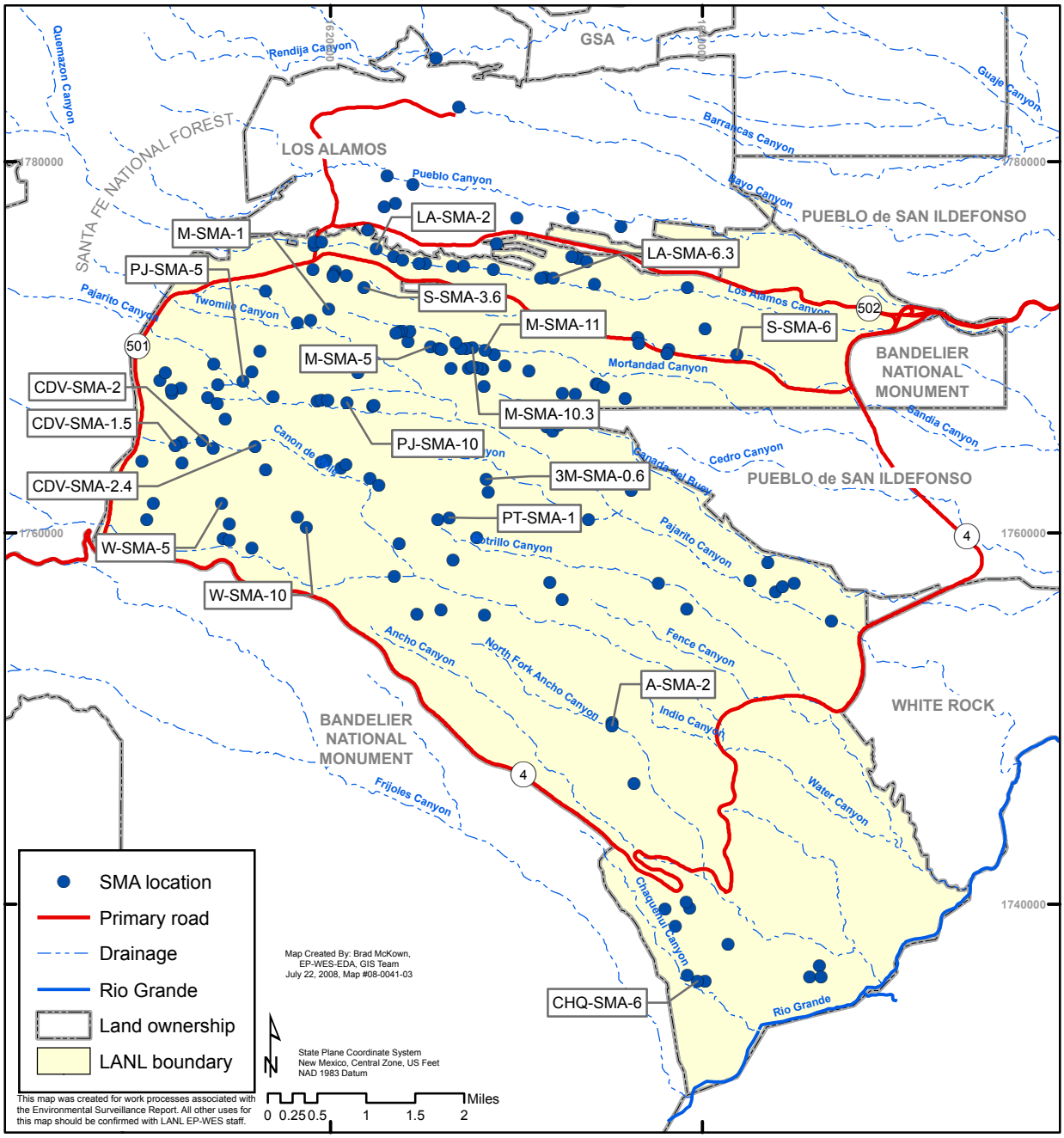


Figure 6-7. Site-specific storm water monitoring stations sampled in 2007 within and in the vicinity of Los Alamos National Laboratory. Labeled stations are referred to in text.

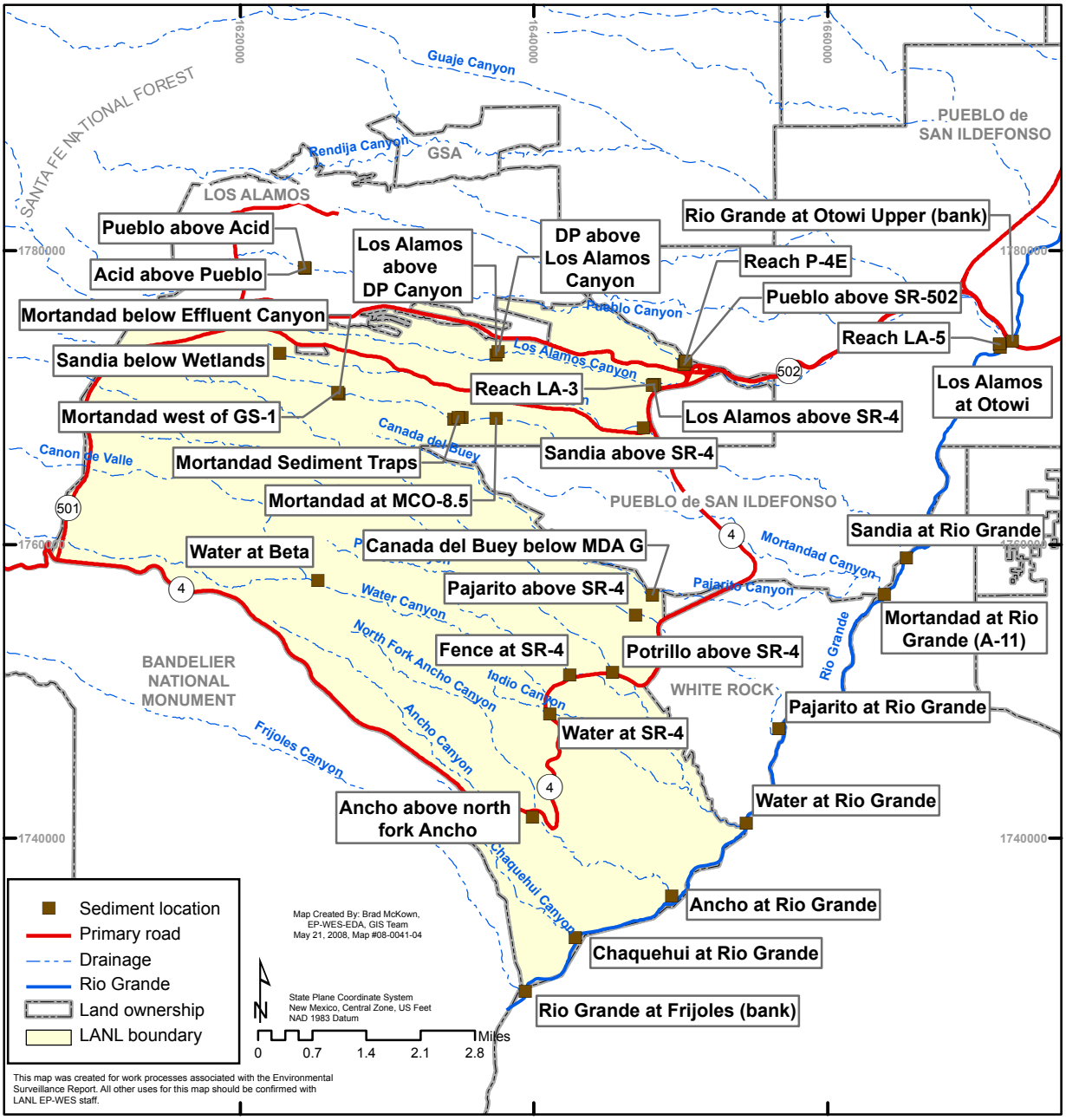


Figure 6-8. Sediment locations sampled in for 2007 within and in the vicinity of Los Alamos National Laboratory. MDA G locations are shown in Figure 6-9.

3. Sampling Procedures

The procedures for sampling depend on the type of stream flow and location. Grab samples of base flow and snowmelt runoff are collected from free-flowing streams near the bank. The grab samples are either filtered or left unfiltered and preserved in the field. The gaging stations, located mostly in canyon bottoms, are equipped with automated samplers that are activated at the start of significant storm water runoff events. Typically, the automated samplers collect water from the first 30 minutes of the runoff event to sample water near the leading edge of flood bores, also called the "first flush." This is the fourth year that the first flush of storm water has been sampled and it is a significant difference from previous years (2003 and before) when samples were collected over a two-hour period. Higher concentrations are expected in the first flush compared to the average concentration during a flow event because suspended sediment concentration is highest near the flood bore (Malmon et al. 2004, 2007). As a result, the post-2003 data are not directly comparable to data from previous years.

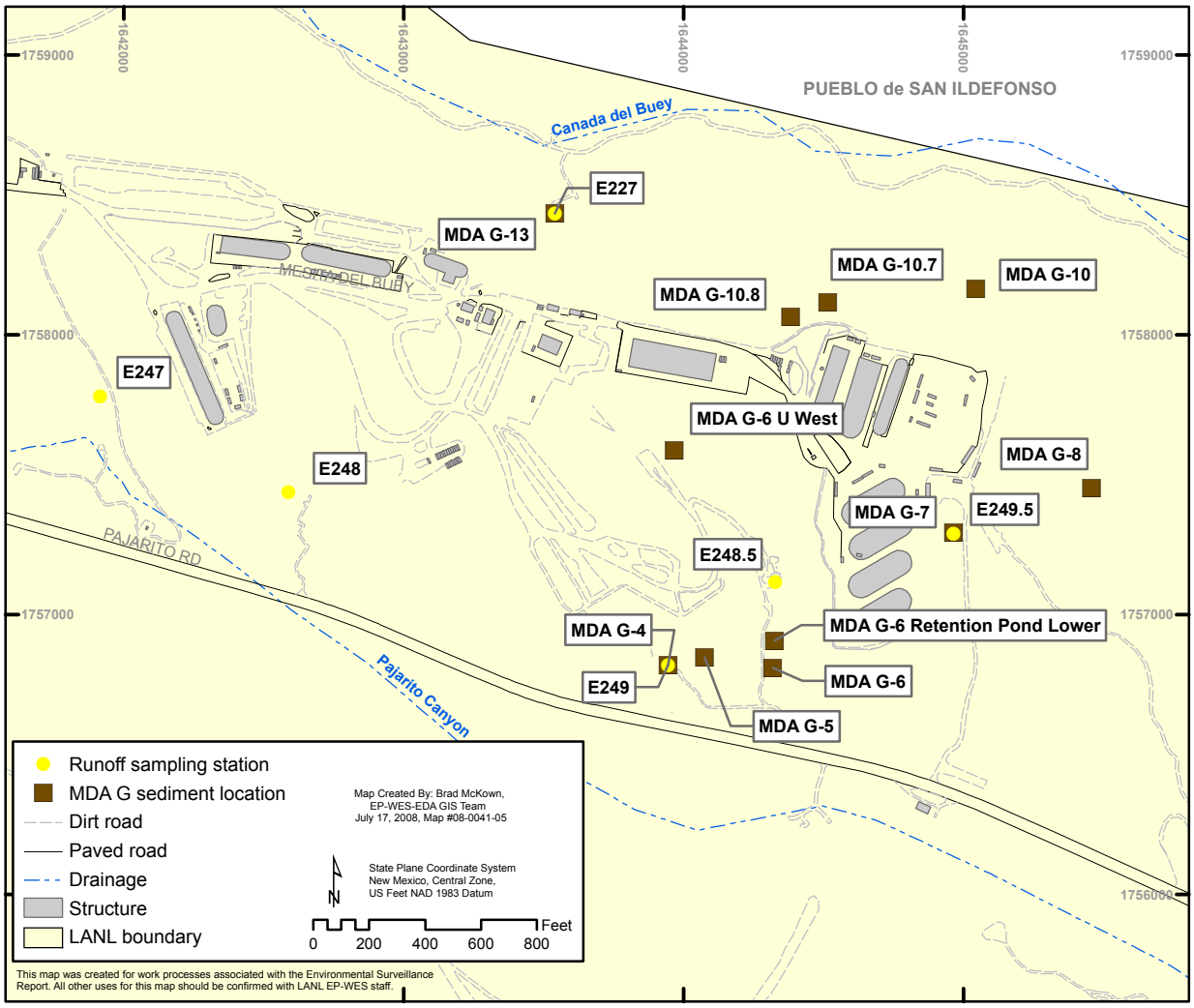


Figure 6-9. Sediment and storm water runoff sampling stations at TA-54, MDA G.

Storm water runoff samples from mesa tops are collected with buried single-stage runoff samplers or automated ISCO samplers at site-specific monitoring areas (SMAs). All storm water samples are filtered and preserved in LANL's storm water operations facility because filtering highly sediment-laden waters in the field is difficult. Samples are then shipped to the commercial analytical laboratory as is, without compositing or splitting.

Sediment samples from dry stream beds are collected across the width of the main channel to a depth of approximately 1 in. (2 cm) For flowing streams, samples are collected from the edge of the main channel. Deposits of fine-grained sediment outside the main channel that resulted from large floods in 2006 were sampled from the sides of shallow hand-dug holes after identifying the base of the 2006 sediment. Sediment samples from reservoirs were collected using a Ponar Grab sampler from a pontoon boat.

E. WATERSHED SAMPLING RESULTS BY CONSTITUENTS

The supplemental data tables on the compact disc included with this report present all the 2007 watershed-related surface water and sediment analytical results. In the tables, radiological results are presented in sequence for each of these media, followed by the results for major water quality analytes, metals, and organic chemicals.

Surface water and sediment samples are analyzed for gross alpha and gross beta radiation and selected radionuclides (americium-241, cesium-137, plutonium-238, plutonium-239/240, strontium-90, uranium-234, uranium-235, uranium-238, tritium, cobalt-60, potassium-40, neptunium-237, radium-226, radium-228, and sodium-22). Table S6-1 lists the results of radiochemical analyses of surface water for 2007. The table also lists the total propagated one-sigma analytical uncertainty and the analysis-specific minimum detectable activity, where available. For most radionuclide measurements, a detection is an analytical result that does not include an analytical laboratory (or in some cases, secondary validation) qualifier codes of X or U (indicating nondetect). Trace-level tritium results for surface water samples are presented in Table S6-2. The results of radiochemical analyses of sediment are presented in Table S6-3.

Concentrations of major chemical constituents in surface water are presented in Table S6-4. Table S6-5 and Table S6-6 present results of metals analyses for surface water and sediment, respectively.

The scope and results of organic chemical analyses are presented in Table S6-7 through Table S6-10. Table S6-7 presents the number and type of organic chemical analyses performed on surface water samples and Table S6-8 presents all detected organic chemical results in surface water. Similarly, Table S6-9 and Table S6-10 present summaries of organic chemical analyses of sediment samples. Table S6-11 presents results of particle size analyses of the sediment samples.

Qualifier codes are shown in some tables to provide additional information on analytical results that are not detections. In some cases, for example, the analyte was found in the laboratory blank, or there were other analytical issues.

The overall quality of most surface water in the Los Alamos area is good, with low levels of dissolved solutes. Of the more than 100 analytes reported in sediment and surface water within the Laboratory, most are at concentrations far below screening levels. However, nearly every major watershed indicates some impact from Laboratory operations, often for just a few analytes. In the following sections, a Laboratory-wide overview of surface water and sediment quality is presented first, and then the key findings are discussed in more detail on a watershed-by-watershed basis. It should be noted that analytical results that are greater than screening levels can be derived from a variety of sources including Laboratory releases, runoff from developed areas such as the Los Alamos town site, naturally occurring radionuclides and chemicals, or "false positives" from analytical laboratories. (Section G of Chapter 5 discusses quality problems that have occurred at analytical laboratories in more detail.) It is not always possible to identify specific sources at present: results greater than standards or screening levels are considered to represent potential Laboratory impacts unless the evidence is compelling for non-LANL sources.

1. Radionuclides in Surface Water and Sediment

a. Surface water

In 2007, concentrations of radionuclides and levels of radiation in surface water and sediment were within ranges measured in recent years. In surface water samples from canyon bottoms, no results for individual radionuclides exceeded DOE BCGs, and annual time-weighted concentrations that consider the combined effects of multiple radionuclides also did not exceed DOE guidelines, as discussed later in this section. For mesa top and hillside storm water monitoring locations (SMAs), two locations had values for uranium isotopes that exceeded BCGs for a storm event on August 6, 2007: PT-SMA-1 in the Potrillo Canyon watershed and

3M-SMA-0.6 in the Threemile Canyon watershed. Maximum results were <5 times greater than BCGs, and because flow is infrequent at these locations, time-weighted averages that consider the extended periods of no flow would also be below BCGs.

Consistent with previous years, most surface water samples in 2007 had gross alpha radiation greater than the NMWQCC surface water standard of 15 pCi/L for livestock watering. Of the 330 non-filtered samples analyzed from the Pajarito Plateau, 57% exceeded 15 pCi/L. However, it has been previously shown that the majority of the alpha radiation in surface water on the plateau is due to the decay of naturally occurring isotopes in sediment and soil from uncontaminated areas carried in storm water runoff, and that Laboratory impacts are relatively small (Gallaher 2007). Naturally occurring alpha emitting radionuclides include isotopes of radium, thorium, and uranium. In addition, as noted previously, no livestock graze at the Laboratory except for some cows trespassing near the Rio Grande.

Figure 6-10 shows the generally a positive correlation between gross alpha radiation and suspended sediment concentration in non-filtered surface water samples collected from streams on the Pajarito Plateau in 2007. Although some samples from canyons that have received discharges of radioactive effluent, such as Mortandad Canyon, have relatively high gross alpha radiation, upstream stations and canyons not receiving radioactive effluent, such as Sandia Canyon, can also have relatively high values. These data support the previous conclusions that gross alpha radiation in suspended sediment is dominated by naturally occurring radionuclides, although some values are probably elevated because of releases from Laboratory sites.

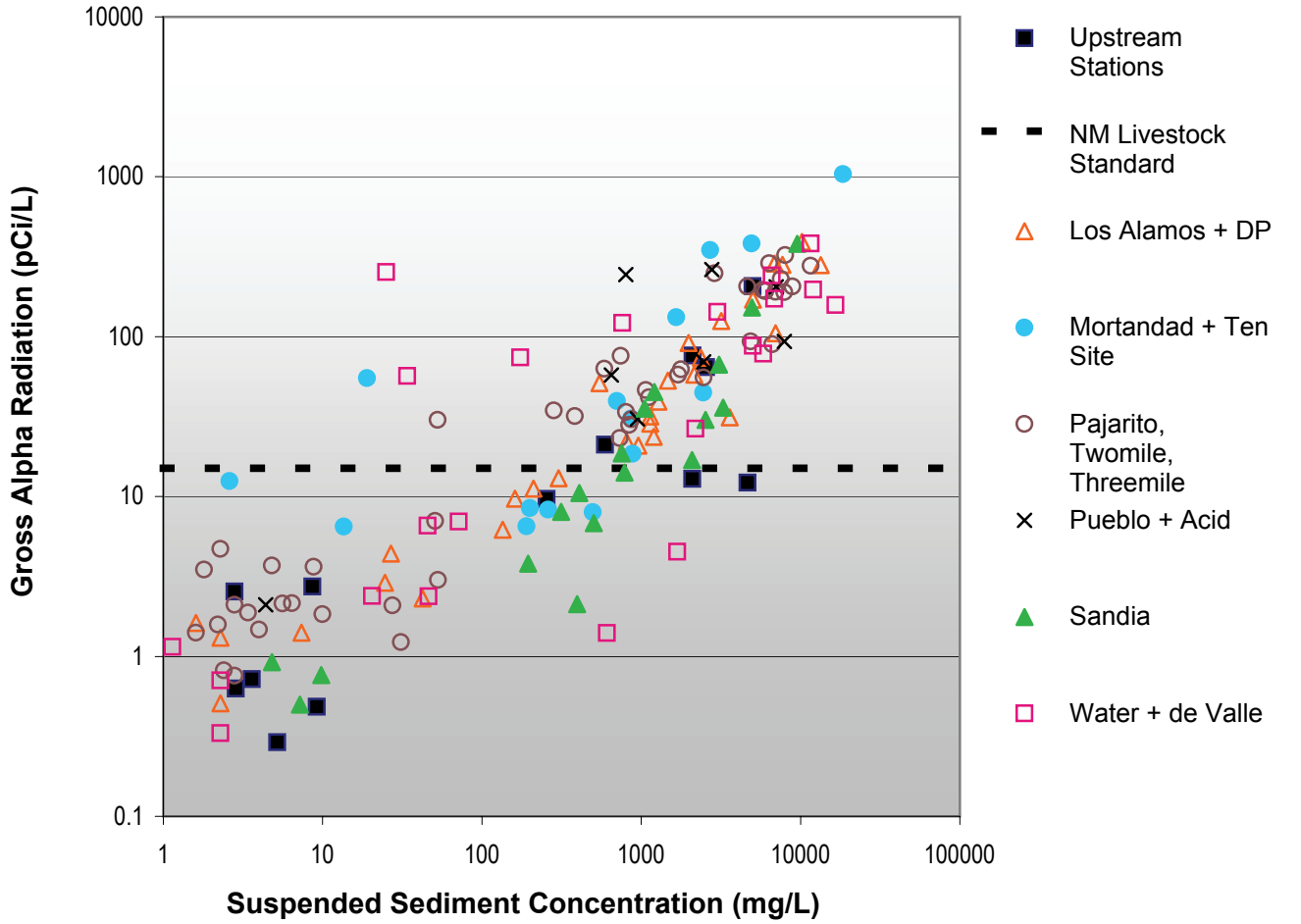


Figure 6-10. Relationship between gross alpha radiation and suspended sediment concentration in surface water samples collected from Pajarito Plateau streams in 2007.

Gross alpha radioactivity is a general screening measurement of limited value in assessing radiological hazards because specific alpha emitters in the water cannot be identified or quantified. Therefore, gross alpha radiation results are not discussed in detail in this report. Instead, this report focuses on specific individual radionuclides identified in LANL waste streams (Watkins and Del Signore 2005) or known to be associated with the nuclear industry (Langmuir 1997).

The highest concentrations of several radionuclides in surface water samples were measured in Mortandad Canyon downstream from the TA-50 Radioactive Liquid Waste Treatment Facility (RLWTF) outfall, including americium-241, cesium-137, plutonium-238, plutonium-239/240, and tritium. These concentrations are below DOE Derived Concentration Guidelines (DCGs) for drinking water, and treated effluent from the RLWTF has always been below the DCGs. The highest concentration of strontium-90 was measured in DP Canyon downstream from a former outfall at TA-21 which also released radioactive effluent. The highest concentrations of uranium-234, uranium-235, and uranium-238 were measured at a SMA location in the Potrillo Canyon watershed associated with a firing site in TA-15 (PT-SMA-1).

Table 6-2 compares the estimated annual average concentrations of specific radionuclides in surface water downstream from past or current radioactive liquid waste discharge locations with the DOE BCGs. In order to compare surface water data with the BCGs, the time-weighted average annual radionuclide concentrations in waters were calculated, focusing on the wetter stream segments. This approach is consistent with DOE guidance (DOE 2003). Time-weighted average concentrations were calculated for the individual radionuclides of primary concern: americium-241, cesium-137, plutonium-238, plutonium-239/240, strontium-90, tritium, uranium-234, uranium-235, and uranium-238. Time-weighted average concentrations were also calculated for the naturally occurring radionuclide radium-226 which can contribute a significant amount of the total dose. Concentrations measured during base flow periods and during storm runoff periods were weighted proportionally after reviewing stream flow records to distinguish the flow regimes; periods with no flow were assigned concentrations of zero.

For waters containing more than one radionuclide, a ratio for each radionuclide was calculated by dividing the concentration of each radionuclide by its particular BCG. To be consistent with DOE Order 5400.5, the sum of the ratios should not exceed 1.0 (DOE 1990). Because the calculations are based on limited sample sets and hydrologic interpretation, these results should be viewed as approximations.

The estimated time-weighted annualized concentrations and sums of ratios for non-filtered surface water in the canyons that have received radioactive effluents were well below the BCGs. Table 6-2 shows the highest concentrations in relation to the BCGs were for radium-226, at 28% of the BCG in lower Pueblo Canyon. Lower Pueblo Canyon also has the highest concentration relative to BCGs for one of the primary radionuclides of concern at LANL, plutonium-239/240, at 11% of the BCG. When the mixtures of isotopes are considered, the largest sum of the ratios was also found in lower Pueblo Canyon at 41% of the BCG.

Although radium-226 measured on the Pajarito Plateau is probably of natural origin, it is of concern because it has the most stringent BCG for all the radionuclides monitored. The BCG was established to protect riparian animals that ingest radium-226 in calcium-deficient waters. However, surface water at Los Alamos is calcium-abundant and the resultant dose from radium-226 is considerably less than calculated as the calcium interferes with the uptake of radium-226.

b. Sediment

In 2007, analytical data on radionuclides in sediment were obtained from 52 samples as part of the annual surveillance program, including 44 samples from the Pajarito Plateau, 2 samples from banks along the Rio Grande, and 6 samples from upriver (Abiquiu) or downriver (Cochiti) reservoirs. The Pajarito Plateau samples included 35 active channel locations that are typically dominated by coarse-grained sediment and 9 locations where fine-grained sediment was deposited from large floods in 2006.

Table 6-2
Comparison of Estimated Annual Average Non-filtered Surface Water Concentrations of Radionuclides in Selected Canyons with DOE Biota Concentration Guides

Radionuclide	BCG[a] (pCi/L)	Acid Canyon above Pueblo Canyon (pCi/L)	Lower Pueblo Canyon (pCi/L)	DP Canyon below TA-21 (pCi/L)	Los Alamos Canyon between DP Canyon and NM 4 (pCi/L)	Los Alamos Canyon at Rio Grande (pCi/L)	Mortandad Canyon below Effluent Canyon (pCi/L)	Maximum percent of BCG
Am-241	400	0.59	0.08	0.4	0.3	0.02	0.9	0.2%
Cs-137[b]	20,000	ND[c]	ND	ND	2	ND	10	0.05%
H-3 (tritium)	300,000,000	17	1.6	23	16	22	853	<0.01%
Pu-238	200	0.04	0.00	0.03	0.03	ND	1.5	0.7%
Pu-239/240	200	5.6	22	0.2	0.6	0.2	2	11%
Sr-90	300	0.5	0.02	35	2	0.08	1.9	12%
U-234	200	1.0	3	2	0.9	1.4	1.0	1%
U-235,236	200	0.06	0.01	0.01	0.05	0.09	0.05	0.1%
U-238	200	0.8	2	2	0.8	1.0	0.9	1%
Ra-226	4	1.0	1.1	ND	ND	ND	0.6	28%
Sum of ratios to BCGs		0.28	0.41	0.14	0.02	0.01	0.19	-

[a] BCG = Biota Concentration Guide (DOE 2002)

[b] The BCG for Cs-137 is a site-specific modified BCG from McNaughton (2005)

[c] ND indicates no analytical laboratory detection in 2007

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

2. Metals in Surface Water and Sediment

a. Surface water

During 2007, analytical data on metals were obtained from 504 surface water sampling events at 169 locations on the Pajarito Plateau, each event consisting of the collection of one or more samples from a specific location. The monitoring included 105 site-specific (mesa top or hillside) sites (SMAs) and 64 canyon bottom sites. These data were compared to screening levels which vary across the Laboratory depending on the designated uses for a particular stream segment, as discussed in Section C.1. Some screening levels are for dissolved constituents, which are compared to filtered sample results, and some are for totals, which are compared to non-filtered sample results. Results for filtered samples were also compared to drinking water and groundwater standards as screening levels because of the possibility for infiltration from streams to impact underlying groundwater. In addition, under the Clean Water Act §303(d) list, the NMWQCC has listed parts of one or more canyons within or near LANL as impaired for nine metals: aluminum, arsenic, cadmium, copper, lead, mercury, selenium, vanadium, and zinc (NMWQCC 2006). The 2007 results for these metals are discussed below, along with other selected metals that have results greater than screening levels or are otherwise of concern at LANL. As mentioned previously in Section C.4, hardness-dependent aquatic life criteria are calculated using a water hardness value of 100 mg $CaCO_3$/L (EPA 2006).

The screening levels for aluminum are based on aluminum dissolved in the water column. In 2007, 33% of filtered surface water samples collected on the Pajarito Plateau contained concentrations of aluminum higher than the screening levels of 750 µg/L for ephemeral or intermittent surface water, although most or all of this aluminum may be naturally occurring. For example, 42% of the filtered surface water samples collected from locations upstream of LANL or in canyons not affected by Laboratory activities also had aluminum >750 µg/L. Other samples from locations with perennial water also exceed the screening levels of 87 µg/L for perennial surface water, including non-LANL affected areas such as Frijoles Canyon in Bandelier National Monument. Aluminum is a natural component of soil and is not known to be derived from Laboratory operations in any significant quantity. In the slightly alkaline waters at Los Alamos, aluminum rarely occurs in solution in natural water at concentrations greater than a few tens to hundreds of micrograms per liter (Hem 1986). Consequently, a large majority of the results greater than the screening levels are probably due to the presence of particulate aluminum (colloids) passing through the filter, rather than aluminum dissolved in the water column.

In 2007, 3% of the filtered surface water samples collected on the Pajarito Plateau contained detected concentrations of arsenic higher than the screening level of 9 µg/L for surface water. These samples are scattered among multiple watersheds (Cañon de Valle and DP, Los Alamos, Pajarito, Potrillo, Pueblo, Sandia, Ten Site, and Threemile Canyons). The highest concentrations and the highest frequency of results >9 µg/L occur in storm water samples from the Ten Site Canyon watershed, associated with samples from near the top of the watershed below MDA C. Downstream surface water sample locations in Ten Site and Mortandad Canyons all had arsenic <9 µg/L in 2007. The source of the arsenic in storm water samples on the Pajarito Plateau is not certain, and may include both natural and anthropogenic sources. For example, prior sediment data have indicated small releases of arsenic from some LANL TAs (LANL 2004a; LANL 2006c), although soils at LANL have high background levels of arsenic (Longmire et al. 1995; Ryti et al. 1998) and most of the arsenic in these watersheds may be naturally occurring. The Laboratory is continuing to evaluate potential sources of arsenic in the affected watersheds.

For cadmium, no filtered surface water sample had a detected result greater than the screening level of 2 µg/L for ephemeral or intermittent streams, and no filtered surface water sample from a designated perennial stream segment had a detected result greater than the applicable screening level of 0.25 µg/L. Although Water Canyon had previously been listed as impaired for cadmium by the NMWQCC, the 2007 surface water data did not indicate any concerns with cadmium in this canyon.

For copper, no filtered surface water sample from a designated perennial stream segment on the Pajarito Plateau had a detected result greater than the applicable screening level of 9.4 µg/L, although 10% of all filtered surface water samples had results greater than the applicable screening level of 14 µg/L for ephemeral and intermittent streams. These results are scattered among multiple watersheds, including Ancho, Chaquehui, DP, Los Alamos, Mortandad, Pajarito, Potrillo, Pueblo, Sandia, Twomile, Threemile, and Water Canyons; Cañada del Buey; and Cañon de Valle. The highest value of 356 µg/L was obtained from a monitoring station near the head of the Potrillo Canyon watershed in TA-15 (PT-SMA-1), and all samples from this station had results for copper greater than 14 µg/L. Flow in this watershed is entirely ephemeral and rarely crosses NM 4, instead infiltrating into the alluvium upcanyon. Copper concentrations greater than 100 µg/L were also measured in the Pajarito, Threemile, Twomile, and Water Canyon watersheds, all at site monitoring stations or in small tributary drainages. Downstream samples from the major stream channels in these canyons all had copper less than 14 µg/L. The sources of copper in these watersheds have not been thoroughly evaluated, but its spatial distribution indicates copper is at least partly derived from firing sites.

For lead, no samples of filtered surface water had concentrations greater than the screening level of 81.7 µg/L for ephemeral and intermittent streams, and no filtered surface water sample from a designated perennial stream segment had a detected result greater than the applicable screening level of 3.2 µg/L. However, two samples of filtered surface water had concentrations greater than the EPA MCL of 15 µg/L for drinking water (screening level), one each from the Threemile Canyon and Water Canyon watersheds, constituting <0.5% of all samples from the Pajarito Plateau. These samples were both from ephemeral storm water at SMA stations (3M-SMA-06 and W-SMA-10), and all other samples from these stations and also from the major stream channels downstream had lead concentrations below the MCL

For mercury, no filtered surface water samples had concentrations greater than the screening level of 0.77 µg/L. However, 4% of the non-filtered samples had detected results greater than 0.77 µg/L. These samples are scattered among multiple watersheds (Acid, Los Alamos, Mortandad, Pajarito, Pueblo, Rendija, Sandia, and Ten Site Canyons). The highest concentrations were in the Sandia Canyon watershed, particularly at the S-SMA-6 monitoring station in TA-72 and along the main stream channel immediately east of the Sandia Canyon wetland (gaging station E123). The highest frequency of detects >0.77 µg/L was in a tributary to Rendija Canyon adjacent to the Guaje Pines Cemetery and below a residential area. Mercury is also above background levels in sediment samples from these areas (LANL 2007d; LANL 2007f). The spatial distribution of mercury in these canyons and other canyons indicates both LANL and non-LANL sources, and the Laboratory is continuing to evaluate potential sources of mercury in the affected watersheds.

For selenium, only two non-filtered surface water samples of the total number of samples from the Pajarito Plateau had detected results greater than the screening level of 5 µg/L, or <0.5%. Both samples were from the Sandia Canyon watershed, from monitoring station S-SMA-6 and from the south fork of Sandia Canyon (gaging station E121). Notably, no canyons at LANL listed as impaired for selenium by the NMWQCC (Cañon de Valle and Los Alamos, Mortandad, Pajarito, Pueblo, and Water Canyons) had any detected results greater than 5 µg/L, indicating that selenium may no longer be of concern in these canyons.

For vanadium, no filtered surface water sample had a detected result greater than the screening level of 100 µg/L. Although Water Canyon had previously been listed as impaired for vanadium by the NMWQCC, the 2007 surface water data did not indicate any concerns with vanadium in this canyon.

For zinc, 2% of the filtered surface water samples collected had detected results greater than the screening level of 120 µg/L. These included locations in the watersheds of DP, Mortandad, Sandia, Twomile, and Water Canyons. The highest concentrations were from a short tributary to Twomile Canyon at TA-3 below large paved areas. Although the main channel of Water Canyon had previously been listed as impaired for zinc by the NMWQCC, the 2007 surface water data did not indicate any concerns with zinc along the main stream in this canyon.

In addition to the metals discussed above, several other metals have some results exceeding screening levels.

For antimony, 5% of the filtered surface water samples from the Pajarito Plateau had concentrations greater than the EPA MCL for drinking water of 6 µg/L. These results were found in several watersheds (Acid, Los Alamos, Mortandad, Pajarito, Sandia, and Twomile Canyons). The highest concentrations were obtained from storm water samples from a short tributary drainage at TA-3 in the Twomile Canyon watershed that receives runoff from a developed area, and the highest frequency of antimony results above the MCL were also from the Twomile Canyon watershed. These samples were all from ephemeral storm water draining TA-3, and all samples downstream along the main Twomile Canyon channel were below the MCL.

For barium, 2% of the filtered surface water samples from the Pajarito Plateau had concentrations greater than the NMWQCC groundwater standard of 1000 µg/L (used as a screening level). All of these results were measured in the Cañon de Valle watershed except one, from a SMA station in the Pajarito Canyon watershed (PJ-SMA-10). Cañon de Valle has been the subject of focused investigations to address barium and HE contamination in surface water and groundwater (LANL 2004b; LANL 2006b), and a corrective measures investigation is planned (LANL 2007a).

For iron, 9% of the filtered surface water samples from the Pajarito Plateau had concentrations greater than the NMWQCC groundwater standard of 1000 µg/L. These results were measured in many watersheds, specifically Acid, DP, Mortandad, Pajarito, Potrillo, Pueblo, Sandia, Ten Site, Threemile, Twomile, and Water Canyons; Cañada del Buey; and Cañon de Valle. Sample locations include site monitoring stations and stream channels in both small and large canyons. Similar to aluminum, the widespread occurrence of elevated iron concentrations suggests that naturally occurring iron dominates these results. The Laboratory is continuing to evaluate the sources of iron in affected watersheds.

For manganese, 14% of the filtered surface water samples from the Pajarito Plateau had concentrations greater than the New Mexico groundwater standard of 200 µg/L. These results were measured in many watersheds, specifically Acid, DP, Mortandad, Los Alamos, Pajarito, Potrillo, Pueblo, Sandia, Threemile, Twomile, and Water Canyons; Cañada del Buey; and Cañon de Valle. Sample locations include site monitoring stations and stream channels in both small and large canyons. As with aluminum and iron, the widespread occurrence of elevated manganese concentrations suggests that naturally occurring manganese dominates these results. The Laboratory is continuing to evaluate the sources of manganese in affected watersheds.

For molybdenum, a single result from filtered storm water at a SMA location in the Mortandad Canyon watershed (M-SMA-1) was greater than the EPA Region 6 tap water screening level of 180 µg/L (EPA 2007), at 268 µg/L, but below the NMWQCC groundwater standard of 1000 µg/L. Three other samples from this SMA and all downstream samples in 2007 were below 180 µg/L. This isolated occurrence indicates that molybdenum is not a significant problem in surface water at LANL.

For silver, 1% of the filtered surface water samples from the Pajarito Plateau had concentrations greater than the screening level of 3.8 µg/L. All of these results were measured from storm water at a site monitoring station in the Cañon de Valle watershed below a former photo-processing facility, CDV-SMA-1.5, indicating localized silver contamination.

One additional metal of concern at LANL is chromium, which is the focus of ongoing investigation because of impacts to groundwater (LANL 2006a; LANL 2007b). Although chromium has been detected at concentrations greater than the EPA MCL for drinking water of 100 µg/L in groundwater beneath the Laboratory, no filtered surface water samples from the Pajarito Plateau in 2007 had chromium results greater than the MCL or the NMWQCC groundwater standard of 50 µg/L.

b. Sediment

During 2007, analytical data on metals in sediment were obtained from 53 samples as part of the annual surveillance program, including 45 samples from the Pajarito Plateau, 2 samples from banks along the Rio Grande, and 6 samples from upriver (Abiquiu) or downriver (Cochiti) reservoirs. The Pajarito Plateau samples included 36 active channel locations typically dominated by coarse-grained sediment and 9 locations where fine-grained sediment was deposited from large floods in 2006.

Twenty metals were detected in sediment at concentrations greater than the LANL background values, although all results are below recreational SSLs. Twelve of the maximum results for these metals were obtained from off-site samples collected from Abiquiu or Cochiti Reservoirs, and differing background conditions along the Rio Grande than on the Pajarito Plateau probably contribute to these elevated values. Five of the maximum concentrations (for barium, copper, lead, manganese, and zinc) were measured in a fine-grained sediment sample from Pajarito Canyon above NM 4. The sediment at this location was primarily deposited in 2000 or 2001 by floods from the Cerro Grande burn area and contains abundant reworked ash, which results in elevated concentrations for many metals (Katzman et al. 2001; LANL 2004a). Two of the maximum concentrations (for antimony and silver) were obtained from small drainages below MDA G at TA-54 within the Pajarito Canyon watershed, although results from samples collected downcanyon along the main stream channel were below the background values. The remaining metal detected above its background value, chromium, had a maximum concentration in upper Sandia Canyon below the wetland. Contaminants in sediment in the Pajarito and Sandia watersheds are currently the subject of more detailed investigations (LANL 2007e; LANL 2007f).

3. Organic Chemicals in Surface Water and Sediment

a. Surface water

During 2007, analytical data for organic chemicals were obtained from 356 surface water sampling events at 126 locations on the Pajarito Plateau, each event consisting of the collection of one or more samples from a specific location. The monitoring included 73 SMAs and 53 canyon bottom sites. The types of organic chemicals analyzed for varied depending on the location and included the following suites: dioxins and furans, explosive compounds, herbicides, pesticides, polychlorinated biphenyls (PCBs), semi-volatile organic compounds (SVOCs), total petroleum hydrocarbons-diesel range organics (TPH-DRO), and volatile organic compounds (VOCs). These data were compared to screening levels which vary across the Laboratory depending on the designated uses for a particular stream segment, as discussed in Section C.1. Results were also compared to drinking water and groundwater standards as screening levels because of the potential for infiltration from streams to impact underlying groundwater. All analyses were on non-filtered samples, and comparisons to drinking water or groundwater standards and screening levels are therefore protective, as concentrations for most analytes in filtered samples would be lower. Under the federal Clean Water Act §303(d) list, the NMWQCC has listed parts of three canyons within LANL as impaired for PCBs in the water column: Los Alamos, Pueblo, and Sandia Canyons (NMWQCC 2006). These organic chemicals are discussed below along with other organic chemicals with results greater than screening levels.

Analyses for dioxins and furans were obtained from 49 non-filtered surface water samples collected at 19 canyon bottom locations on the Pajarito Plateau in 2007. One or more dioxin or furan congeners were detected in 18 samples from 9 locations in Los Alamos, Mortandad, Pajarito, Pueblo, Ten Site, and Twomile Canyons. The highest concentrations were measured at a station in lower Twomile Canyon (gaging station E244), which is downstream of locations where dioxins and furans have previously been detected in sediment samples (LANL 2007e); a former incinerator ash pond at TA-69 is a possible source for these chemicals (LANL 1998). Both detections for hexachlorodibenzodioxins, from two separate sampling events in lower Twomile Canyon, exceeded the EPA drinking water screening level of 1.1×10^{-5} µg/L (EPA 2007). However, all results from downstream stations were non-detects, and some of the dioxin and furan detections may represent false positives from the analytical laboratory, as found in groundwater samples from 2006 (Rogers and Vanden Plas 2007).

Analyses for explosive compounds were obtained from 148 non-filtered storm water samples collected at 60 locations on the Pajarito Plateau in 2007. A total of 15 different explosive compounds were detected, and one of these, RDX ("research department explosive", or hexahydro-1,3,5-trinitro-1,3,5-triazine), had detected results in 10 samples greater than EPA Region 6 tap water screening level of 6.1 µg/L. All RDX results greater than the screening level were collected from the Cañon de Valle watershed, including both SMA stations and the main stream channel. Cañon de Valle is the subject of focused investigations to address barium and HE contamination in surface water and groundwater (LANL 2004b; LANL 2006a), and a corrective measures investigation is planned (LANL 2007a).

Analyses for herbicides were obtained from 22 non-filtered surface water samples collected at 21 canyon bottom locations on the Pajarito Plateau in 2007. No herbicides were detected in these samples.

Analyses for PCBs were obtained from 218 non-filtered surface water samples collected at 77 locations on the Pajarito Plateau in 2007, and 21% of the samples had detected PCBs. The most commonly detected PCBs were Aroclor-1254 and Aroclor-1260, which were detected in 15% and 19% of the samples, respectively. A single detected result was also obtained for Aroclor-1242. All samples with detected PCBs had concentrations above the screening level, including SMAs and canyon bottom locations in the watersheds of Los Alamos, Mortandad, Pajarito, Pueblo, Sandia, Ten Site, and Twomile Canyons. The highest concentrations were measured at SMAs in the Los Alamos, Pueblo, and Sandia Canyon watersheds, and along the stream channel in upper Sandia Canyon. Excavation of PCB-contaminated soil at a former transformer storage area in the Sandia Canyon watershed was conducted in 2001 (LANL 2001a), and an interim measure to address the transport of PCBs in storm water in Los Alamos and Pueblo Canyons was begun in 2008 (LANL 2008).

Analyses for pesticides were obtained from 69 non-filtered surface water samples collected at 35 canyon bottom locations on the Pajarito Plateau in 2007. Pesticides were rarely detected, with only four pesticides detected from four samples at three locations, although three detected results were above screening levels. Both of the detected results for chlordane, from Pueblo Canyon below the Los Alamos County WWTP (Pueblo 3 station), were above the screening level of 0.0081 µg/L. The single detected result for DDT, in lower Effluent Canyon (a tributary to Mortandad Canyon; E1E station), was above the screening level of 0.001 µg/L. However, there were some quality problems with pesticide analyses in water samples in 2007, as discussed in Section G of Chapter 5, and these detected results may in part represent false positives from the analytical laboratory.

Analyses for SVOCs were obtained from 115 non-filtered surface water samples collected at 52 locations on the Pajarito Plateau in 2007. Twenty-two SVOCs were detected in one or more samples from 24 locations. Two SVOCs, benzo(a)anthracene and benzo(b)fluoranthene, each have two results above the EPA Region 6 tap water screening values of 0.92 µg/L, from SMAs in the Pajarito Canyon and Sandia Canyon watersheds. These analytes are commonly detected below urban areas and other developed areas (LANL 2004a). Another SVOC, bis(2-ethylhexyl)phthalate, has three results above the EPA MCL of 6 µg/L. The highest result for bis(2-ethylhexyl)phthalate is from Mortandad Canyon at the Rio Grande, downstream from the community of White Rock and from a stream receiving treated sanitary wastewater from a Los Alamos County WWTP (Cañada del Buey). The second highest result is from a SMA location in the Water Canyon watershed, and the third is from Pueblo Canyon downstream from the other active Los Alamos County WWTP. The sources of the bis(2-ethylhexyl)phthalate are uncertain. All of the SVOCS are infrequently detected at any location, and there were also some quality problems with SVOC analyses in water samples in 2007, as discussed in Section G of Chapter 5, and the detected results may in part represent false positives from the analytical laboratory.

Analyses for TPH-DRO were obtained from 25 non-filtered storm water samples collected at 9 locations on the Pajarito Plateau in 2007. There are no TPH-DRO standards for surface water, but results from three locations are greater than the NMED screening guideline of 1720 µg/L for potable groundwater and below the screening guideline of 30,400 µg/L for inhalation of vapors from shallow groundwater (NMED 2006c). The highest concentration of TPH-DRO was measured at a site monitoring station in upper Sandia Canyon in TA-60 (S-SMA-3.6), and some results from two monitoring stations in the Mortandad Canyon watershed at TA-35 (M-SMA-10.3 and M-SMA-11) were also above the potable groundwater screening guideline. However, there were quality problems with TPH-DRO analyses in water samples in 2007, as discussed in Section G of Chapter 5, and many detected results represent false positives from the analytical laboratory.

Analyses for VOCs were obtained from 53 non-filtered surface water samples collected at 27 canyon bottom locations on the Pajarito Plateau in 2007. Ten VOCs were detected in one or more samples from 22 locations. None of these results exceed standards or screening levels.

b. Sediment

Analytical data on explosive compounds in sediment were obtained from 17 samples in 2007 as part of the annual surveillance program, including 9 samples from active channels on the Pajarito Plateau downgradient from firing sites, 2 samples from banks along the Rio Grande, and 3 samples each from upriver (Abiquiu) and downriver (Cochiti) reservoirs. There were no detected explosive compounds in these samples.

Analytical data on PCBs in sediment were obtained from 42 samples in 2007 as part of the annual surveillance program, including 34 samples from the Pajarito Plateau, 2 samples from banks along the Rio Grande, and 6 samples from Abiquiu and Cochiti Reservoirs. The Pajarito Plateau samples included 25 active channel locations that are typically dominated by coarse-grained sediment and 9 locations where fine-grained sediment was deposited from large floods in 2006. The PCB Aroclor-1242 was detected in 1 sample from the Pajarito Plateau, Aroclor-1254 was detected in 12 samples, and Aroclor-1260 was detected in 19 samples. In addition, Aroclor-1248 was detected in a Rio Grande bank sample near Otowi Bridge, upriver of LANL, and this sample had the highest detected PCB result in the 2007 samples, 0.355 mg/kg. None of the PCB results were greater than recreational or residential screening levels.

On the Pajarito Plateau, PCBs were detected in sediment in the watersheds of Los Alamos, Mortandad, Pajarito, Pueblo, Sandia, and Water Canyons. For total PCBs (the sum of all detected PCBs in each sample), the highest concentrations were measured in Los Alamos Canyon, followed by Pueblo and Mortandad Canyons. The fourth highest concentration was measured in Pueblo Canyon upstream of Acid Canyon, indicating a non-Laboratory source for some of the PCBs.

F. IMPACTS TO THE RIO GRANDE

Potential Laboratory impacts to the Rio Grande were assessed in 2007 by comparing data from sediment samples collected upriver and downriver of LANL. River sediment was collected from the banks of the Rio Grande at the Otowi gage (upriver of LANL) and at the confluence with Frijoles Canyon in Bandelier National Monument (downriver of LANL). Additionally, samples of bottom sediment were collected at three separate locations each in Abiquiu Reservoir (upriver) and in Cochiti Reservoir (downriver). All of these samples were analyzed for the same suite of radionuclides, metals, and organic chemicals.

All measurements of radionuclides in sediments from the Rio Grande and Cochiti Reservoir were orders of magnitude below recreational and residential SALs. In river sediment, no radionuclides were detected above background levels either above or below the Laboratory. Concentrations of one radionuclide from Cochiti Reservoir bottom sediment, plutonium-239/240, were above background levels in two samples. These concentrations were comparable to those measured in previous years after the Cerro Grande fire, slightly elevated above regional background levels resulting from atmospheric fallout (Figure 6-11).

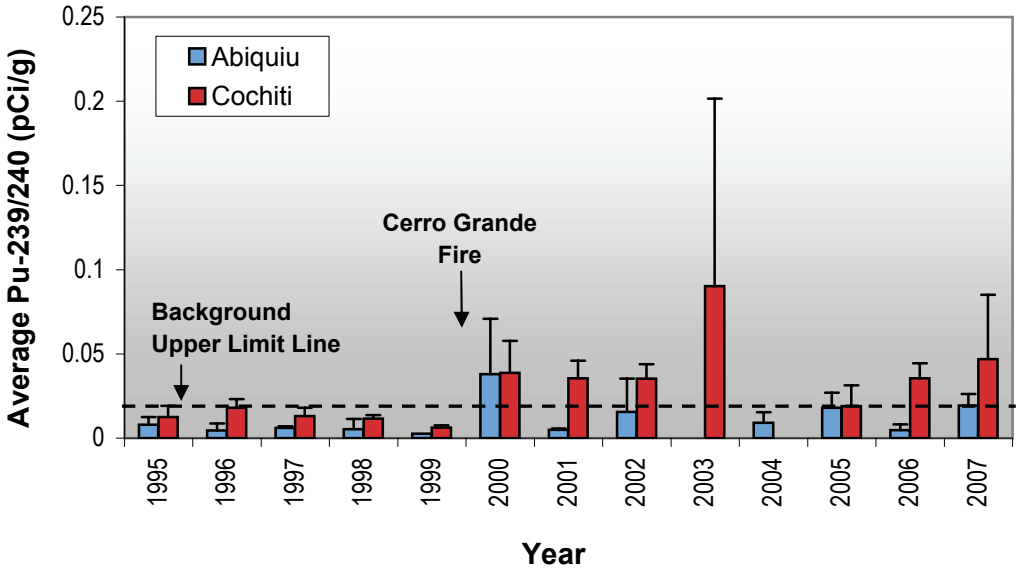


Figure 6-11. Plutonium-239/240 concentration (mean ±1 standard deviation of results from 3 samples) in Abiquiu and Cochiti Reservoir bottom sediment, 1995-2007.

Concentrations of many metals are elevated in Rio Grande and Cochiti Reservoir bottom sediment relative to background levels in Pajarito Plateau sediment, but these may reflect different background conditions along the Rio Grande than on the plateau or upriver sources. For example, in 2007, the highest concentrations were obtained from Cochiti Reservoir for 11 metals (aluminum, arsenic, beryllium, cadmium, cobalt, iron, magnesium, nickel, potassium, selenium, and vanadium), but if the main source was the Pajarito Plateau, then concentrations should instead be higher on the plateau. Some metals that are elevated in Cochiti Reservoir sediments have similar concentrations in Abiquiu Reservoir sediments, indicating that there is no recognizable Laboratory contribution to the Rio Grande (barium, chromium, copper, nickel, and vanadium). The other metals

with concentrations above background levels in both Pajarito Plateau and Cochiti Reservoir sediment samples (lead, manganese, and zinc) have the highest concentration on the plateau in an ash-rich post-fire sediment sample from Pajarito Canyon; concentrations of many metals have been shown to be elevated in ash, not reflecting Laboratory contributions (Katzman et al. 2001; LANL 2004a).

No explosive compounds were detected in sediment samples from the Rio Grande or from Abiquiu or Cochiti Reservoirs in 2007. PCBs were detected only in a single sample from these sites, collected from the banks of the Rio Grande at Otowi, upriver of LANL. These results indicate that there is no recognizable Laboratory contribution to organic chemicals along the Rio Grande.

Natural stream flow and sediment loading in the Rio Grande are quite large compared to Los Alamos area streams. These factors reduce the possibility of identifying significant impacts from the Laboratory in the Rio Grande. A hydrographic comparison of 2007 flows in Los Alamos area canyons to flows in the Rio Grande is shown in Figure 6-12. Daily average flow in the Rio Grande at the Otowi gage ranged from about 400 to 3700 cfs. In contrast, combined flows from all the Los Alamos area canyons exceeded 5 cfs only on December 1, 2007, when the estimated average daily discharge was 22 cfs. Similarly, the average annual budgets of suspended sediment and bed sediment passing the Otowi gaging station has been calculated to be 1,000 and 100 times, respectively, more than those contributed by Los Alamos Canyon (Graf 1994).

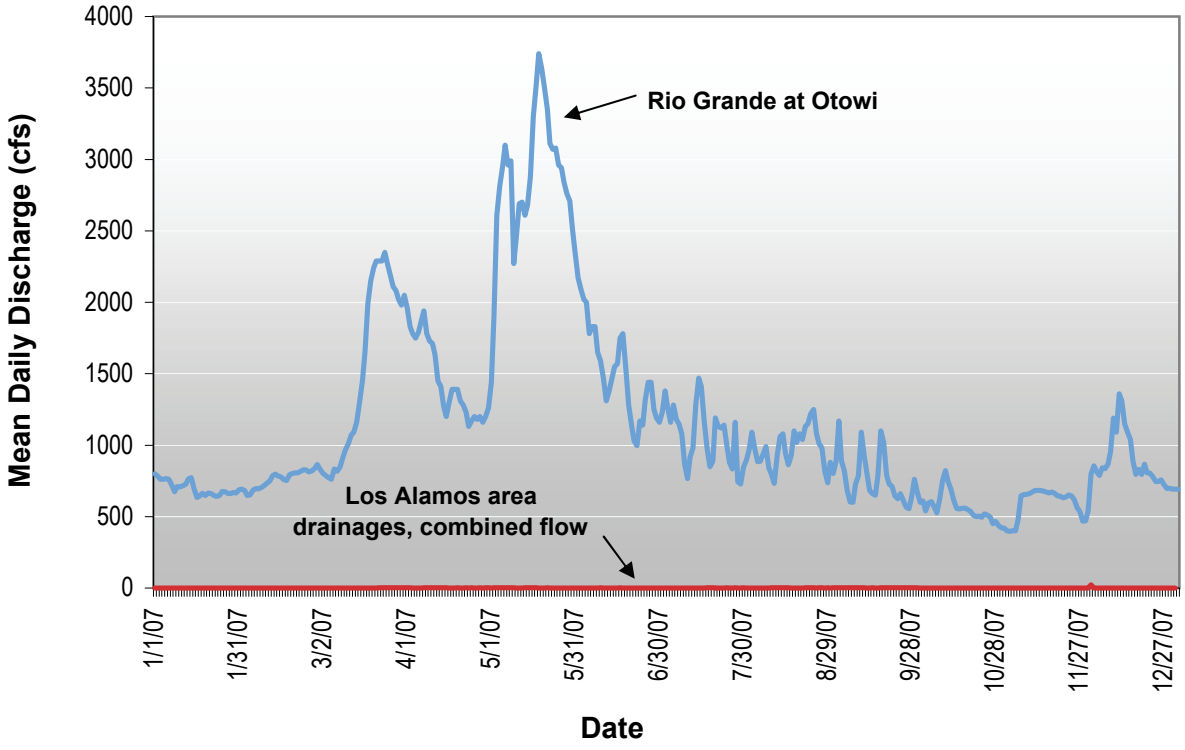


Figure 6-12. Discharge from Los Alamos drainages in 2007 in comparison to discharge in the Rio Grande at Otowi gaging station.

Surface water samples were collected from two locations along the Rio Grande downriver from Los Alamos Canyon in September 2007 for analysis of radionuclides, metals, and organic chemicals. These locations are at a proposed surface water diversion-site for Santa Fe at Buckman (at the mouth of Cañada Ancha), and at the mouth of Frijoles Canyon in Bandelier National Monument. No upriver samples were collected, which prevents a complete evaluation of potential Laboratory impacts, but these data provide an indication of water quality in the Rio Grande near Los Alamos.

The non-filtered surface water sample from Buckman had gross alpha radiation greater than the NMWQCC livestock watering standard of 15 pCi/L, but the downriver station at Frijoles Canyon had gross alpha radiation below the standard. The result from Buckman, 23.5 pCi/L, was less than many samples from canyons on the Pajarito Plateau that are unaffected by Laboratory operations, which range up to 200 pCi/L. Neither sample from the Rio Grande had radionuclide concentrations greater than DOE BCGs.

The surface water samples from the Rio Grande had no concentrations of metals in filtered water above drinking water MCLs, and no concentrations of metals in non-filtered water above screening levels. No explosive compounds, PCBs, or pesticides were detected in these samples. The SVOC bis(2-ethylhexyl)phthalate was detected in non-filtered water from the Frijoles Canyon location, and the VOC methylene chloride was detected in non-filtered water from the Buckman location, but both results were below screening levels.

G. CANYON-SPECIFIC RESULTS

a. Guaje Canyon (includes Barrancas and Rendija Canyons)

Guaje Canyon is a major tributary of Los Alamos Canyon that heads in the Sierra de los Valles and lies north of Laboratory land. The total drainage area above Los Alamos Canyon is about 33 mi2 (85 km2), and the stream channel has a length of about 16 mi (25 km). Guaje Canyon and its tributaries have not received any effluents from LANL activities, but contained some firing sites and other locations with potential Laboratory contaminants (LANL 2001b). In 2007, a storm water sample from a gaging station in lower Guaje Canyon (E099) had measured gross alpha radiation of 209 pCi/L, well above the NMWQCC livestock watering standard of 15 pCi/L. This result indicates the pervasive nature of gross alpha radiation above the standard in storm water on the Pajarito Plateau due to the presence of naturally occurring radionuclides. Concentrations of metals in Guaje Canyon storm water in 2007 were below applicable screening levels except for aluminum, which was greater than the screening level of 750 µg/L in a filtered sample. Aluminum results above the screening level are also widespread on the Pajarito Plateau. Mercury was detected above the screening level of 0.77 µg/L at a site-monitoring area in Rendija Canyon adjacent to the Guaje Pines Cemetery and below residential areas. Mercury has also been detected above background levels in sediment samples from this area (LANL 2007d). The source of this mercury is uncertain, and is under continued evaluation. No PCBs or pesticides were detected in Guaje Canyon storm water samples in 2007.

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

Los Alamos Canyon has a large drainage area that heads in the Sierra de los Valles. Excluding Guaje Canyon and its tributaries, the drainage area is about 28 mi^2 (72 km^2), and the stream channel has a length of about 17 mi (27 km). The Laboratory has used land in the Los Alamos Canyon watershed continuously since the early 1940s with operations conducted at some time in the watersheds of several tributary canyons (Acid, Bayo, DP, and Pueblo Canyons). Several of the canyons within the watershed also receive urban runoff from the Los Alamos town site, and lower Pueblo Canyon receives treated sanitary municipal wastewater from the Los Alamos County WWTP.

Historical releases of radioactive liquid effluents into Acid, DP, and Los Alamos Canyons have introduced americium-241, cesium-137, plutonium-238, plutonium-239/240, strontium-90, and tritium, among other radionuclides, into the canyon bottoms. Most of these radionuclides bind to stream sediment and persist at concentrations well above atmospheric fallout levels. Cesium-137 and plutonium-239/240 are the most important radionuclides in the Los Alamos Canyon watershed from the perspective of potential human health risk, although concentrations are low enough that they do not pose an unacceptable risk to recreational users of the canyons (LANL 2004a; LANL 2005b). Discharges into DP Canyon from a treatment facility at TA-21 between 1952 and 1986 were the main source for cesium-137. Discharges between 1945 and 1964 into Acid Canyon from former TA-1 and former TA-45, located within the current Los Alamos town site, were

the main source for plutonium-239/240. These radionuclides and other contaminants have been transported by floods down these canyons, off-site across Pueblo de San Ildefonso land, and to the Rio Grande near Otowi Bridge (Graf 1994, 1996; Reneau et al., 1998; LANL 2004a). Plutonium-239/240 from historical Acid Canyon discharges has been traced in sediment more than 55 km to lower Cochiti Reservoir (Gallaher and Efurd 2002). A major contaminated sediment removal effort was conducted in Acid Canyon in 2001 to reduce concentrations of plutonium-239/240 in the canyon bottom (Reneau et al. 2002). In 2005, additional stabilization of sediment was performed in Pueblo Canyon to reduce downstream transport of plutonium-contaminated sediment. The installation of 3,000 linear feet of jute matting along channel banks with elevated radionuclide concentrations, and the planting of 3,000 willow stems to provide additional stream bank support, was completed in 2005 (PPWP 2005). Additional actions to reduce the transport of contaminated sediment in the Los Alamos Canyon watershed began in 2008 (LANL 2008).

The highest concentrations of cesium-137 measured in storm water in 2007 within the Los Alamos Canyon watershed were from Los Alamos Canyon above the low-head weir (gaging station E042, 31.4 pCi/L) and lower DP Canyon (gaging station E040, 18.6 pCi/L) (Figure 6-13). These values are well below the maximum measured in 2006, from Los Alamos Canyon below the low-head weir (E050, 87.7 pCi/L). The highest concentrations of plutonium-239/240 measured in storm water within the Los Alamos Canyon watershed were from lower Acid Canyon (gaging station E056, 34.7 pCi/L) and lower Pueblo Canyon (gaging station E060, 34.3 Ci/L) (Figure 6-14). These values are also well below the maximum concentration measured in 2006, from a hillside monitoring station in Los Alamos Canyon (LA-SMA-6.3, 117 pCi/L). Measured concentrations of both cesium-137 and plutonium-239/240 in 2007 were much lower in lower Los Alamos Canyon near the Rio Grande (gaging station E110) than upstream on LANL land. At E110, plutonium-239/240 was detected in one of two samples, at 1.13 pCi/L, and cesium-137 was not detected in either sample.

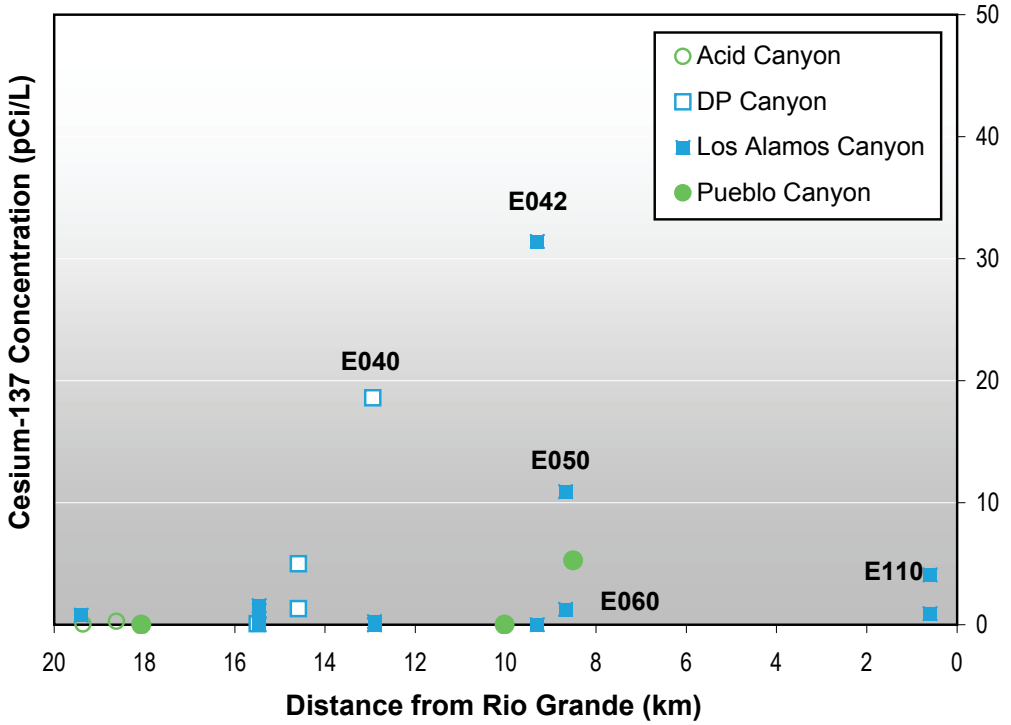


Figure 6-13. Spatial variations in cesium-137 concentration in non-filtered surface water samples from the Los Alamos Canyon watershed in 2007; values below 8 pCi/L are non-detects.

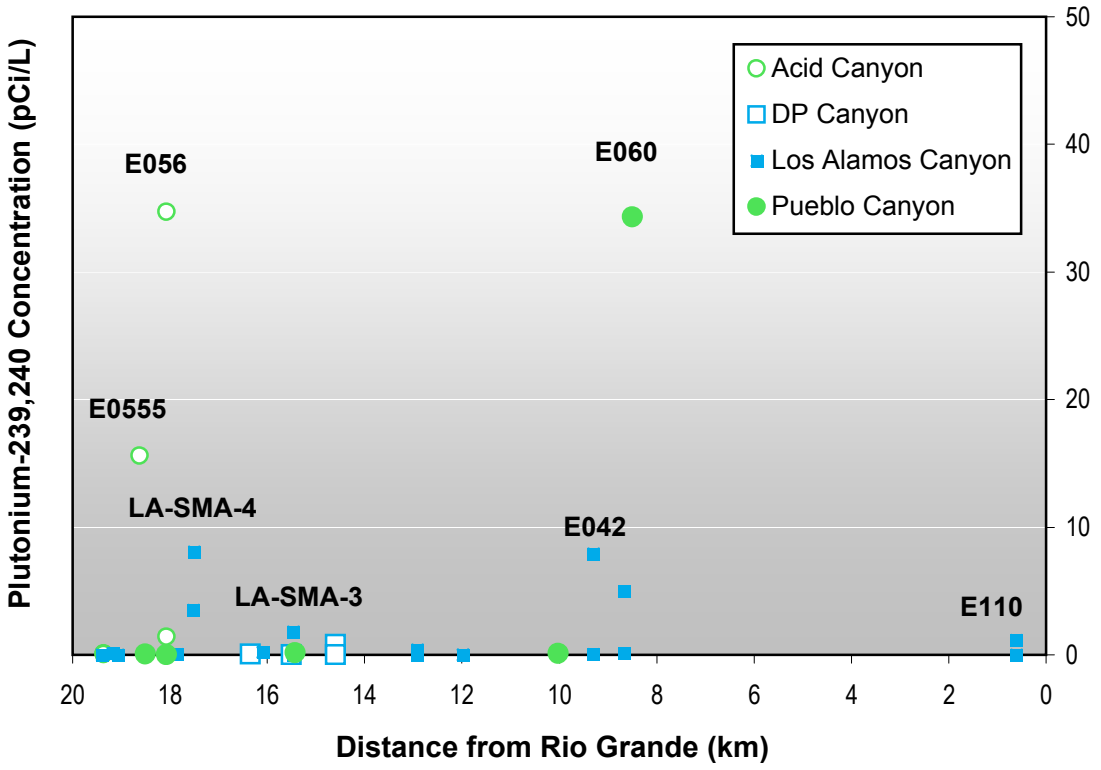


Figure 6-14. Spatial variations in plutonium-239/240 concentration in non-filtered surface water samples from the Los Alamos Canyon watershed in 2007; the average detection limit for these samples is about 0.03 pCi/L.

The annual time-weighted average concentrations of radionuclides are well below the BCGs in non-filtered surface water collected from Acid, DP, Los Alamos, and Pueblo Canyons (Table 6-2). When the mixture of radionuclides is considered (see discussion in D.4), surface water along the stream channels in these canyons ranged from 1% to 41% of the BCGs, with the highest percentage in lower Pueblo Canyon and the lowest in Los Alamos Canyon at the Rio Grande. The largest contribution to the value from lower Pueblo Canyon is radium-226, a naturally-occurring radionuclide.

The transport of PCBs in storm water is also of concern in the Los Alamos Canyon watershed, and an interim measure has been proposed to mitigate this transport (LANL 2008). In 2007, the highest concentrations of PCBs in storm water were detected at a hillside monitoring station in Los Alamos Canyon below former Manhattan Project facilities in what is now the Los Alamos town site (LA-SMA-2) (Figure 6-15). Concentrations at downstream gaging stations were much lower. The highest detected concentration of PCBs at LANL in the 2007 surveillance sediment samples were also in Los Alamos Canyon, from a fine-grained floodplain deposit above NM 4 resulting from the large flood of August 6, 2006. This result, 0.0362 mg/kg, is the sum of detected Aroclor-1254 and Aroclor-1260 concentrations; concentrations are well below recreational SSLs for these PCBs (6.65 and 10.5 mg/kg, respectively).

Plutonium-239/240 is the most important radionuclide in Pueblo Canyon from the perspective of potential human health risk (LANL 2004a), and plutonium-239/240 concentrations in sediment transported by floods today are much less than concentrations during the period of active releases of radioactive effluent into Acid Canyon from 1945 to 1964. Figure 6-16 shows variations in plutonium-239/240 concentration in active channel sediment in lower Pueblo Canyon between ca. 1950 and 2007, extending the record presented previously (LANL 2004a; Reneau et al. 2004) with data from more recent surveillance sediment samples. As shown in the previous studies, plutonium-239/240 concentrations were much higher prior to 1965, and since that time have shown no distinct trends. The year-to-year variations seen in these samples may be due at least in part to variability in silt and clay percentages, as there are strong relations between sediment particle size and contaminant concentration (LANL 2004a; Reneau et al. 2004).

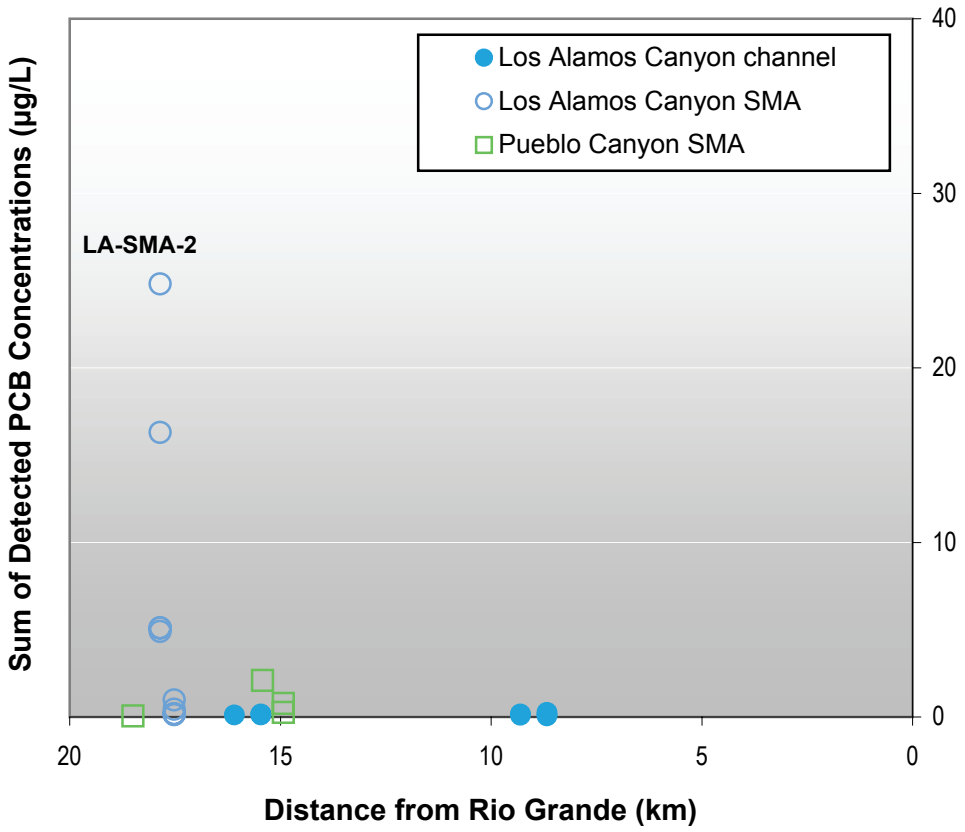


Figure 6-15. **Spatial variations in detected PCB concentration in non-filtered surface water samples from the Los Alamos Canyon watershed in 2007.**

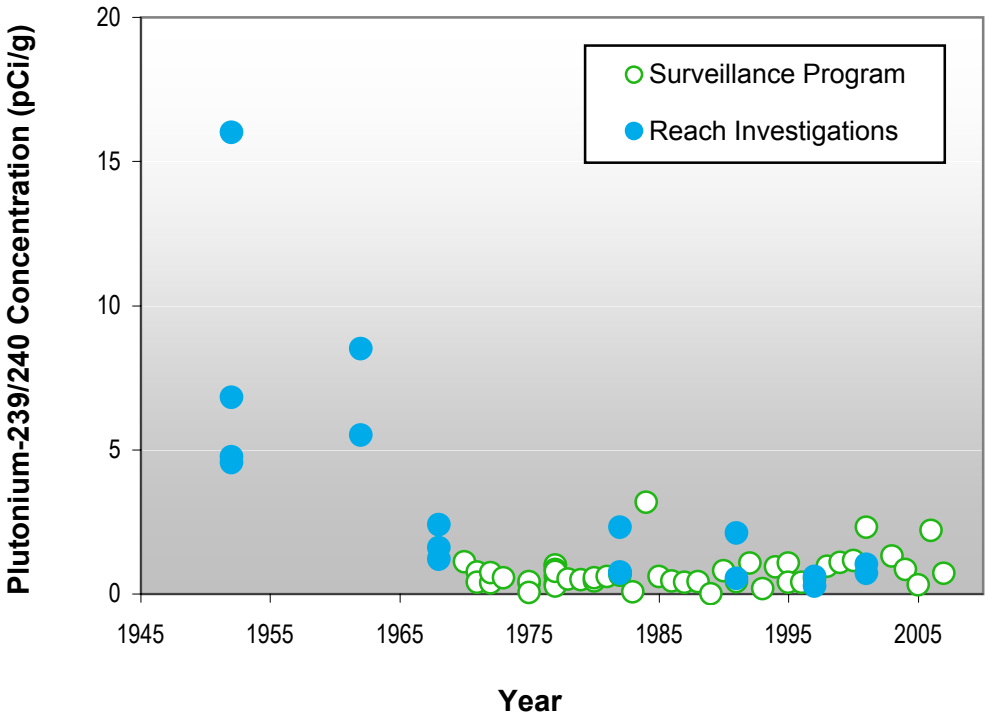


Figure 6-16. **Variations in plutonium-239/240 concentration over time in active channel sediment in lower Pueblo Canyon; all results are detects and most are above the background value of 0.068 pCi/g.**

In lower Acid Canyon, analyses of active channel sediment samples show an overall decrease in plutonium-239/240 concentrations between 1970 and 2007 (Figure 6-17, modified from LANL 2004a and Reneau et al. 2004), with inter-year and intra-year variability also seen. Downstream in lower Los Alamos Canyon, analyses of active channel sediment samples indicate no trends in plutonium-239/240 concentrations between 1977 and 2007, although inter-year and intra-year variability is also seen here (Figure 6-18). The variability between samples in these figures may also be due in part to differences in silt and clay content between samples. All concentrations in these figures are less than the recreational and residential SALs of 300 and 33 pCi/g, respectively.

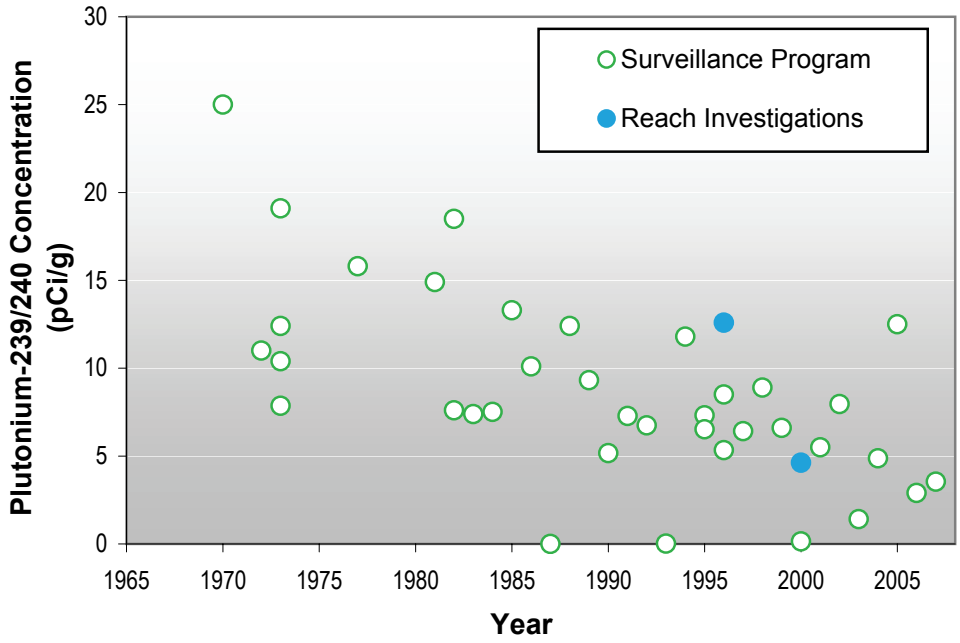


Figure 6-17. **Variations in plutonium-239/240 concentration over time in active channel sediment in lower Acid Canyon; most values are detects and are above the background value of 0.068 pCi/g.**

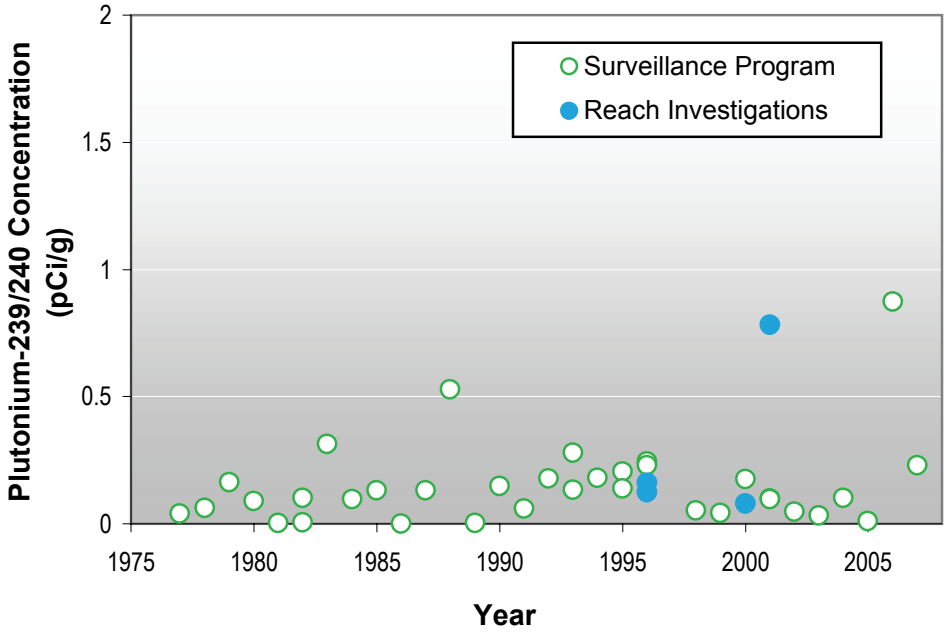


Figure 6-18. **Variations in plutonium-239/240 concentration over time in active channel sediment in lower Los Alamos Canyon near the Rio Grande; most values are detects and are above the background value of 0.068 pCi/g.**

Two samples of fine-grained sediment deposited on the lower Pueblo Canyon floodplain by the record flood of August 8, 2006, were collected to evaluate how plutonium-239/240 concentrations in floodplain sediment resulting from this flood compared to the active channel sediment and to older floodplain deposits. These samples, with 61% and 85% silt plus clay, contained roughly twice as much plutonium-239/240 as the active channel sample with 24% silt plus clay (1.3-1.6 pCi/g vs. 0.7 pCi/g). In comparison, fine-grained sediment deposited on the active floodplain of lower Pueblo Canyon between roughly 1945 and 1964 averaged about 35 pCi/g plutonium-239/240, and between roughly 1965 and 1985 averaged about 6.6 pCi/g (Reneau et al. 2004). Concentrations of plutonium-239/240 in sediment transported in suspension by floods in lower Pueblo Canyon are therefore decreasing over time. Plutonium-239/240 concentrations in fine-grained sediment sampled in 2007 also decrease downstream, as found in previous years (LANL 2004a), averaging about 0.36 pCi/g in lower Los Alamos Canyon near the Rio Grande.

Cesium-137 is the most important radionuclide in Los Alamos Canyon from the perspective of potential human health risk (LANL 2004a). Cesium-137 concentrations in sediment transported by recent floods are much less than concentrations measured during the period of active releases of radioactive effluent into DP Canyon from 1952 to 1986. Figure 6-19 plots cesium-137 concentrations in samples from the active channel of lower DP Canyon since 1971, and shows that concentrations have been relatively low and constant since about 1989. Figure 6-20 plots cesium-137 concentrations in samples from the active channel of Los Alamos Canyon above NM 4 since 1968, and shows that concentrations have been relatively low and constant since about 1993. Downstream, all samples from the active stream channel in Los Alamos near the Rio Grande have had cesium-137 concentrations below the background value of 0.9 pCi/g since 2001.

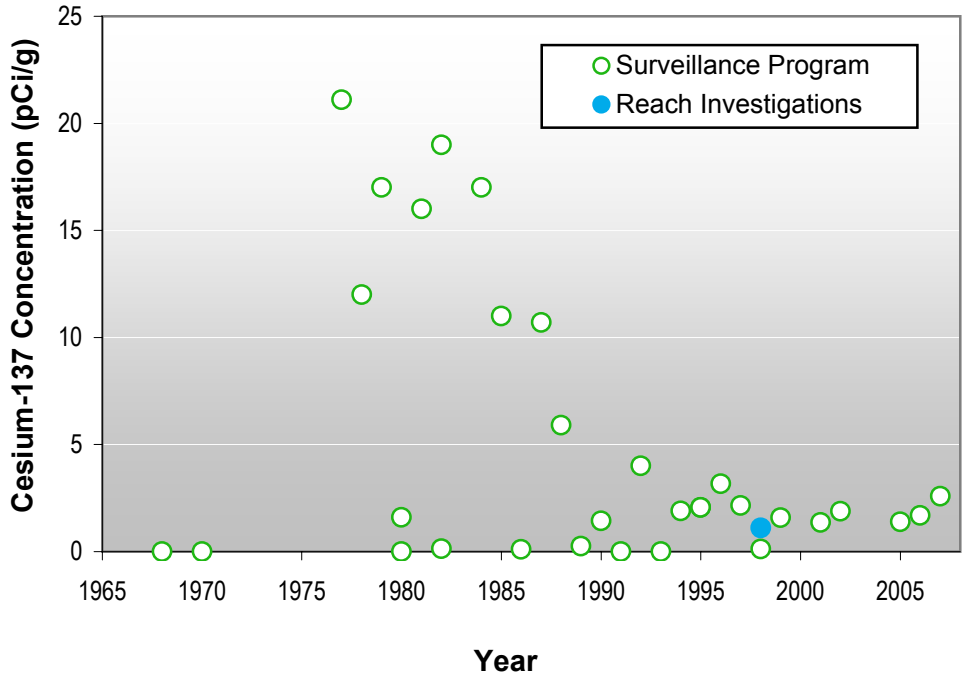


Figure 6-19. Variations in cesium-137 concentration over time in active channel sediment in lower DP Canyon; most values are detects and are above the background value of 0.9 pCi/g.

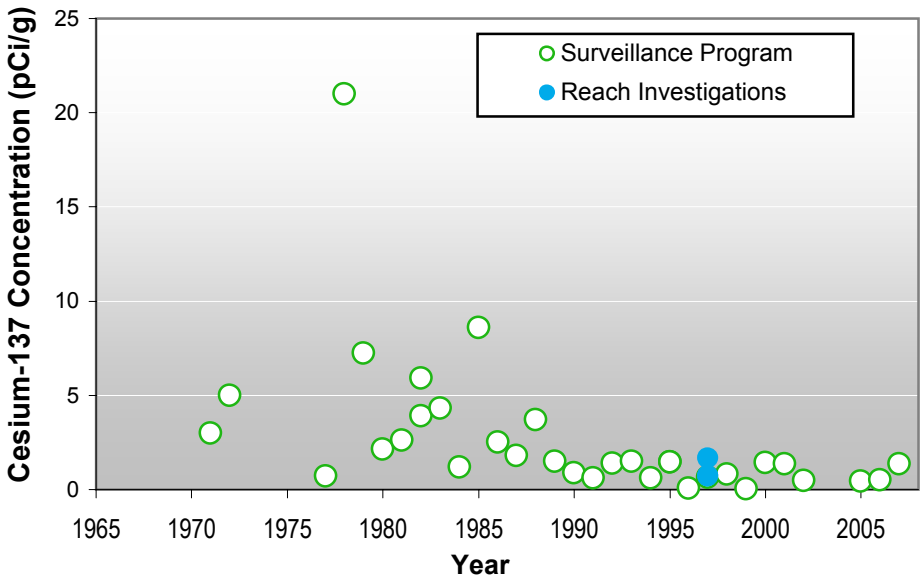


Figure 6-20. Variations in cesium-137 concentration over time in active channel sediment in Los Alamos Canyon above NM 4; all values are detects and most are above the background value of 0.9 pCi/g.

c. Sandia Canyon

Sandia Canyon heads on the Pajarito Plateau within the Laboratory's TA-3 and has a total drainage area of about 5.5 mi^2 (14 km^2) and a channel length of about 11 mi (18 km). This relatively small drainage extends eastward across the central part of the Laboratory and crosses Bandelier National Monument and Pueblo de San Ildefonso land before ending at the Rio Grande. Effluent discharges from a sanitary wastewater treatment plant, supplemented by releases from a steam plant, create perennial flow conditions along a two-mile reach below TA-3. Surface flow rarely extends past the Laboratory boundary, and no runoff event was recorded at the E125 gaging station above NM 4 in 2007. Two contaminants that have been of concern in Sandia Canyon are chromium and PCBs. Chromium was discharged in water from the TA-3 power plant from 1956 to 1972, and is the focus of extensive ongoing investigations related to groundwater contamination (LANL 2006a; LANL 2007b). PCBs were released from a former transformer storage area at TA-3, and were the target of remediation activities involving excavation of soil near the source (LANL 2001a). Contaminant concentrations in sediment deposits decrease downstream from TA-3, and relatively low levels of contaminants are present above NM 4, adjacent to the eastern Laboratory boundary (LANL 2007f).

Chromium concentrations in Sandia Canyon storm water are much higher in non-filtered samples than filtered samples, indicating that it is largely associated with suspended sediment particles. Relatively high chromium concentrations were measured in 2007 at two gaging stations along the main stream channel, E123 and E124, and higher concentrations were measured in one sample from a SMA adjacent to the firing range in TA-72 (S-SMA-6; Figure 6-21). No samples were collected farther downstream because all flow completely infiltrated into the alluvium before the next downstream gaging station above NM 4 (E125). All filtered surface water samples from the Sandia Canyon watershed in 2007 had chromium concentrations below the EPA MCL 100 µg/L and below the NMWQCC groundwater standard of 50 µg/L.

The concentrations of detected PCBs in Sandia Canyon storm water are highest at the upstream gaging stations E123 and E121, below and above the wetland, respectively. PCBs are also relatively high at one downcanyon SMA monitoring area in TA-72 (S-SMA-6), as also seen for chromium (Figure 6-22). As with chromium, no samples were collected farther downstream because flow had completely infiltrated into the alluvium before the next downstream gaging station above NM 4 (E125).

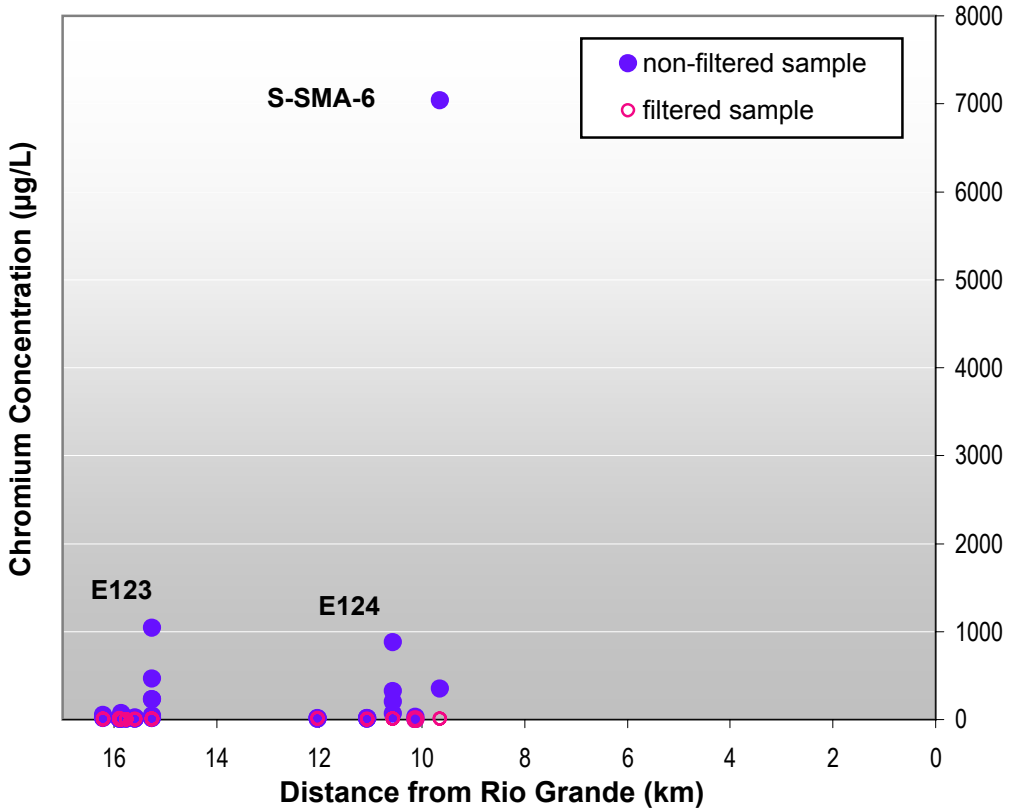


Figure 6-21. **Spatial variations in chromium concentration in surface water samples from the Sandia Canyon watershed in 2007; all values above 10 µg/L are detects.**

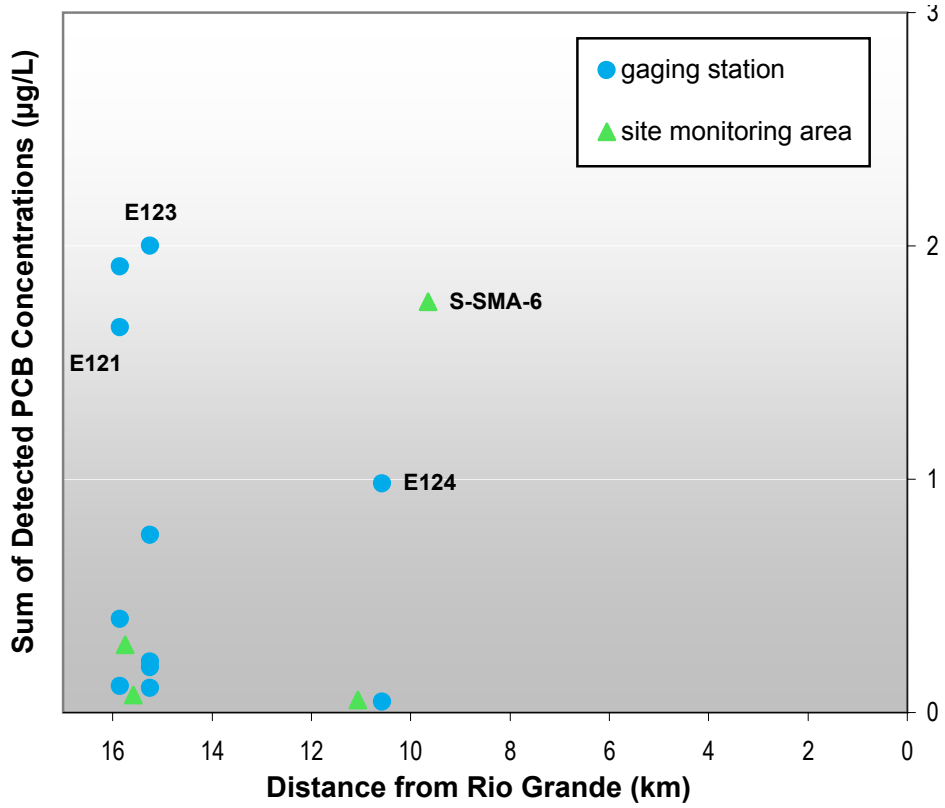


Figure 6-22. **Spatial variations in total detected PCB concentration in surface water samples from the Sandia Canyon watershed in 2007.**

The highest concentrations of mercury and selenium measured in non-filtered storm water at the Laboratory in 2007 were in samples collected from the Sandia Canyon watershed. Mercury results above the screening level of 0.77 µg/L were measured at two gaging stations along the main stream channel (E123 and E124), and at the same SMA where elevated values of chromium and PCBs were measured (S-SMA-6; Figure 6-23). Mercury is also elevated in the north fork of Sandia Canyon (gaging station E121), but below the screening level. Selenium results above the screening level of 5 µg/L were measured in one sample each from S-SMA-6 and gaging station E122 in the south fork of Sandia Canyon.

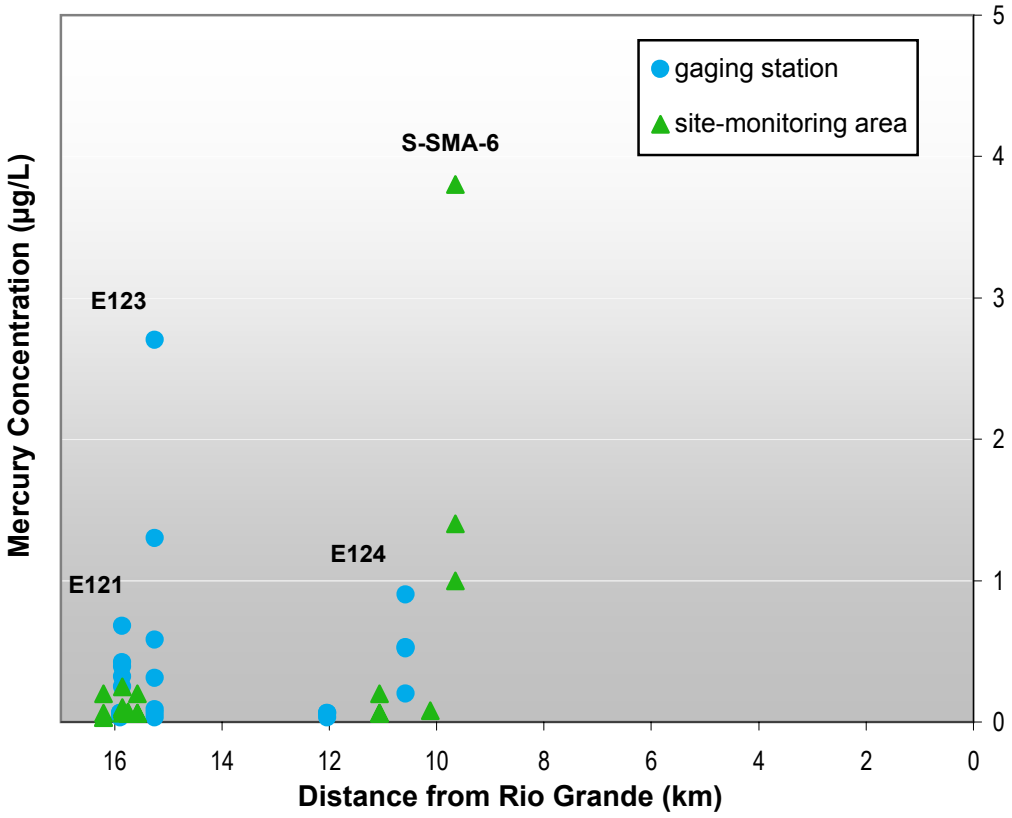


Figure 6-23. Spatial variations in mercury concentration in non-filtered surface water samples from the Sandia Canyon watershed in 2007; all values above 0.2 µg/L are detects.

Active channel sediment collected in the upper portion of Sandia Canyon below the wetland contained chromium above background levels (19.4 mg/kg vs. 10.5 mg/kg for the upper level of background), but downstream samples from the Laboratory boundary and the Rio Grande had chromium within background ranges. Low concentrations of PCBs were detected in the active channel below the wetland (0.0070 mg/kg) and at the Laboratory boundary (0.0023 mg/kg), but PCBs were not detected from the Sandia Canyon channel at the Rio Grande. These concentrations of chromium and PCBs are well below recreational SALs.

d. Mortandad Canyon (includes Cañada del Buey and Effluent, Pratt, and Ten Site Canyons)

Mortandad Canyon heads on the Pajarito Plateau in the main Laboratory complex at TA-3, and crosses Pueblo de San Ildefonso land before reaching the confluence with the Rio Grande. It has a total drainage area of about 10 mi^2 (27 km^2) and a main channel length of about 10 mi (16 km). Mortandad Canyon receives treated water discharged into Effluent Canyon from the TA-50 RLWTF. No runoff events have crossed the Laboratory boundary in Mortandad Canyon proper since a stream gage was installed in 1993, and the only reported event that crossed the boundary occurred in 1952 (LANL 2006c). The Mortandad Canyon sediment traps are located approximately two miles upstream of the Laboratory's eastern boundary, and in most years, including 2007, runoff events have not extended past here.

Cañada del Buey is a major tributary that heads in TA-63 and passes through the community of White Rock and Pueblo de San Ildefonso land before reaching the confluence with Mortandad Canyon near the Rio Grande. It has a drainage area of about 4 mi^2 (11 km^2) and a main channel length of about 8 mi (13 km). Runoff events have crossed the Laboratory boundary in Cañada del Buey every year since a gaging station (E230) was established above NM 4 in 1994, although in most years flow has not been recorded at the next upstream station (E225), indicating that the runoff originates in the lower part of the watershed.

The highest concentrations of several radionuclides in surface water samples collected at the Laboratory in 2007 were measured in the Mortandad Canyon watershed, including americium-241, cesium-137, plutonium-238, plutonium-239/240, and tritium. The highest concentrations for all these radionuclides were along the stream channel downstream from the TA-50 RLWTF outfall, between Effluent Canyon and the sediment traps. As an example, the spatial distribution of plutonium-239/240 results in the Mortandad Canyon watershed is shown in Figure 6-24. The annual time-weighted average concentrations of radionuclides are well below the BCGs in non-filtered surface water collected from Mortandad Canyon below Effluent Canyon (Table 6-2). When the mixture of radionuclides is considered (see discussion in D.4), the surface water here was at 19% of the BCGs.

Stream sediment in Mortandad Canyon downstream of Effluent Canyon to near regional well R-28 (1 km above the LANL boundary) contains above-background concentrations of radionuclides, with concentrations decreasing to at or near background levels at the Laboratory boundary (LANL 2006c). Mortandad Canyon had the highest concentrations at the Laboratory of five radionuclides in the sediment samples collected in 2007: americium-241, cesium-137, plutonium-238, plutonium-239/240, and strontium-90. All of these concentrations were below the recreational SALs.

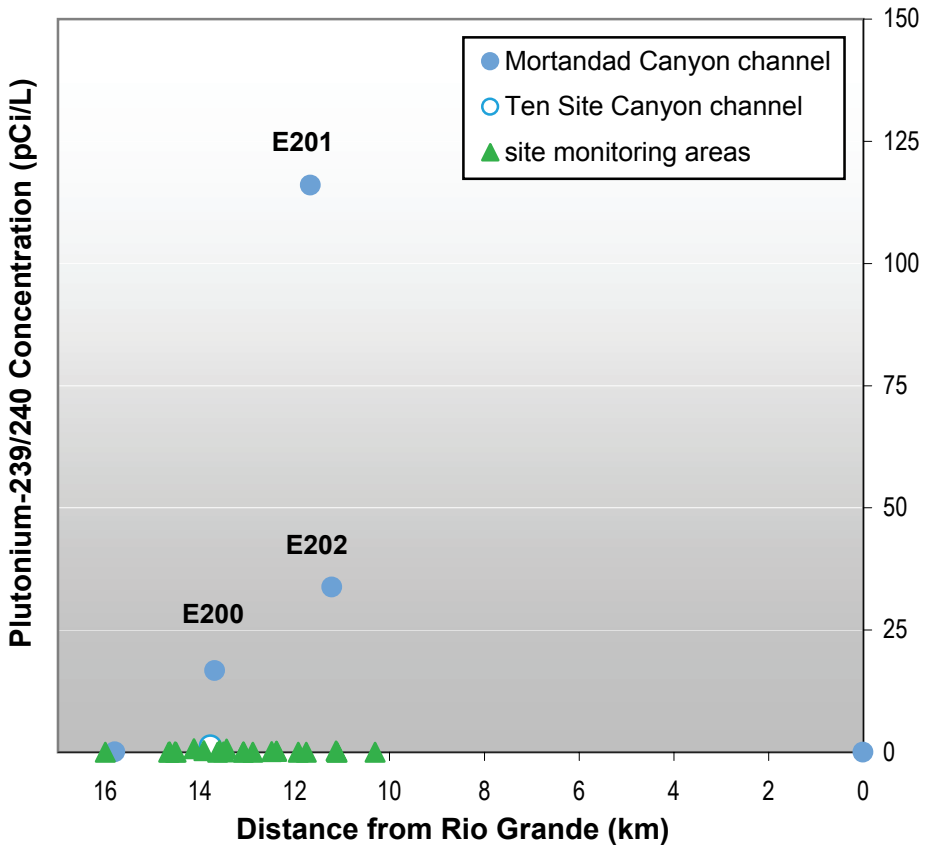


Figure 6-24. Spatial variations in plutonium-239/240 concentration in surface water samples from the Mortandad Canyon watershed in 2007; most values are detects.

Cesium-137 is the most important radionuclide in Mortandad Canyon from the perspective of potential human health risk (LANL 2006c). Cesium-137 concentrations in sediment transported by recent floods are much less than concentrations measured during the period of peak releases of radioactive effluent from the RLWTF into Effluent Canyon prior to 1980. Figure 6-25 plots cesium-137 concentrations in samples from the active channel of Mortandad Canyon below Effluent Canyon since 1972 (updated from LANL 2006c), and shows that concentrations have been relatively low and constant since about 1983, below the recreational SAL of 210 pCi/g. Similar trends are present for other radionuclides in Mortandad Canyon (LANL 2006c).

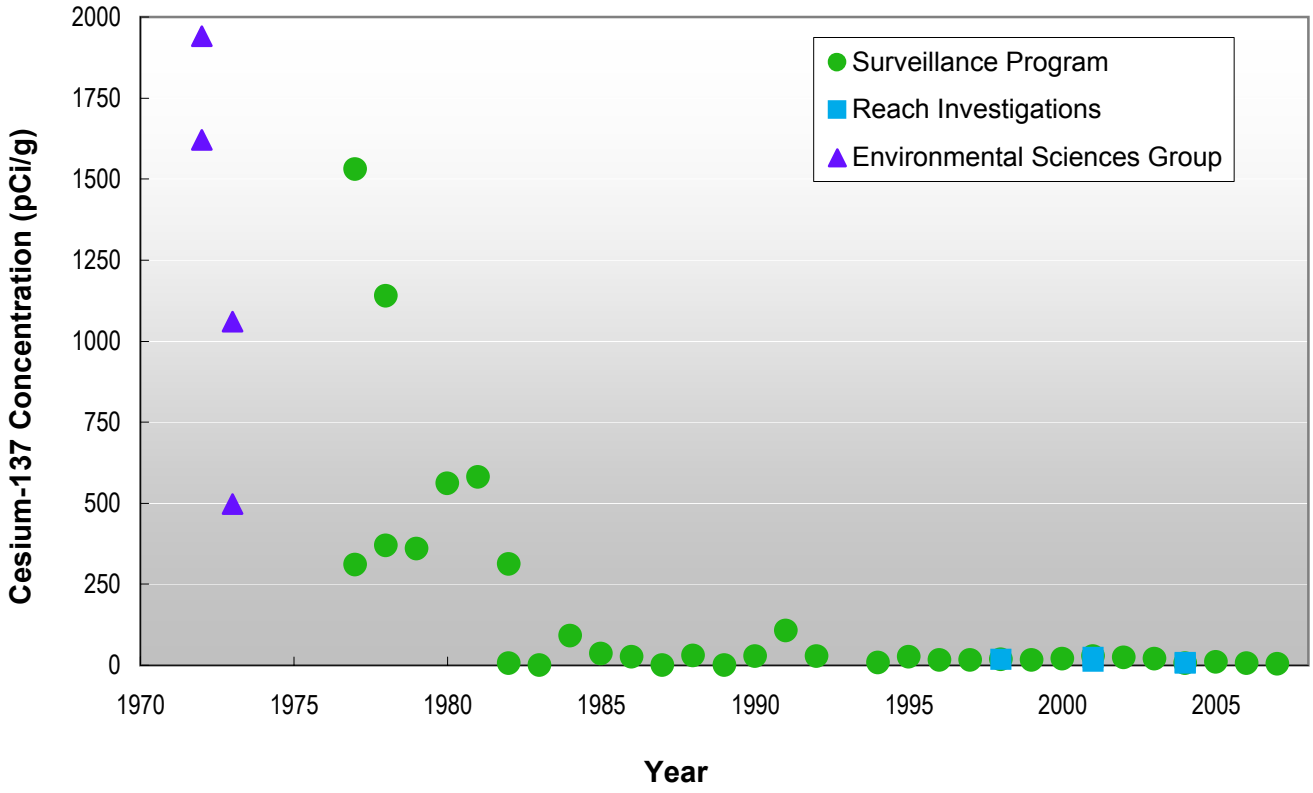


Figure 6-25. Variations in cesium-137 concentration over time in active channel sediment in Mortandad Canyon below Effluent Canyon; most values are detects and are above the background value of 0.9 pCi/g.

Concentrations of radionuclides are higher in fine-grained sediment transported in suspension in floods than in coarse-grained sediment transported along the stream bed. Fine-grained sediment deposited in the Mortandad Canyon sediment traps during the record flood of August 25, 2006, was sampled to help evaluate changes in radionuclide concentration over time. Figures 6-26 to 6-28 show estimated average concentrations of five radionuclides over time in fine-grained sediment deposits in Mortandad Canyon near the confluence with Ten Site Canyon, including the area of the sediment traps, extending the record presented in a previous study (LANL 2006c; each value on these plots is the average of multiple individual samples). For cesium-137 and strontium-90, radionuclides with relatively short half-lives, concentrations are shown adjusted for radioactive decay both for 2008 (the year of this report) and for the time of deposition. All five radionuclides show similar trends, with the highest concentrations between the late 1960s and the mid-1980s, much lower and gradually decreasing concentrations since about 1987, and the lowest concentrations in the August 2006 flood deposits. Figures 6-27 and 6-28 show the significant decreases in the concentrations of cesium-137 and strontium-90 that have occurred over time due to radioactive decay.

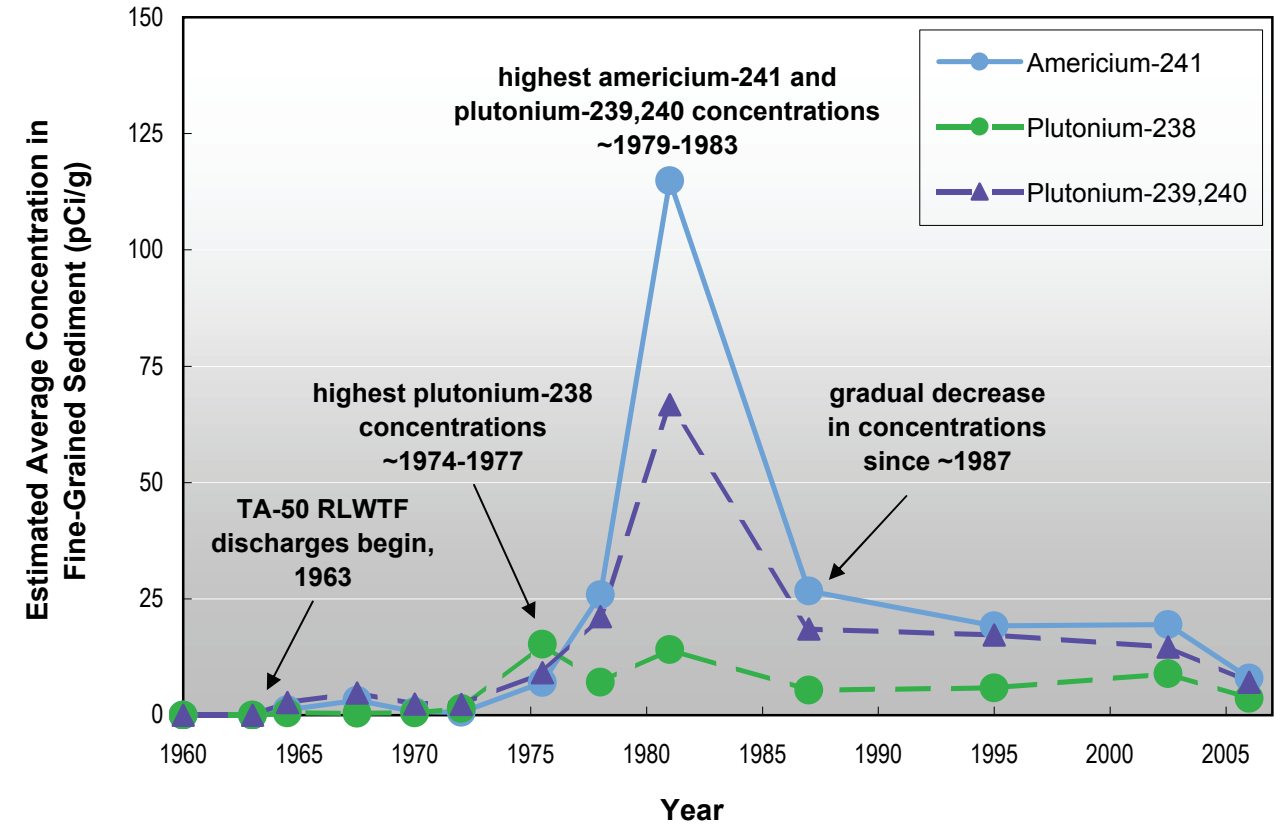


Figure 6-26. Variations in the concentrations of americium-241, plutonium-238, and plutonium-239/240 in fine-grained sediment in Mortandad Canyon near the confluence with Ten Site Canyon, plotted against year.

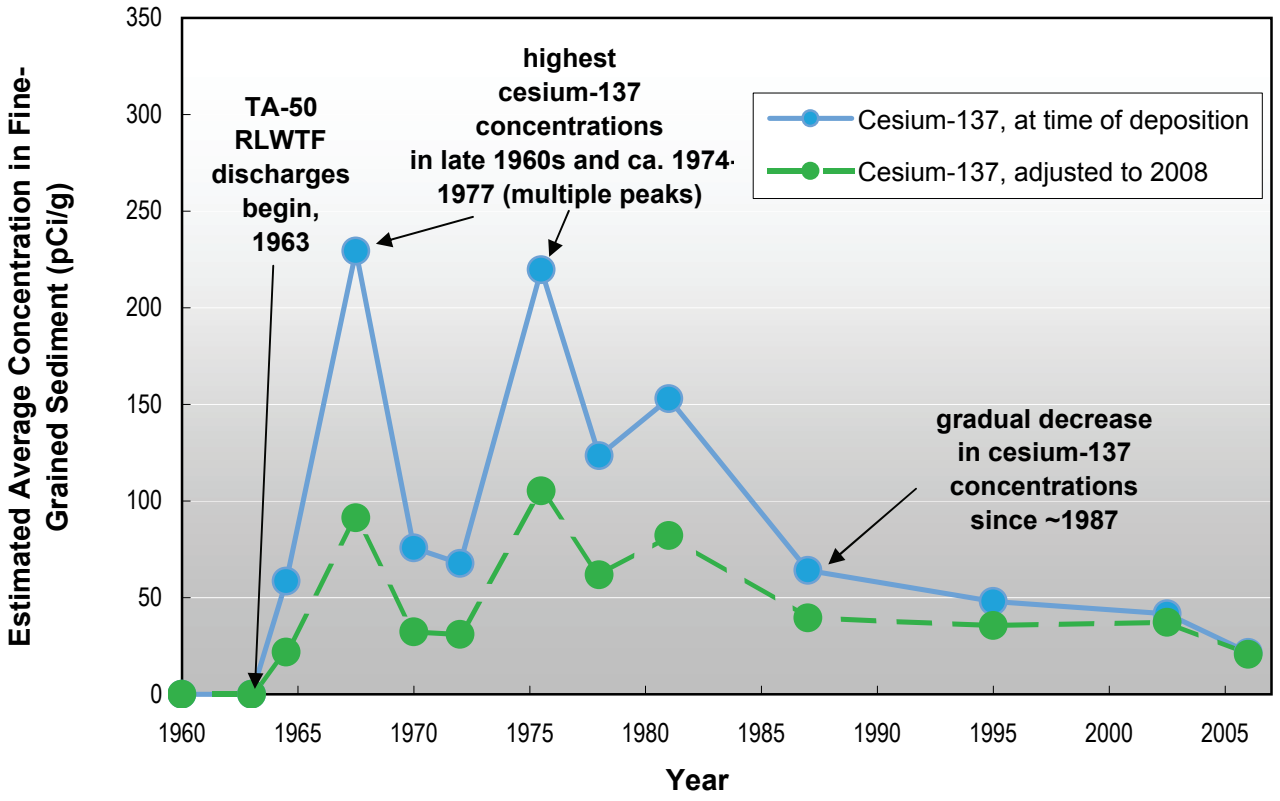


Figure 6-27. Variations through time in the concentrations of cesium-137 in fine-grained sediment in Mortandad Canyon near the confluence with Ten Site Canyon.

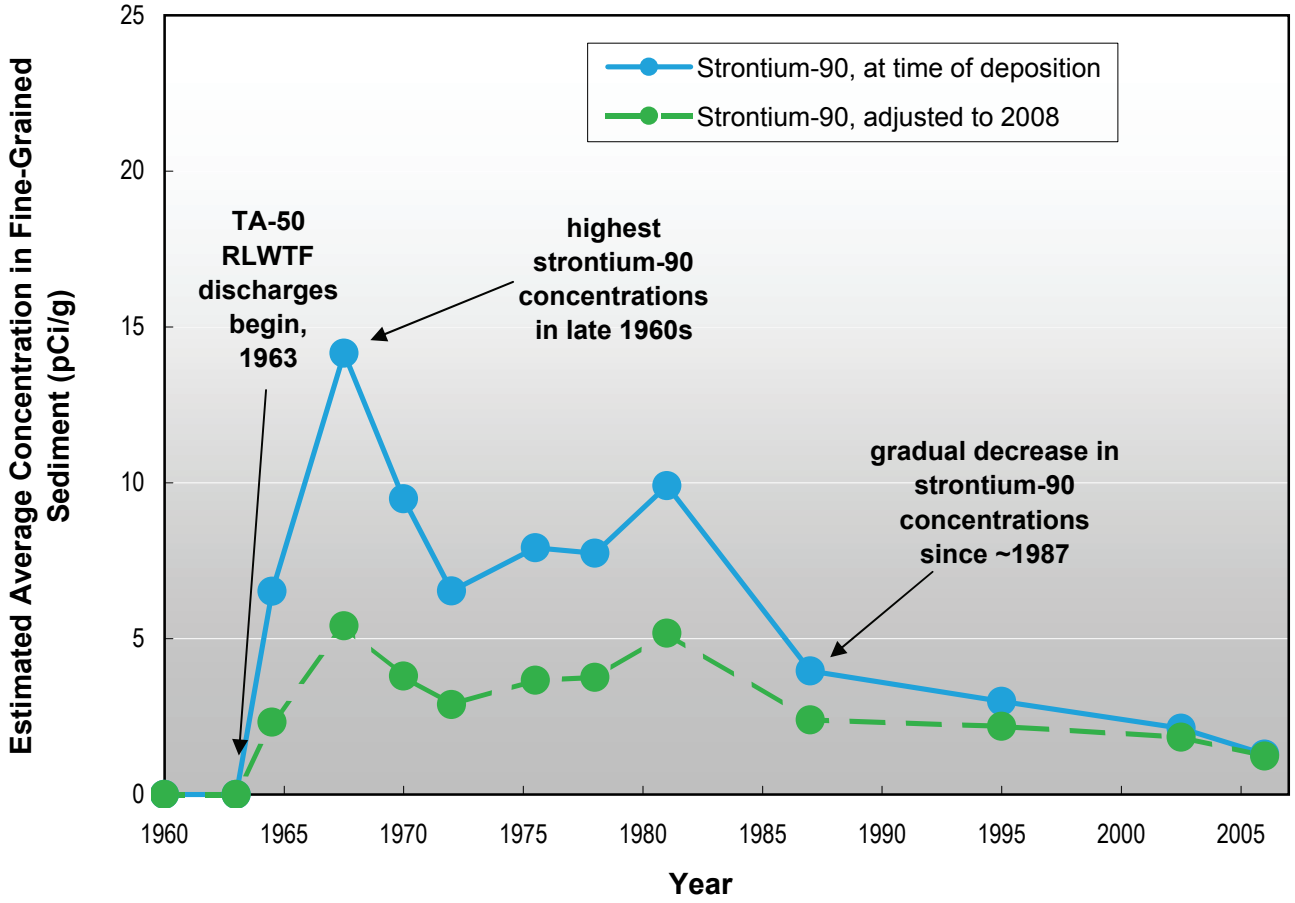


Figure 6-28. Variations through time in the concentrations of strontium-90 in fine-grained sediment in Mortandad Canyon near the confluence with Ten Site Canyon.

The highest concentrations of arsenic measured in filtered surface water at the Laboratory in 2007 were in samples collected from the head of Ten Site Canyon below MDA C, in TA-50. Arsenic concentrations at this location were above the screening level of 9 µg/L in three out of four samples, with a maximum sample result of 20.3 µg/L. However, all concentrations measured downstream were below 9 µg /L, indicating little chance for impacts to groundwater.

Several radionuclides were measured at low concentrations above background levels in sediment in small drainages below MDA G in the Cañada del Buey watershed, specifically americium-241, plutonium-238, and plutonium-239/240. Concentrations for these radionuclides in 2007 were all less than 2 pCi/g, which is consistent with previous years. All results are well below the recreational and residential SALs. None of these radionuclides were detected above background levels downstream in the active channel of Cañada del Buey.

e. Pajarito Canyon (includes Twomile and Threemile Canyons)

Pajarito Canyon heads in the Sierra de los Valles in the Santa Fe National Forest, and crosses the central part of the Laboratory before passing through the community of White Rock east of NM 4. It has a total drainage area of about 13 mi^2 (33 km^2) and a main channel length of about 15 mi (24 km). Major tributary canyons include Twomile Canyon, which also heads in the Sierra de los Valles, and Threemile Canyon, which heads on the Pajarito Plateau. The Pajarito Canyon watershed includes a variety of active and inactive Laboratory sites, which are discussed in an earlier report (LANL 1998).

Uranium-238 was measured at concentrations above the DOE BCG of 200 pCi/L in two storm water samples from a site monitoring location in the Threemile Canyon watershed in 2007 (3M-SMA-0.6), located at a firing site in TA-15 (Figure 6-29). Except for this one SMA, all other locations in the Pajarito Canyon watershed had low levels of uranium-238 and other uranium isotopes in surface water, including stations downstream of this SMA.

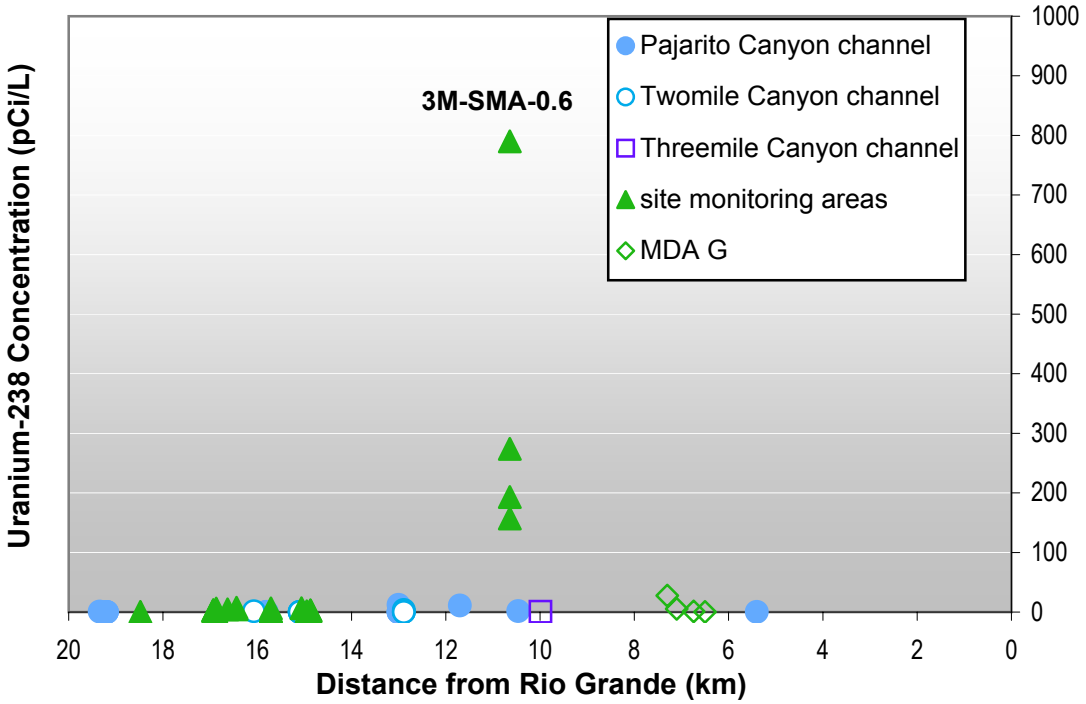


Figure 6-29. **Spatial variations in uranium-238 concentration in surface water samples from the Pajarito Canyon watershed in 2007; most values are detects.**

Copper was measured at concentrations greater than the screening level of 14 µg/L in filtered surface water collected from the Pajarito, Threemile, and Twomile Canyon watersheds in 2007, consistent with results from previous years (Gallaher 2007). The highest concentrations were measured from SMAs in TA-22 (PJ-SMA-5), TA-40 (PJ-SMA-10), and TA-15 (3M-SMA-0.6), and in a tributary channel to Twomile Canyon at TA-3 (E243.5) (Figure 6-30). Concentrations east of the confluence of Pajarito and Threemile Canyons were all less than the screening level.

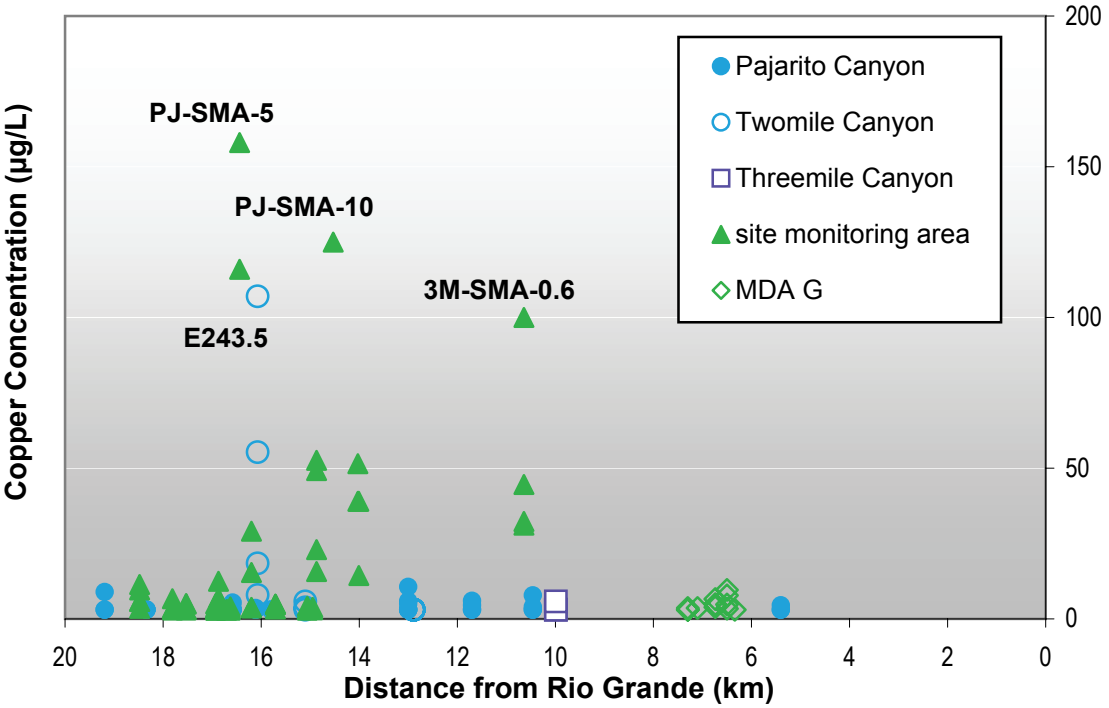


Figure 6-30. **Spatial variations in copper concentration in surface water samples from the Pajarito Canyon watershed in 2007; all values above 3 µg/L are detects.**

One sample from 3M-SMA-0.6 had the highest lead concentration measured in filtered surface water at the Laboratory in 2007, 26.3 µg/L, which is above the EPA MCL for drinking water of 15 µg/L. Three other samples from this location in 2007 had lead concentrations below the MCL. All flow at this location is ephemeral, and all samples from downcanyon locations had lead below the MCL, indicating little chance for impacts to groundwater. Samples from another of these locations, E243.5, had the highest antimony concentration measured in filtered surface water at the Laboratory in 2007, 104 µg/L, also greater than the EPA MCL for drinking water of 6 µg/L. Three other samples from this location in 2007 also had antimony concentrations above the MCL. However, all flow at this location is ephemeral, and all samples from downcanyon locations had antimony less than the MCL, indicating little chance for impacts to groundwater.

The highest concentrations of dioxins and furans in storm water measured at the Laboratory in 2007 were in samples from lower Twomile Canyon above Pajarito Canyon, at gaging station E244. Dioxins and furans had previously been measured in sediment deposits farther west in Twomile Canyon (LANL 2007e), and a possible source is a former incinerator ash pond at TA-69 (LANL 1998). Concentrations measured downstream in Pajarito Canyon above NM 4 were less than 1/10th those measured in Twomile Canyon.

Consistent with past years, americium-241, plutonium-238, plutonium-239/240, and tritium concentrations were measured above background levels in sediment samples from channels in the Pajarito Canyon watershed draining MDA G at TA-54. Americium-241, cesium-137, and plutonium-239/240 were also detected above background levels downstream in Pajarito Canyon above NM 4, but this was from an ash-rich sample deposited soon after the Cerro Grande fire; concentrations of fallout radionuclides are elevated in ash from the Cerro Grande burn area (Katzman et al. 2001; LANL 2004a), and these results therefore do not necessarily indicate Laboratory impacts. All of the radionuclides were at concentrations below recreational and residential SALs.

The highest concentrations of antimony and silver in the 2007 surveillance sediment samples were measured in drainages below MDA G at TA-54 in the Pajarito Canyon watershed. Antimony was above the background value of 0.83 mg/kg in 2007 in the MDA G-7 drainage (1.95 mg/kg), but was within the background range in 2006 at this location. Silver was above the background value of 1 mg/kg in 2007 in the MDA G-6 retention pond, and was also elevated here in 2006. Silver concentrations were somewhat less in 2007 (2.02 vs. 3.39 mg/kg). These concentrations are all below recreational and residential SSLs.

f. Water Canyon (includes Cañon de Valle and Fence, Indio, and Potrillo Canyons)

Water Canyon heads in the Sierra de los Valles in the Santa Fe National Forest and extends across the southern portion of the Laboratory to the Rio Grande. It has a total drainage area of about 19 mi^2 (49 km^2) and a main channel length of about 14 mi (23 km). Cañon de Valle is a major tributary that also heads in the Sierra de los Valles. The Water Canyon watershed also includes the shorter canyons of Fence, Indio, and Potrillo Canyons that head on the Pajarito Plateau within LANL. Explosives development and testing and other activities take place in this part of the Laboratory, and elevated concentrations of uranium isotopes, barium, silver, the HE compounds HMX and RDX, along with other analytes, have previously been measured in sediment and surface water in the watershed (LANL 2006d). Cañon de Valle has been the subject of focused investigations to address barium and HE contamination in surface water and groundwater (LANL 2004b; LANL 2006a), and a corrective measures investigation is planned (LANL 2007a).

The highest concentrations of RDX in surface water at the Laboratory in 2007 were measured in non-filtered samples at two SMAs in the Cañon de Valle watershed in TA-16 (CDV-SMA-2 and CDV-SMA-2.4), in an area where development of explosive compounds has occurred (Figure 6-31). Concentrations are lower downstream along the Cañon de Valle stream channel, and RDX was not detected farther downstream in Water Canyon, which is consistent with analyses from previous years (Gallaher 2007).

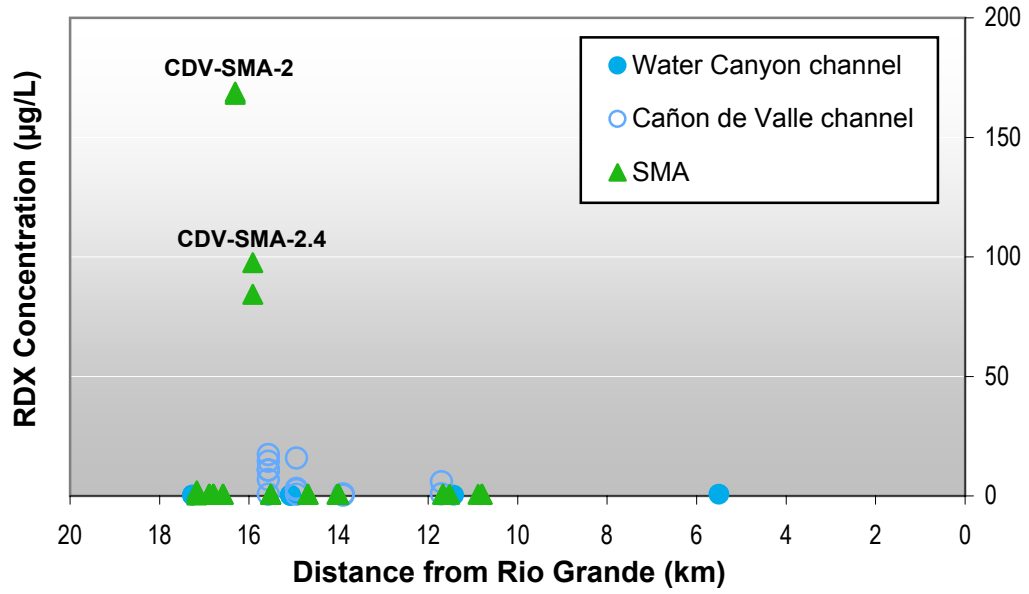


Figure 6-31. **Spatial variations in RDX concentration in non-filtered surface water samples from the Water Canyon watershed in 2007; all values above 0.65 µg/L are detects.**

Barium is also associated with explosive compounds at TA-16 and is elevated in the Cañon de Valle watershed. Barium concentrations in filtered water in this area are above the NMWQCC groundwater standard of 1000 µg/L. The highest concentrations in filtered surface water in 2007 were measured at the same SMAs where RDX is elevated (CDV-SMA-2 and CDV-SMA-2.4), with decreasing concentrations measured downstream along the main stream channels in Cañon de Valle and Water Canyon, as seen for RDX (Figure 6-32).

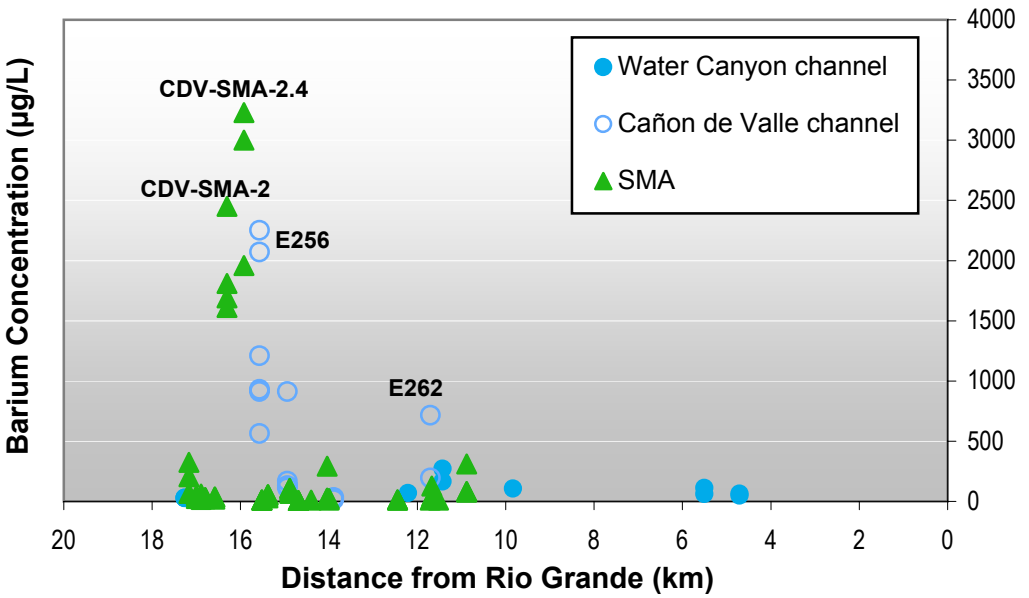


Figure 6-32. **Spatial variations in barium concentration in filtered surface water samples from the Water Canyon watershed in 2007; all values are detects.**

Copper was measured at concentrations above the screening level of 14 µg/L in filtered surface water samples collected from SMAs in the watersheds of Potrillo and Water Canyons and Cañon de Valle in 2007. The highest concentrations of copper in filtered surface water from the Laboratory in 2007 were measured at an SMA at a firing site in the Potrillo Canyon watershed at TA-15 (PT SMA 1) (Figure 6-33). Copper concentrations were also above the screening level at a SMA in the Water Canyon watershed at TA-16 (W-SMA-5). Concentrations in the main stream channels were all less than the screening level.

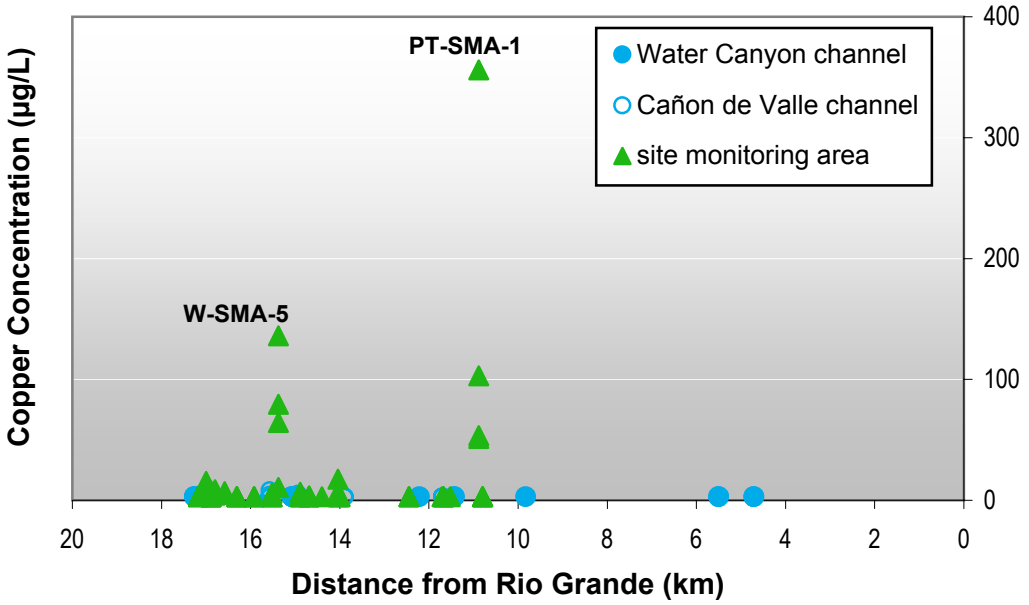


Figure 6-33. Spatial variations in copper concentration in filtered surface water samples from the Water Canyon watershed in 2007; all values above 3 µg/L are detects.

The highest concentrations of silver in filtered surface water from the Laboratory in 2007 were measured at an SMA in the Cañon de Valle watershed at TA-16 (CDV-SMA-1.5), below a former photo-processing facility. Three of the four silver results from this location, 4.6-12.2 µg/L, are higher than the screening level of 3.8 µg/L. However, surface water here is ephemeral, and silver was not detected in filtered surface water samples downstream along the main channels of Cañon de Valle or Water Canyon.

The highest concentrations of uranium-234 and uranium-238 in surface water from the Laboratory in 2007 were measured at a site monitoring location in the Potrillo Canyon watershed at a TA-15 firing site (PT-SMA-1, 545 and 945 pCi/L, respectively, in the same sample), and were above the DOE BCGs of 200 pCi/L. Surface water is ephemeral here and downstream in Potrillo Canyon, and there is little opportunity for biological exposure from this water. All other uranium concentrations from the Water Canyon watershed in 2007 were less than the BCGs.

Within the Water Canyon watershed, the metals barium and cobalt were detected above background levels in a single surveillance sediment sample in 2007, from Fence Canyon above NM 4. Selenium was also detected above background in this sample and in three other samples from Potrillo and Water Canyons. All of these concentrations are below recreational and residential SSLs. The PCB Aroclor-1260 was detected in one surveillance sediment sample from the Water Canyon watershed in 2007, from the main stream channel of Water Canyon below NM 4, at a concentration below the recreational and residential SSL. No radionuclides were detected at concentrations above background levels in these sediment samples.

g. Ancho Canyon

Ancho Canyon heads on the Pajarito Plateau in TA-49 and extends across the Laboratory to the Rio Grande. It has a total drainage area of about 7 mi2 (17 km2) and a main channel length of about 7 mi (12 km). Potential Laboratory sources of contamination in the Ancho Canyon watershed include MDA AB in TA-49, the site of underground testing from 1959 to 1961, and firing sites in the north fork of Ancho Canyon in TA-39 (LANL 2006d). The only analyte of note in surface water samples from this watershed is copper, which was detected above the screening level of 14 µg/L in one filtered storm water sample from a site monitoring location (18.8 µg/L, at A-SMA-2). No metal or radionuclide was detected above background levels in sediment samples from active stream channels in the Ancho Canyon watershed and no explosive compounds were detected.

h. Chaquehui Canyon

Chaquehui Canyon heads on the Pajarito Plateau near the Bandelier National Monument entrance station and extends across the Laboratory to the Rio Grande. It is the smallest of the primary watersheds at LANL, with a total drainage area of about 1.6 mi2 (4 km2) and a main channel length of about 3 mi (5 km). Potential Laboratory sources of contamination in the Chaquehui Canyon watershed are located at TA-33, and include firing sites and outfalls (LANL 2006d). The only analyte of note in surface water samples from this watershed is copper, which was detected in three filtered storm water samples from one site monitoring location (CHQ-SMA-6) above the screening level of 14 µg/L (at 46.5 to 59.9 µg/L). The metals nickel and selenium were detected above background levels but below recreational and residential SSLs in a sediment sample from the active stream channel of Chaquehui Canyon. No radionuclide was detected above background levels in this sediment sample and no explosive compounds were detected.

H. QUALITY ASSURANCE

To process watershed samples, the same quality assurance (QA) protocols and analytical laboratories described in Chapter 5 were used. QA performance for the year is also described in Chapter 5.

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7. Soil Monitoring

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A. INTRODUCTION

A soil sampling and analysis program offers the most direct means of determining the concentrations (activities), distribution, and long-term trends of radionuclides and chemicals around nuclear facilities (DOE 1991). Soil provides an integrating medium that can account for contaminants released to the atmosphere, either directly in gaseous emissions or indirectly from re-suspension of on-site contamination, or through liquid effluents released to a stream that is subsequently used for irrigation on farm lands. Consequently, soil contaminant data may provide information about potential pathways (e.g., soil ingestion, food ingestion, re-suspension into the air, and groundwater contamination) that may deliver radioactive materials or chemicals to humans.

The overall soil surveillance program at Los Alamos National Laboratory (LANL or the Laboratory) consists of

1. An institutional component that monitors soil within and around the perimeter of LANL in accordance with US Department of Energy (DOE) Orders 450.1 (DOE 2003) and 5400.5 (DOE 1993); and
2. A facility component that monitors soil (and sediment) within and around the perimeter of two Laboratory sites:
   - principal radioactive waste disposal area (Area G) in accordance with DOE Orders 435.1 (DOE 1999a) and M 435.1-1 (DOE 1999b), and
   - principal explosive test facility (Dual Axis Radiographic Hydrodynamic Test [DARHT]) in accordance with the Mitigation Action Plan (DOE 1996).

The objectives of LANL's soil surveillance program are to determine

1. Radionuclide and chemical (inorganic and organic chemicals) concentrations in soil collected from potentially impacted areas (institution-wide and facility-specific) and compare them to the appropriate soil standards (e.g., regional background levels, screening levels, and DOE standards);
2. Trends over time (i.e., whether radionuclide and chemical concentrations are increasing or decreasing); and
3. The committed effective dose equivalent potentially received by surrounding area residents (see Chapter 3 for the potential radiation doses that individuals may receive from exposure to soil).

B. SOIL COMPARISON LEVELS

To evaluate Laboratory impacts from radionuclides and chemicals in soil, we first compare the analytical results of samples collected from the Laboratory's on-site and perimeter areas with regional background levels. Where the results exceed these background levels, we then compare the concentrations with screening levels (SLs) and, finally, if needed, with the appropriate standard. Descriptions of the levels and/or the standard used to evaluate sthe results of radionuclides and chemicals in soil are as follows and an overall summary can be found in Table 7-1.

- Regional Statistical Reference Levels: RSRLs are the upper-level background concentration (mean plus three standard deviations = 99% confidence level) for radionuclides and chemicals calculated from soil data collected from regional locations away from the influence of the Laboratory over at least the last five sampling periods. RSRLs, which represent natural and fallout sources, are calculated as data become available and can be found in the supplemental data tables of this report.
- Screening Levels: SLs for radionuclides are set below the DOE single-pathway dose limit of 25 mrem/yr (DOE 1993, DOE 1999c) so that potential concerns may be identified in advance, i.e., a "yellow flag." If a radionuclide exceeds the SL, we investigate the basis for the exceedance. LANL developed SLs to identify radionuclides of potential concern on the basis of a 15-mrem/yr protective dose limit for several scenarios (LANL 2005) using the residual radioactive (RESRAD) computer model (Yu et al. 1995). We compare chemicals to the New Mexico Environment Department (NMED) SLs that are set at a 10^{-5} risk level for carcinogens and a hazard quotient (HQ) of 1 for non-carcinogens (NMED 2006). To evaluate these constituents in the most conservative manner, the values from perimeter and on-site areas are compared to SLs based on a residential scenario.
- Standard: If an SL for a radionuclide is exceeded, then a dose to a person is calculated using RESRAD and all of the measured radionuclide concentrations available from supplemental data Table S7-1. The calculated dose is based on a residential scenario with soil ingestion, inhalation of suspended dust, external irradiation, and ingestion of homegrown fruits and vegetables as the exposure pathways. Unit conversions, input parameters, model and parameter assumptions, and the uncertainty analysis we used are presented in Fresquez et al. 1996. This calculated dose is compared to the 25-mrem/yr DOE dose constraint standard.

Table 7-1
Application of Soil Standards and Other Reference Levels to LANL Monitoring Data

Constituent	Sample Location	Standard	Screening Level	Background Level
Radionuclides	Perimeter, On-site, and Area G	25 mrem/yr	15 mrem/yr (resident)	RSRL
	DARHT	25 mrem/yr	15 mrem/yr (resident)	RSRL/BSRL[a]
Chemicals	Perimeter, On-site, Area G		10^{-5} risk (resident) or HQ = 1	RSRL
	DARHT		10^{-5} risk (resident) or HQ = 1	RSRL/BSRL[a]

[a] Baseline Statistical Reference Levels (BSRL); a discussion of these levels is provided in Section D.3.

C. INSTITUTIONAL MONITORING

1. Monitoring Network

Institutional surface soil samples are collected from 17 on-site, 11 perimeter, and six regional (background) locations on a triennial basis (every third year) (Figure 7-1). Our last soil survey, which included the analysis of radionuclides, target analyte list (TAL) inorganic elements, polychlorinated biphenyls (PCBs), semi-volatile organic compounds (SVOCs), and high explosives (HE), occurred in 2006 (Fresquez 2007a). The next planned full-scale institutional soil assessment will occur in 2009.

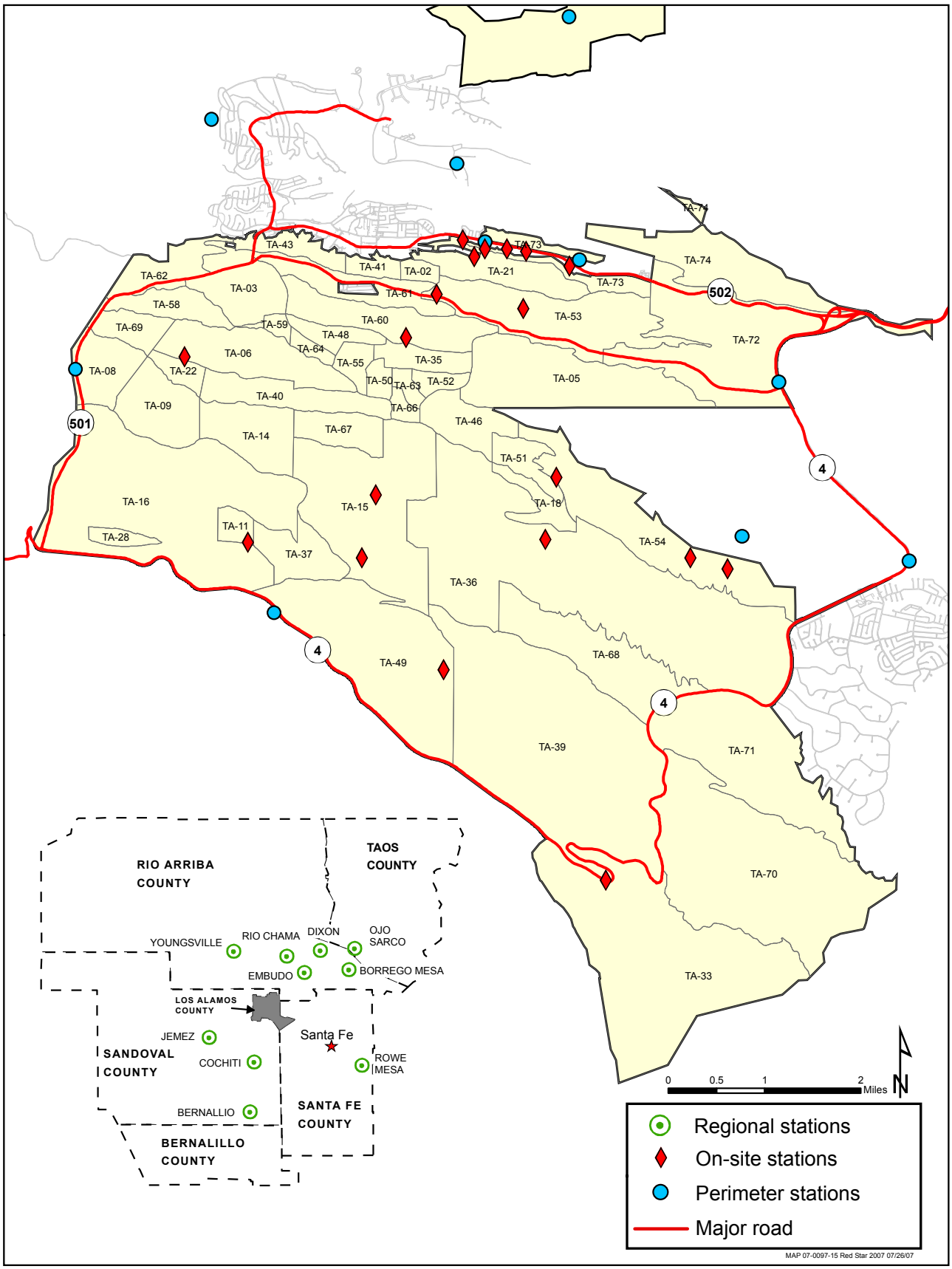

Figure 7-1. **On-site Laboratory, perimeter, and off-site regional soil sampling locations. (The two perimeter soil samples collected in 2007 are north of TA-54.)**

Although the institutional soil-sampling program was changed to a three-year sampling cycle, the Pueblo de San Ildefonso requested that we annually collect two perimeter soil samples for radionuclides and TAL elements on their lands that are downwind of Area G, the Laboratory's principal radioactive waste disposal site. Area G, approximately 63 acres in size, is located in Technical Area (TA) 54 at the Laboratory's eastern boundary. Soil samples on Pueblo de San Ildefonso lands were collected from relatively level, open (unsheltered by trees or buildings), and rock-free areas. One sample, identified as "San Ildefonso," was collected across Mortandad Canyon about one-half mile northeast (and downwind) of Area G, and the other sample, identified as "Tsankawi/PM-1," was collected just a little over two miles north of Area G.

Soil samples from these two perimeter stations were compared with soil samples collected from regional areas in northern New Mexico that surround the Laboratory in all major directions and where radionuclides and chemicals are mostly from natural sources or worldwide fallout events. These areas are located near Ojo Sarco, Dixon, and Borrego Mesa (near Santa Cruz dam) to the northeast; Rowe Mesa (near Pecos) to the southeast; Youngsville to the northwest; and Jemez to the southwest. All locations are at similar elevations to LANL, are more than 20 mi away from the Laboratory, and are beyond the range of potential influence from normal Laboratory operations as required by the DOE (DOE 1991).

Samples were analyzed for tritium, plutonium-238, plutonium-239/240, strontium-90, americium-241, cesium-137, uranium-234, uranium-235, and uranium-238 by Paragon Analytics, Inc. The soil samples were also analyzed for 23 TAL elements (aluminum, barium, beryllium, calcium, chromium, cobalt copper, iron, magnesium, manganese, nickel, potassium, sodium, vanadium, zinc, antimony, arsenic, cadmium, lead, selenium, silver, thallium, and mercury). The results from these sample analyses are presented in supplemental Table S7-1 and Table S7-2.

2. Radionuclide Analytical Results

All radionuclide (activity) concentrations in soil collected from both perimeter locations on Pueblo de San Ildefonso lands in 2007 were low (pCi range), and most were either not detected or detected below RSRLs (Table S7-1). A nondetected value is one in which the result is lower than three times the counting uncertainty and is not significantly ($\alpha = 0.01$, or 99% confidence level) different from zero (Keith 1991, Corely et al. 1981). The only radionuclides detected above the RSRLs were americium-241, uranium-234, and uranium-238 in the Tsankawi/PM-1 sample and plutonium-239/240 and americium-241 in the San Ildefonso sample.

Although these radionuclides were detected above the RSRLs, they are far below the SLs and thus do not pose a potential unacceptable dose to the public. Moreover, the uranium in the soil at the Tsankawi/PM-1 site was naturally occurring as the distribution of uranium-234 and uranium-238 was at equilibrium. These levels are very similar to past years and not increasing over time (Fresquez 2007a).

3. Chemical Analytical Results: Trace and Abundant Elements

Table S7-2 shows the results of the inorganic chemical analyses in surface soil collected from two perimeter sites located on Pueblo de San Ildefonso lands in 2007. All inorganic chemical concentrations from these two areas, with the exception of sodium, were detected below RSRLs. Sodium is a natural and essential element in soil and the difference between the concentration in the Tsankawi/PM-1 sample and the RSRL is small. There are no SLs for sodium in soils.

D. FACILITY MONITORING

1. Monitoring Network for Area G at TA-54

The Laboratory conducts facility-specific soil monitoring on an annual basis at Area G (Lopez 2002). Area G is a 63-acre radioactive waste processing area located on the east end of Mesa del Buey at TA-54 (Figure 7-1). Established in 1957, Area G is (as noted above) the Laboratory's primary radioactive solid waste burial and storage site (Hansen et al. 1980, Soholt 1990). Tritium, plutonium, americium, uranium, and a variety of fission and activation products are the main radionuclides in waste materials disposed at Area G (DOE 1979). Facility monitoring at Area G includes sample collection and analysis of air, sediment, surface water runoff, soil, vegetation, and small mammals for contaminants. Section D.2, below, reports on the 30 soil surface samples collected in 2007 at designated locations around the perimeter of Area G and one soil surface sample (T-3) collected at the LANL/Pueblo de San Ildefonso boundary line approximately 800 ft northeast of Area G (Figure 7-2).

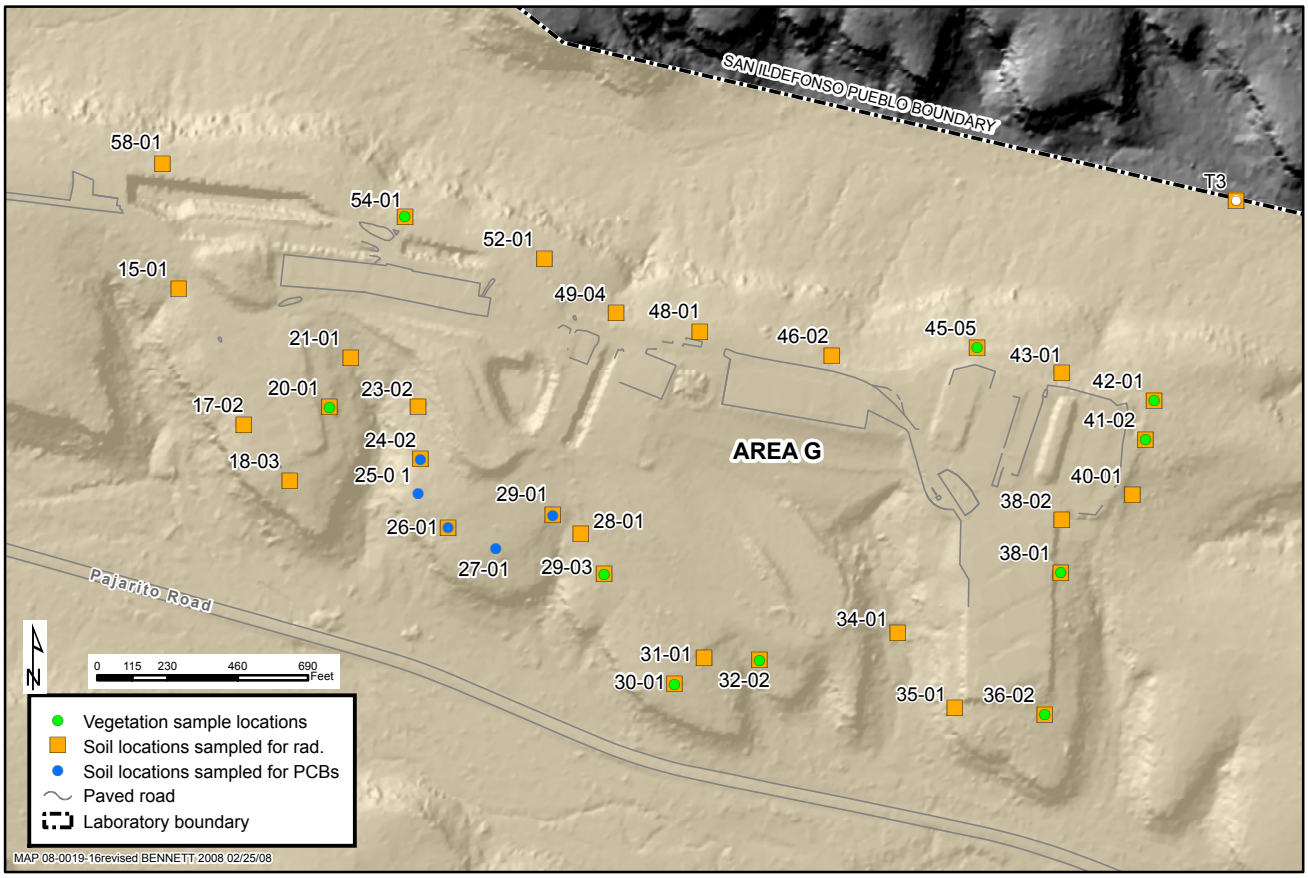

Figure 7-2. Locations of soil and vegetation samples collected at Area G in 2007.

Samples for analysis of radionuclides (tritium, plutonium-238, plutonium-239,240, americium-241, uranium-234, uranium-235, and uranium-238) were collected. In addition, five soil samples for polychlorinated biphenyl (PCB) analysis were collected from the southwestern side of Area G where traces of PCBs were detected in 2006 (location #26-01). All samples were analyzed by Paragon Analytics, Inc. The results from these samples are presented in supplemental Table S7-3 and Table S7-4. (Note: We report on the analyses of vegetation collected at Area G in Chapter 8, Section 4.a.)

2. Radionuclide and Nonradionuclide Analytical Results for Area G

a. Perimeter Results

Tritium, americium-241, plutonium-238, and plutonium-239/240 were detected at concentrations above the RSRLs in many of the 30 soil samples collected around the perimeter of Area G in 2007 (Table S7-3). Specifically, tritium was detected above the RSRL (0.86 pCi/mL) in 9 of the 30 samples with the majority of the concentrations above the RSRL reported in the southern portion of Area G where the tritium shafts are located. Although these data are within the range of concentrations detected in past years (Fresquez et al. 2004a, Fresquez and Lopez 2004, Fresquez et al. 2005, Fresquez 2006) they are variable from year to year (Figure 7-3). Nonetheless, with the exception of two years (2002 and 2003), the concentrations of tritium in soil at Area G have been below the SL of 5,400 pCi/mL, and the migration of tritium from the Area G boundary, at least at surface and subsurface depths, is not extensive. In a recent study involving the measurement of tritium in trees starting from the perimeter fence line outward (approximately 33, 165, 330, 490, and 660 ft), the concentrations of tritium decreased greatly with distance; at about 330 ft away, they were similar to the RSRL (Fresquez et al. 2003).

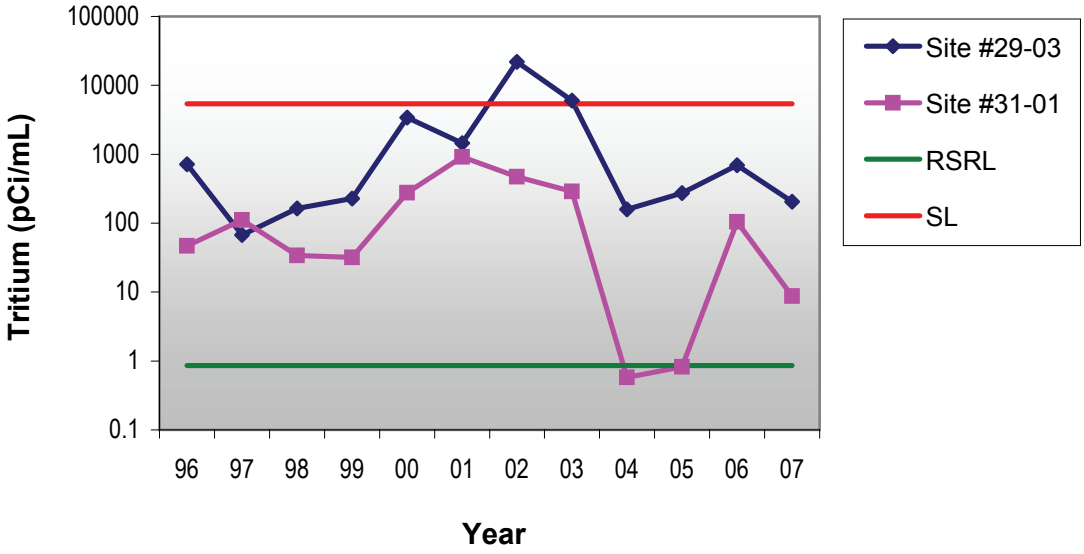

Figure 7-3. Tritium in surface soils collected from the southern portions of Area G at TA-54 from 1996 to 2007 as compared with the regional statistical reference level (RSRL) and the residential screening level (SL).

With respect to the concentrations of americium-241, plutonium-238, and plutonium-239/240 in soil at Area G, most samples showed higher amounts than the RSRLs, particularly around the perimeter of the northern, northeastern, and eastern sections (Table S7-3). Americium-241 was higher than the RSRL in 17 of 30 samples, plutonium-238 was higher in 18 of 30 samples, and plutonium-239/240 was higher in 19 of 30 samples. The highest concentrations (americium-241 = 2.4 pCi/g dry; plutonium-238 = 1.1 pCi/g dry; and plutonium-239/240 = 14 pCi/g dry) were detected in soil samples located on the perimeter of the eastern side of Area G near the Transuranic Waste Inspection Project (TWISP) domes. Plutonium-239/240, in particular, has doubled in concentration on the eastern part (location #38-01) over the past two years (Figure 7-4). Concentrations of plutonium-239/240 in other sections of Area G that have historically high levels (locations #41-02 and 43-01) have not generally increased over the years. However, all radionuclide concentrations, including plutonium-239/240, were below SLs.

No TAL elements were tested in 2007, but in 2006 most elements (478 out of 483 measurements) were at background levels (Fresquez 2007a), and the few detected above RSRLs were far below the SLs.

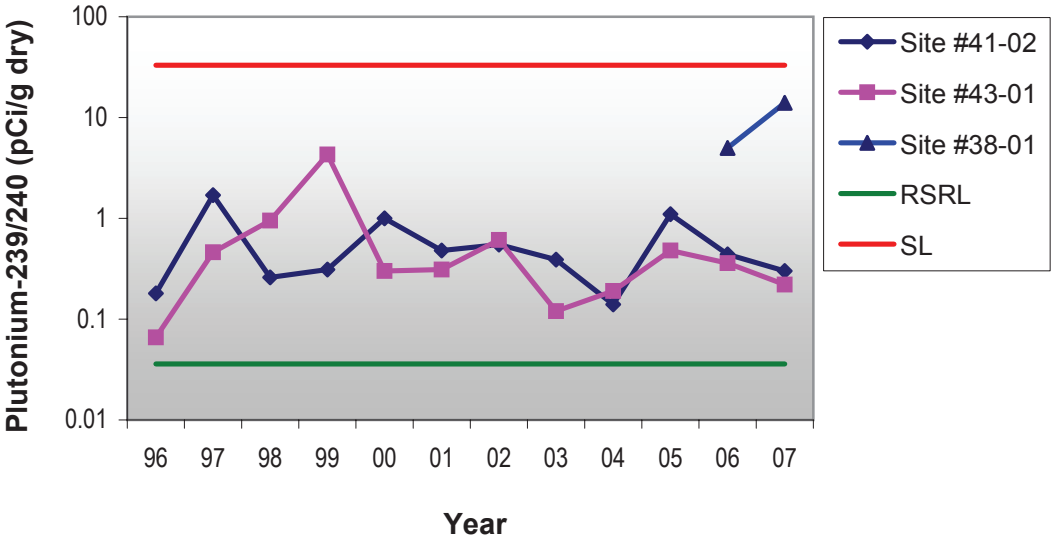

Figure 7-4. **Plutonium-239/240 in surface soils collected from the northeastern and eastern portions of Area G at TA-54 from 1996 to 2007 as compared with the regional statistical reference level (RSRL) and the residential screening level (SL).**

Last year, one soil sample out of 21 collected contained PCBs—namely at location #26-01 (Figure 7-2), which is on the southwester side of Area G. Aroclor-1254 and Aroclor-1260 (these are PCB commercial mixtures) concentrations in this one soil sample were reported at 0.067 and 0.094 mg/kg dry, respectively. Although the concentrations are two orders of magnitude below the residential SL of 1.1 mg/kg dry, we re-sampled this same location and collected two more samples on each side of the target area. No PCBs were detected above reporting limits in any of the five soil samples in 2007, including site #26-01 (Table S7-4). The results in 2006, therefore, may have been false positives.

b. Results at the Pueblo de San Ildefonso Boundary

Americium-241and plutonium-239/240 in a soil sample collected at the LANL/Pueblo de San Ildefonso boundary northeast of Area G were detected at concentrations above the RSRLs (Table S7-3). The level of americium-241in 2007 was similar to the level in 2006, but the concentration of plutonium-239/240 in 2007 was about four times higher than in the previous year (Figure 7-5). Although the plutonium-239/240 concentration in a soil sample collected at the LANL/Pueblo de San Ildefonso boundary was higher than the RSRL, the amounts are still far below the SLs. Moreover, the concentrations of plutonium-239/240 on Pueblo de San Ildefonso decrease to RSRLs within a relatively short distance from the San Ildefonso/Laboratory fence line. For example, most (nine out of 12) soil samples collected as part of the institutional monitoring program about 800 ft northeast of the fence line on the mesa top (the "San Ildefonso" site) from 1996 through 2007 showed plutonium-239/240 concentrations below the RSRL (Figure 7-6).

3. Monitoring Network for DARHT at TA-15

The Laboratory conducts facility-specific soil and sediment monitoring on an annual basis at DARHT (Nyhan et al. 2001). Approximately 20 acres in size, DARHT is located at R-Site (TA-15) at the Laboratory's southwestern end. Activities at DARHT include the utilization of very intense X-rays to radiograph a full-scale non-nuclear mock-up of a nuclear weapon's primary during the late stages of the explosively driven implosion of the device (DOE 1995). Open-air detonations occurred from 2000 to 2006, foam mitigation was used from 2002 to 2006, and closed steel containment vessels were used starting in 2007. Since May 2007, four hydrodynamic test shots at DARHT have been conducted within steel containment vessels. Potential contaminants include radionuclides, beryllium, heavy metals, and possibly organic chemicals like PCBs, high explosives (HE), and semi-volatile organic compounds (SVOCs).

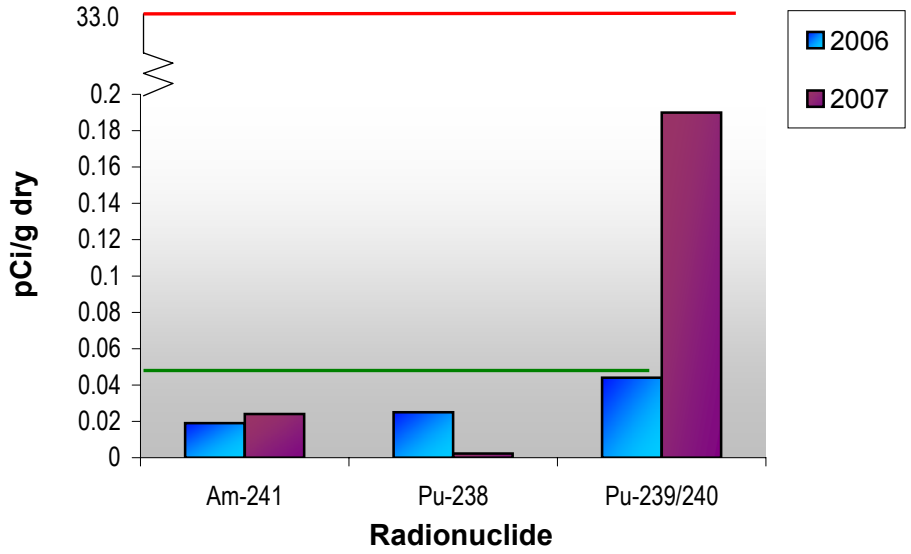

Figure 7-5. Transuranic radionuclides in surface soil collected from the LANL/ Pueblo de San Ildefonso boundary northeast of Area G at TA-54 in 2006 and 2007. The regional statistical reference level (green line) and the residential screening level (red line) are shown with respect to plutonium-239/240 levels.

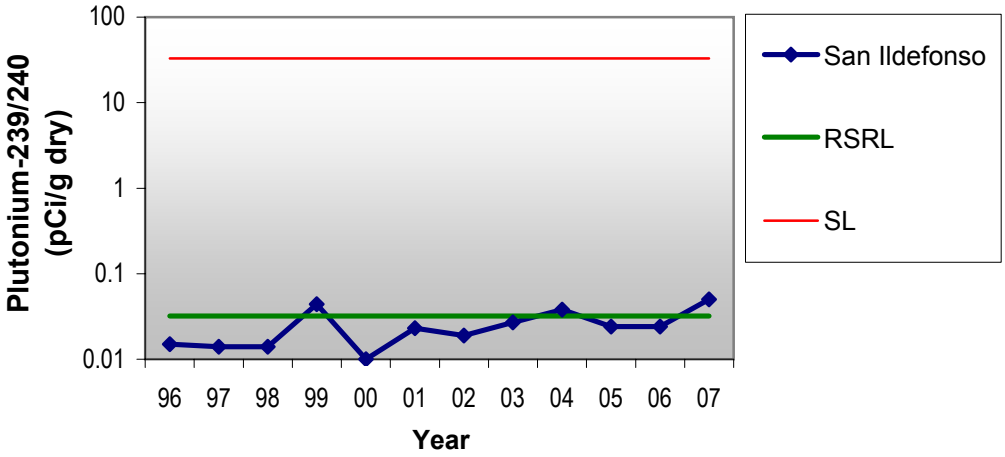

Figure 7-6. Plutonium-239/240 concentrations in soil samples collected from Pueblo de San Ildefonso lands approximately one-half mile northeast of Area G from 1996 through 2007 as compared with the regional statistical reference level (RSRL) and the residential screening level (SL).

Soil samples analyzed for radionuclides and inorganic chemicals are collected around the perimeter of the DARHT facility on the north, east, south, and west sides (Figure 7-7). An additional soil sample is collected on the north side near the firing point. Sediment samples were collected on the north, east, south, and southwest sides. All samples were analyzed for tritium; plutonium-238; plutonium-239/240; strontium-90; americium-241; cesium-137; uranium-234; uranium-235; uranium-238; and TAL elements. This year in addition to inorganic chemicals, we sampled and analyzed the same soil and sediment locations for PCBs, HEs, and SVOCs. (Note: We report on the analyses of vegetation, small mammals, and birds collected around the DARHT facility in Chapter 8, Section 4.b.)

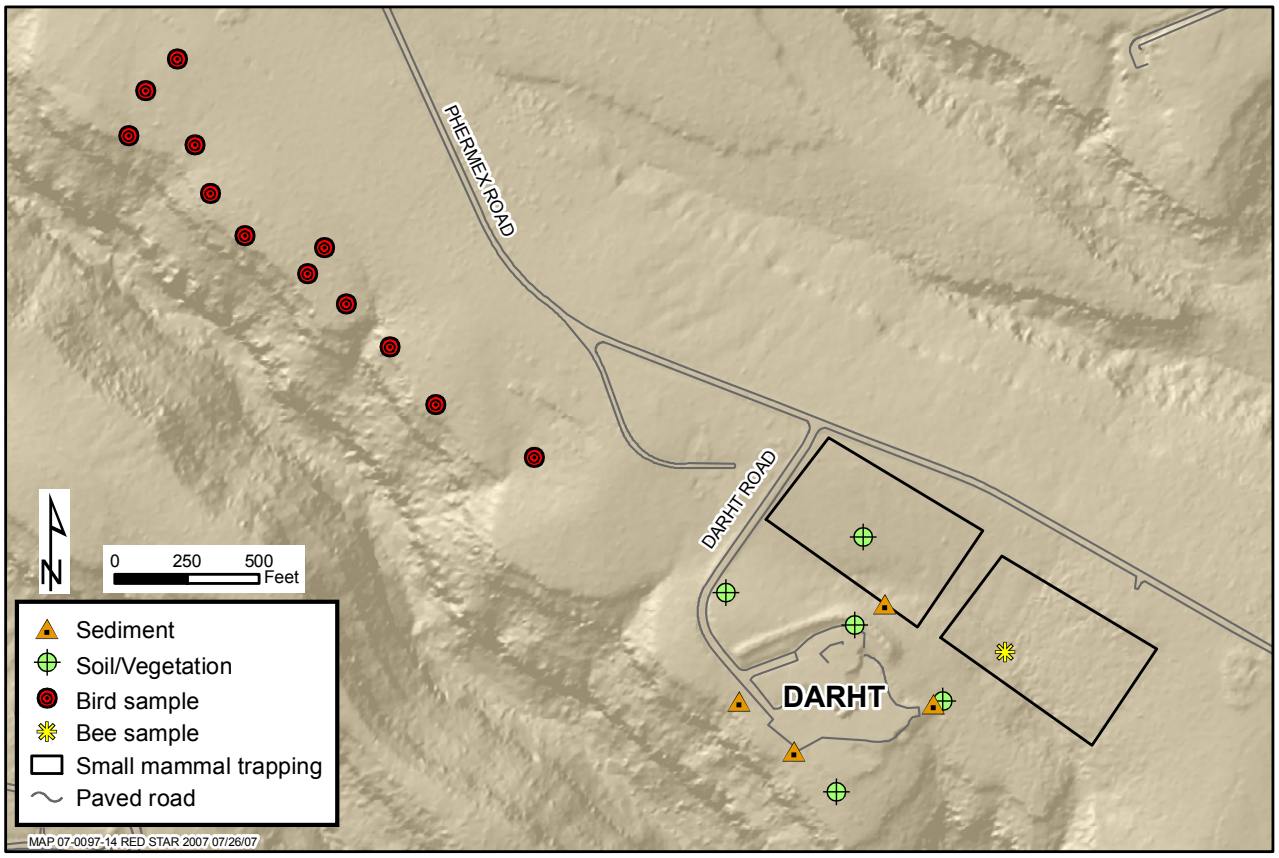

Figure 7-7. Sample locations of soil, sediment, and biota at DARHT in 2007.

We compared the radionuclide and chemical results in soil and sediment from the DARHT sampling to both RSRLs and baseline statistical reference levels (BSRLs). BSRLs are the concentrations of radionuclides and chemicals (mean plus three standard deviations) in soil and sediment collected from around the DARHT facility from1996 through 1999 before the start-up of operations (Fresquez et al. 2001), per the DARHT Mitigation Action Plan (DOE 1996). Both reference levels are employed because the BSRLs for some elements may be biased as a result of changes in pre- and post- sampling locations and a change in analytical techniques. A comparison of BSRLs with RSRLs, for example, shows some baseline radionuclide concentrations, like cesium-137, may be biased low and some baseline inorganic chemical concentrations, like silver, may be biased high irrespective of DARHT activities. Moreover, some TAL metals analyzed recently have no baselines at all. To accommodate parking spaces and storage areas within the DARHT complex after operations began, soil sampling locations had to be moved from within the fenced perimeter boundary (<100 ft. from the facility) to sites located outside the perimeter fence boundary (>300 ft. from the facility). This may have affected the concentrations of some radionuclides, particularly cesium-137, because the pre-operation samples were collected in mostly disturbed soil and the post-operation samples were collected in mostly undisturbed soil.

Higher amounts of fallout radionuclides would be expected in the undisturbed soil rather than the disturbed soil because of the mixing associated with disturbed soil. Moreover, the change in analytical techniques may have improved detection capabilities for some metals. The use of inductively coupled plasma mass spectrometry instrumentation to analyze post-operation samples, for example, substantially decreased the detection limits of silver, from 2 to 0.2 mg/kg.

4. Radionuclide and Nonradionuclide Analytical Results for DARHT

Soil from the firing site area was not sampled this year because of scheduling conflicts associated with entrance requirements within the control area at DARHT. Last year, only uranium-238 and beryllium were detected above the statistical reference levels in the soil sample collected nearest the firing point. While the beryllium concentration was slightly above the BSRL (Figure 7-8), the concentration of uranium-238 was approximately an order of magnitude above the BSRL and appears to be increasing over time through 2006 (Figure 7-9). Although the concentrations of uranium-238 and beryllium in the soil sample collected near the firing point were above BSRLs, the levels were still far below SLs.

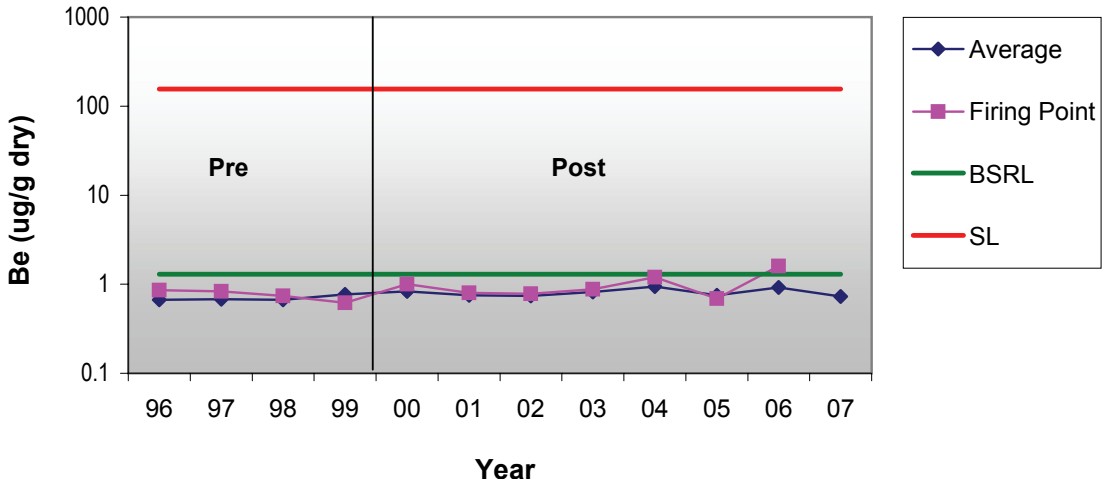

Figure 7-8. **Beryllium concentrations in soil collected within (near the firing point) and around (n = 4) the DARHT facility at TA-15 from 1996-1999 (pre-operation) to 2000-2007 (post-operation) as compared with the baseline statistical reference level (BSRL) and the residential screening level (SL).**

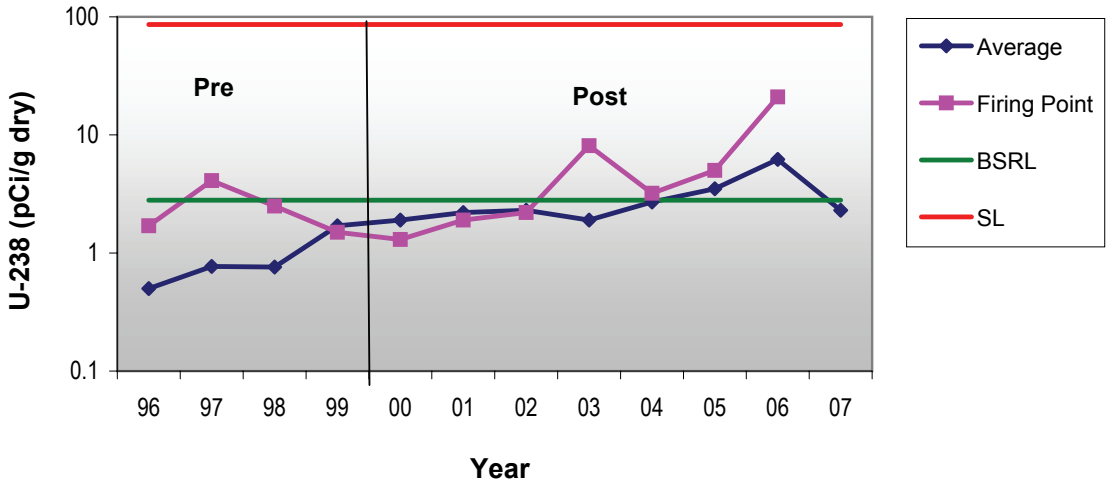

Figure 7-9. **Uranium-238 concentrations in soil collected within (near the firing point) and around (n = 4) the DARHT facility at TA-15 from 1996-1999 (pre-operation) to 2000-2007 (post-operation) as compared with the regional statistical reference level (BSRL) and the residential screening level (SL).**

This year, almost all the soil and sediment collected from around the perimeter of the DARHT facility contained concentrations of radionuclides and chemicals that were either not detected or below the statistical reference levels (Table S7-5 and Table S7-6). The amounts of beryllium and uranium-238, in particular, decreased from the years prior to 2006, a difference that may be associated with the change from foam to steel vessels for containment mitigation. The only radionuclide that was above the

BSRLs was uranium-235 in soil samples collected on the north and east sides of DARHT. These amounts, however, were just above the BSRL (0.14 versus 0.13 pCi/g dry) and far below the SL.

Analyses of PCBs, HE, and SVOCs in soil and sediment samples collected around the perimeter of the DARHT facility resulted in no detections in any of the constituents above the reporting limits (Table S7-7).

E. SPECIAL MONITORING STUDIES

1. Los Alamos Canyon Weir and Pajarito Flood Control Structure: Third Year Results

Special monitoring studies of sediment (and biota) were conducted at the Los Alamos Canyon Weir (LACW) and the Pajarito Canyon Flood Control Structure (PCFCS); this is the third year of study. The LACW is located at the northeastern boundary of LANL within TA-72 near the junction of NM State Road 4 and NM State Road 502. The PCFCS is located downstream of the confluence of Two-Mile and Pajarito Canyons at TA-18. Sediment samples along with vegetation and small mammals were collected upgradient (upstream) of the structures to assess potential impacts to the biota as a result of potentially contaminated surface water runoff and sediment. Because sediment was collected and analyzed in support of the biota monitoring, the results are presented in Chapter 8, Section C.1 and C.2.

2. Results of the Analysis of High Explosives in Soil from LANL to the Valles Caldera

A request was made by the Pueblo of Jemez to collect soil samples and analyze the material for high-explosive residues at locations from Minnie Site, the main open-air detonation point for disposal shots at LANL, to the Valles Caldera. To this end, we collected soil samples from six areas along a western line starting at a point west of Minnie Site at TA-49. Samples were also collected at a point at TA-16 (S-Site) (collected in 2006 and reported in the Environmental Surveillance Report, LA-14341-ENV, Table S7-3), a point at the boundary of LANL near the SR501/SR4 intersection across from TA-16, and three points in the Vales Caldera identified by Jemez Pueblo environmental staff.

Fourteen types of high explosives were analyzed. There were no high-explosive residues above the reporting limits in any of the soil samples collected. All data are presented in Fresquez (2007b).

3. Baseline Radionuclide and Chemical Concentrations in Soils, Vegetation, and Small Mammals at the Proposed Expansion Area at TA-54 Area G

Area G is a low-level radioactive solid waste processing and disposal area located on the east end of Mesa del Buey at TA-54. This disposal area has been in existence since 1957 and is expected to be filled by the year 2015. A new area, adjacent to Area G on the west side, has been proposed for the expansion of disposal activities. Since 1994 to present, baseline levels of 20 radionuclides and 12 TAL elements have been collected in soils, vegetation, and small mammals (field mice and rock squirrels). These data will be used to assess potential impacts, if any, at the expanded site once operations begin. BSRLs (mean plus three standard deviations= 99% confidence level) of radionuclides and chemicals in these media were calculated and compared with RSRLs. RSRLs are calculated from regional areas away from the influence of the Laboratory and represent natural and worldwide fallout sources.

BSRLs in most media, with the exception of the field mice (mostly *Peromyscus spp.*), compare very well with RSRLs. Field mice do appear to be impacted by Area G operations, showing higher concentrations of tritium, plutonium-238, plutonium-239/240, and americium-241 as compared to RSRLs. This finding probably stems from the fact that field mice are highly mobile and likely to spend time within the active disposal area. Overall, however, the preoperational data from the other media show that the proposed expansion area has been impacted very little by Area G operations.

For a full description of years sampled, sampling sites, number of samples, media, and data, see Romero and Fresquez (2007).

F. QUALITY ASSURANCE FOR THE SOIL, FOODSTUFFS, & BIOTA MONITORING PROGRAM

1. Quality Assurance Program Development

The sampling team collects soil, foodstuffs, and biota (SFB) samples according to written, standard quality assurance and quality control procedures and protocols. These procedures and protocols are identified in the *LANL Quality Assurance Project Plan for the Soil, Foodstuffs, and Biota Monitoring Project* and in the following LANL standard operating procedures:

- Produce Sampling
- Fish Sampling
- Game Animal Sampling
- Processing and Submitting Samples
- Soil Sampling
- Chain-of-Custody
- Sampling Soil and Vegetation at Facility Sites
- Analytical Chemistry Data Management and Review for Soil, Foodstuffs and Biota

These procedures, which are available on the LANL public website (http://www.lanl.gov/environment/all/qa.shtml), ensure that the collection, processing, and chemical analysis of samples, the validation and verification of data, and the tabulation of analytical results are conducted in a manner consistent from year to year. Locations and samples have unique identifiers to provide chain-of-custody control from the time of collection through analysis and reporting.

2. Field Sampling Quality Assurance

Overall quality of field sampling is maintained through the rigorous use of the carefully documented procedures, listed above, which govern all aspects of the sample-collection program.

The team collects all samples under full chain-of-custody procedures, to minimize the chances of data transcription errors. Once collected, we hand-deliver the samples to the LANL Sample Management Office, which ships them via FedEx directly to an external analytical laboratory under full chain-of-custody control. The LANL project leader tracks all samples. Upon receipt of data back from the laboratory (electronically and in hard copy), a LANL chemist assesses the completeness of the field-sample process along with other variables. A quality assessment document is created, attached to the data packet, and provided to the LANL project leader.

3. Analytical Laboratory Quality Assessment

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

Each analytical laboratory conducts chain-of-custody and analytical processes under its own quality plans and analytical procedures. Each laboratory returns data by e-mail in an electronic-data deliverable with a specified format and content. The analytical laboratory also submits a full set of paper records that serves as the legal copy of the data. Each set of records contains all the internal quality control data the analytical laboratory generates during the analyses (including laboratory control standards, method blanks, matrix spikes, duplicates, and replicates, when applicable). The electronic data are uploaded into the database and immediately subjected to a variety of quality and consistency checks. Analytical completeness is determined, tracking and trending of all blank and control-sample data are performed, and all the data are included in the quality assessment memo mentioned in the field sampling section. We track all parts of the data-management process electronically and prepare periodic reports to management.

4. Field Data Quality Assessment Results

Field data completeness for SFB in 2007 was greater than 95%.

5. Analytical Data Quality Assessment Results

Analytical data completeness for all SFB sampling programs was greater than 95% in 2007. We track, trend, and report all quality control data in specific quality evaluation memos which we submit to project staff along with each set of analytical data received from our chemistry laboratories. Overall results of the 2007 quality program indicate that all analytical laboratories maintained the same high level of control observed in the past several years.

6. Analytical Laboratory Assessments

During 2007, two external laboratories performed all chemical analyses reported for SFB samples:

- Paragon Analytics, Inc., Fort Collins, Colorado, provided radiological, TAL element, and organic chemical analysis of soil and sediment; radionuclide and TAL analysis of vegetation and small mammals; and processing of small mammals for PCB analysis.
- Alta Laboratories, California, provided PCB analysis from samples processed by Paragon.

We performed an assessment of Paragon Analytics, Inc., during 2004. The laboratory participated in national performance-evaluation studies during 2004 and 2005. Detailed results of these performance evaluations are included in the assessment report. Overall, the study sponsors judged the analytical laboratory to have acceptable performance for almost all analytes attempted in all matrices.

7. Program Audits

In 2005, we hosted a data quality assessment and evaluation to evaluate whether the procedures in various programs were being implemented as written. The auditors (Time Solutions 2) were professional external quality assurance experts (ISO 9000 and 14000 certified) and they examined all aspects of the SFB program procedures. While it was noted that improvements had been made to the SFB program since a previous audit (performed by auditors external to the sampling group but internal to LANL), several observations led to recommendations for improving processes for keeping procedures up to date and meeting internal commitments made in quality assurance plans. Since the data quality assessment, we have implemented all the recommendations.

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8. Foodstuffs and Biota Monitoring

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A. FOODSTUFFS MONITORING

1. Introduction

Foodstuffs within and around LANL may become contaminated through air (stack emissions and fugitive dust), soil (directly from the source), and water (storm water runoff and irrigation). The ingestion of these foods constitutes an important exposure pathway by which radionuclides (Whicker and Schultz 1982) and chemicals (inorganic and organic) (Gough et al. 1979) may be transferred to humans.

A wide variety of wild and domestic produce crops, including leafy vegetables, fruits, nuts, and grains are grown and harvested at many locations surrounding the Los Alamos National Laboratory (LANL or the Laboratory). Also, many food products from animals are available (e.g., milk, honey, and eggs), and fishing and hunting for small and big game animals (e.g., rabbits, deer and elk) on neighboring properties around LANL is a common occurrence. Elk and deer, for example, may graze through areas on LANL lands or drink from water catchments that may contain radioactive or chemical contamination. Fish could be exposed to potential contaminants entering the Rio Grande from runoff discharging from the canyons that cross Laboratory property.

The purpose of the foodstuff monitoring program is to determine whether Laboratory operations are impacting human health via the food chain. US Department of Energy (DOE) Orders 450.1 (DOE 2003) and 5400.5 (DOE 1993) mandate this monitoring program, and we accomplish this effort through the following tasks:

1. Measure radioactive and chemical concentrations in foodstuffs from neighboring communities and compare these results to regional (background), screening, and standard levels;

2. Determine concentration trends over time; and

3. Provide data used to estimate dose and risk from the consumption of the foodstuffs (see Chapter 3 for dose and risk estimates to individuals from the ingestion of foodstuffs).

In general, major foodstuffs like food crops and fish are collected every third year in a rotation with soil (and native vegetation). Other foods and wildlife are analyzed as they become available. We collected fish in 2005 (Fresquez et al. 2006) and soil and native vegetation in 2006 (Fresquez 2007). This year, we focused on the collection and analysis of radionuclides and other inorganic chemicals in domestic crop plants from neighboring communities surrounding the Laboratory. Also, we report on the analysis of wild edible plant foods collected downwind and down gradient of Area G, a low-level waste site, from within Cañada del Buey at the LANL/Pueblo de San Ildefonso boundary line, and on goat milk collected from the White Rock/Pajarito Acres area.

2. Foodstuffs Comparison Levels

To evaluate potential Laboratory impacts on foodstuffs in the neighboring communities from radionuclides and chemicals, we first compared the analytical results to regional statistical reference levels (RSRLs). RSRLs are the upper-level background concentration (mean plus three standard deviations = 99% confidence level) in foodstuffs collected from regional locations away from the influence of the Laboratory (> nine miles away) (DOE 1991) over at least the last five sampling periods. RSRLs represent natural and fallout sources, are calculated as data become available, and can be found in each of the supplemental data tables of this report.

If any radionuclide concentrations exceed RSRLs, we then compared the concentrations to screening levels (SLs). SLs are set below federal standards (= 1 mrem/yr, which is 4% of the 25 mrem/yr DOE single-pathway constraint) (DOE 1999) so that potential concerns may be identified in advance, i.e., a "yellow flag." If a radionuclide exceeds an SL, the basis for that increase is investigated. For target analyte list (TAL) metals, we are not aware of any specific SLs for most inorganic elements in foodstuff plants (the exception is 1 part per million [ppm] of mercury in plants) (FDA 2000); however, we attempt to calculate and compare the highest result against the % daily value (%DV) recommended by the Food and Drug Administration (FDA 1994). DVs are reference numbers to help consumers determine how much of a specific nutrient a food contains.

In the event that a radionuclide in foodstuffs exceeds an SL, then, based on the concentrations of all radionuclides in that foodstuff, we would calculate a dose to a person (Chapter 3). This dose is compared with the 25-mrem/yr DOE single-pathway dose constraint (DOE 1999). There are no standards for inorganic chemicals in most foodstuffs.

A summary of the RSRLs, SLs and the standard used to evaluate the results of radionuclides and inorganic elements in foodstuffs is presented in Table 8-1.

Table 8-1
Standards and Other Reference Levels Applied to Foodstuffs

Constituent	Sample Location	Media	Standard	Screening Level	Background Level
Radionuclides	On-site and perimeter	Foodstuffs	25 mrem/yr	1.0 mrem/yr	RSRLs
Inorganic Elements	On-site and perimeter	Foodstuffs	NA	% DV	RSRLs

NA = Not Available

3. Domestic Edible Plants

a. Monitoring Network

We collected 10 fruit and vegetable samples (apples, apricots, cherries, chile, corn, grapes, lettuce, peaches, squash, and tomatoes) from each of four communities surrounding the Laboratory in the summer/fall of 2007 (Figure 8-1). The four communities, their location with respect to the Laboratory, and the potential transport pathway(s) were as follows:

- Los Alamos, located north of LANL, air pathway;
- White Rock/Pajarito Acres, located southwest of LANL, air pathway;
- Pueblo de San Ildefonso/El Rancho, located northeast of LANL, air pathway; and
- Cochiti Pueblo/Sile/Pena Blanca, located south of LANL, water/irrigation pathway.

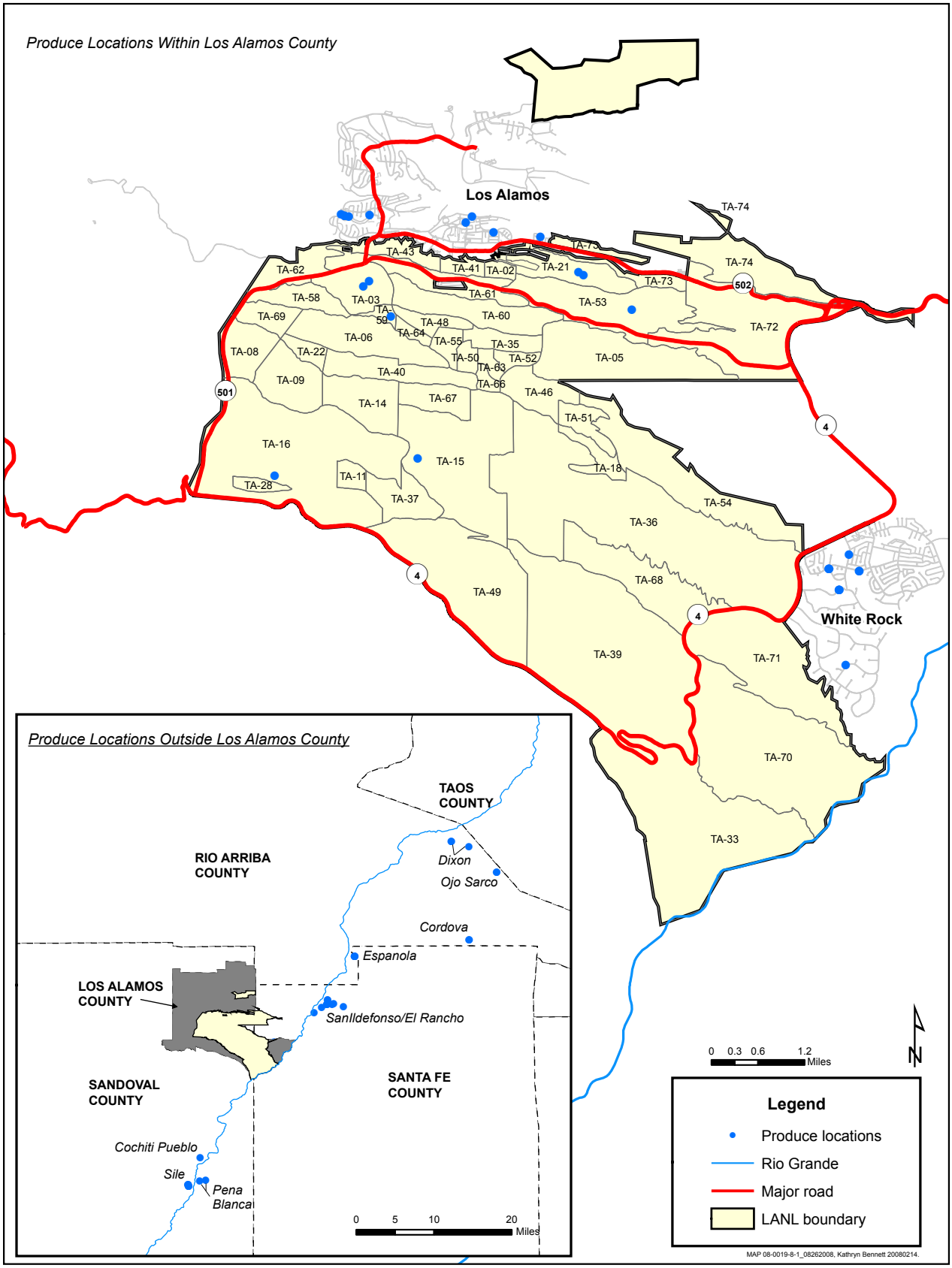


Figure 8-1. Locations of crops collected within and around LANL, 2007.

In addition, eight fruit samples (four apple, one apricot, one nectarine, and two peach) from six technical areas (TAs-3, 15, 16, 21, 53, and 59) within the Laboratory were collected. All samples were submitted to Paragon Analytical, Inc., where they were processed and analyzed for tritium, strontium-90, cesium-137, plutonium-238, plutonium-239/240, uranium-234, uranium-235, and uranium-238 and for 23 TAL inorganic elements (aluminum, barium, beryllium, calcium, chromium, cobalt, copper, iron, magnesium, manganese, nickel, potassium, sodium, vanadium, zinc, antimony, arsenic, cadmium, lead, selenium, silver, thallium, and mercury). Results for tritium are reported on a pCi/mL basis; results for the other radionuclides are reported on a pCi/g ash basis; and the results for the TAL elements are reported on an mg/kg dry basis.

The results from the on-site and perimeter area samples were compared to the results for the same types of fruits and vegetables collected from regional (background) areas away from the Laboratory. Radionuclides and TAL elements detected in produce from background areas are the result of worldwide fallout and naturally occurring sources. Regional sample areas included Cordova, Española, Dixon, and Ojo Sarco, New Mexico (Figure 8-1).

b. Radionuclide Analytical Results

Radionuclide (activity) concentrations in produce collected from on-site, perimeter, and regional (background) locations during the 2007 growing season are presented in Table S8-1. Most (99%) radionuclide concentrations in fruits and vegetables collected from on-site and perimeter areas were either not detected or detected below the RSRLs and are consistent with results from previous years (Fresquez et al. 2005). A nondetected result is one in which the result is lower than the minimum detectable amount and/or lower than three times the total propagated uncertainty (e.g., not significantly [$\alpha = 0.010$] different from zero [Keith 1991, Corely et al. 1981]).

The only radionuclides that were detected above RSRLs in 2007 were tritium in two fruit samples (apples and peaches) from the DP East facility at TA-21; a tritium research site (Figure 8-2) and uranium-234 and uranium-238 in a lettuce sample collected from the Los Alamos town site (Figure 8-3). (Note: The uranium in lettuce from Los Alamos was naturally occurring as the distribution of uranium-234 to uranium-238 was at 1:1). In both cases, the concentrations were similar or below levels from past years and far below SLs, and thus do not pose a potential unacceptable dose to humans who may ingest these fruits and vegetables.

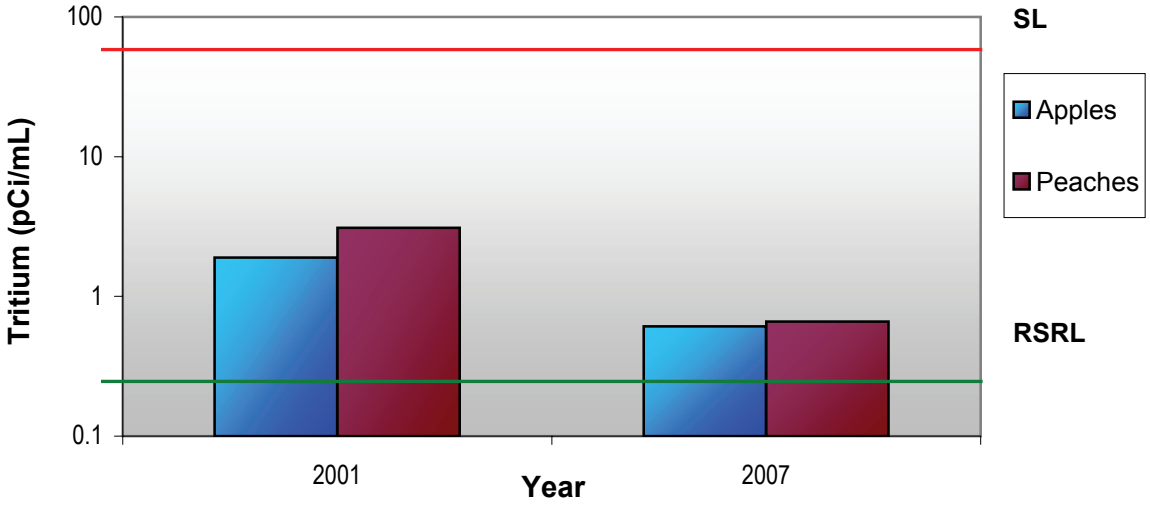


Figure 8-2. Concentrations of tritium in apples and peaches from DP East at TA-21 in 2001 and 2007 as compared with the regional statistical reference level (RSRL) and screening level (SL).

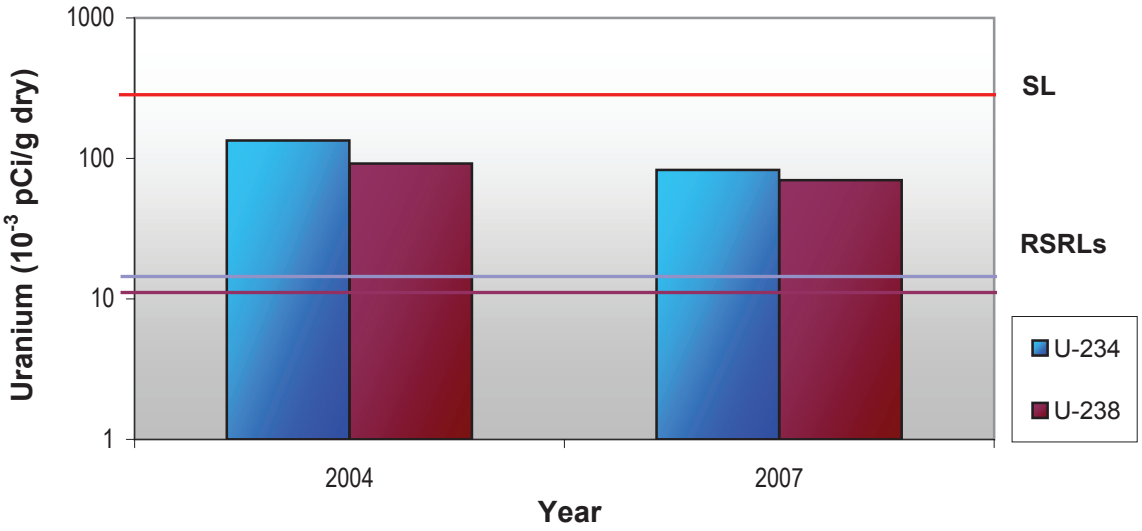


Figure 8-3. Concentrations of uranium-234 and uranium-238 in lettuce from the Los Alamos town site area in 2004 and 2007 as compared with the regional statistical reference levels (RSRLs) and screening level (SL).

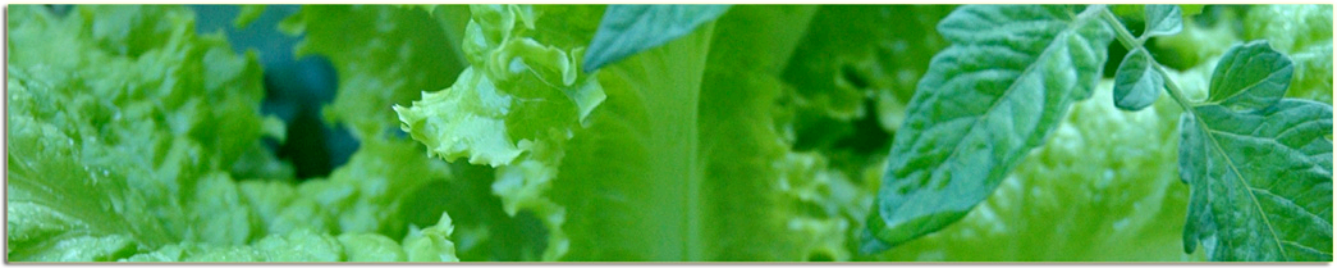
c. Chemical Analytical Results

Most (98%) TAL element concentrations in produce from on-site and perimeter areas were either not detected or were detected below the RSRLs (Table S8-2). The two elements in two or more produce samples from a community area that were above RSRLs included chromium (two samples from Cochiti/Sile/Pena Blanca) and selenium (two samples from White Rock/Pajarito Acres, four samples from Los Alamos townsite and two samples from Pueblo de San Ildefonso/El Rancho). The slightly higher concentrations of chromium and selenium in produce from perimeter areas as compared with RSRLs are more likely a result of (trace mineral) fertilizer additions by the small-scale farmer rather than from Laboratory operations since all of the sampled Laboratory fruit was at normal levels (<RSRLs).

Chromium and selenium are naturally occurring and widely distributed in the soil (Bowen 1979), with low concentrations in the diet being essential for good health (National Institute of Health 2004, 2005). A calculation, below, of the %DV using the highest amounts of chromium in lettuce and selenium in kale from the perimeter locations show that the contribution of these minerals to the recommended daily value required for good nutrition is still relatively low (FDA 1994).

Chromium in (green leaf) lettuce: 2.2 µg/g dry × 0.092 (dry to wet weight conversion ratio) = 0.20 µg/g wet × 36 g (one cup shredded) = 7.2 µg ÷ 120 µg (FDA daily value) = 0.060 × 100 = 6% (%DV).

Selenium in (raw) kale: 0.23 µg/g dry × 0.12 (dry to wet weight conversion ratio) = 0.028 µg/g wet × 67 g (one cup chopped) = 1.9 µg ÷ 70 µg (FDA daily value) = 0.027 × 100 = 3% (%DV).



4. Goat Milk

a. Monitoring Network

No commercial dairies operate in the general vicinity of LANL. However, there are a few residents of White Rock who raise goats for milk. The milk is for private use and is not sold commercially.

This year, one whole goat milk sample was collected from a farm located in the White Rock/Pajarito Acres area and compared with goat milk collected from three farms from regional locations (Pena Blanca, Penasco, and Lumberton, New Mexico). Radionuclides in milk from regional areas are due to worldwide fallout and to naturally occurring sources. The goat milk samples were collected directly by the farmer, placed into labeled 1L polyethylene bottles provided by the Laboratory, and submitted under chain of custody to Paragon Analytics, Inc., for the analysis of tritium, iodine-131, cesium-137, strontium-90, americium-241, uranium-234, uranium-235 and uranium-238. All results are reported on a pCi/L basis.

b. Radionuclide Analytical Results

All radionuclide concentrations in goat milk from White Rock/Pajarito Acres were either not detected or below RSRLs (Table S8-3). These data are very similar to past years and are not increasing over time (Fresquez 1998, Fresquez et al. 2004).

5. Wild Edible Plants

a. Monitoring Network

Over the past years, we have collected a variety of wild edible plants from the mesa top and canyon bottom areas within the Laboratory. Our most recent sampling of wild edible plants was within the ephemeral stream channels of Mortandad Canyon on the eastern side of LANL on Pueblo de San Ildefonso land. Results of common purslane, acorns, common lambsquarters (Fresquez et al. 2005b, 2006), and pigweed amaranth (Fresquez et al. 2007a) showed that there were no significant impacts from Laboratory operations on these wild food plants in those areas.

This year, we focused on collecting wild edible plants downwind (northeast) and down gradient of Area G, a low-level radioactive waste site, in Cañada del Buey at the LANL/Pueblo de San Ildefonso boundary. Samples of piñon pine (two samples), wax current (two samples), purslane (one sample), and common lambsquarters (two samples) were collected. Plants were processed and analyzed by Paragon Analytics, Inc., for tritium, plutonium-238, plutonium-239/240, strontium-90, americium-241, cesium-137, uranium-234, uranium-235, and uranium-238. Also, 23 TAL elements were analyzed. Results are reported on the same basis as the domestic crops.

b. Radionuclide Analytical Results

Most of the radionuclide results for the four species of wild edible plants collected from within Cañada del Buey at the LANL/Pueblo de San Ildefonso boundary northeast of Area G were either not detected or had concentrations below the RSRLs (Table S8-4). The only radionuclide that was detected above the RSRL was tritium in three of the seven wild food plant samples. Tritium is commonly detected in soil (see section Chapter 7 and section D.2.a for soil tritium results) and native vegetation (see Chapter 8, Section B.4.a.ii for native plant results) at Area G, but the amounts in these wild edible plants were still far below the SL (Figure 8-4) and do not pose a potential unacceptable dose to humans who may ingest them.

c. Chemical Analytical Results

Most (87%) TAL element concentrations in piñon, wax current, purslane, and common lambsquarters collected northeast of Area G from within Cañada del Buey at the LANL/Pueblo de San Ildefonso boundary were either not detected (below the reporting limits) or detected below the RSRLs (Table S8-5). The elements that were detected above the RSRLs in two or more samples included manganese, selenium, thallium, and mercury. All of

these elements in wild edible plants in Cañada del Buey were just above the RSRLs and do not pose a significant risk. Mercury was still far below the 1 mg/kg FDA screening level and a calculation of the %DV using the highest selenium and manganese levels (thallium is not considered a required nutrient and no data intakes were available) in lambsquarters shows that the nutrients are below or near the recommended percent daily intake.

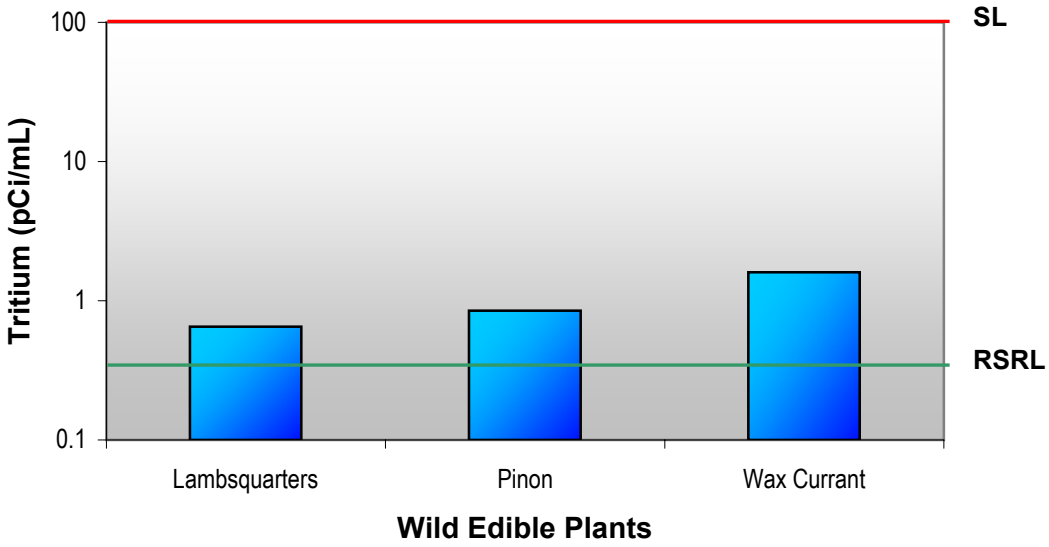


Figure 8-4. The highest concentrations of tritium in three wild food plants collected northeast of Area G at the bottom of Cañada del Buey on the LANL/ Pueblo de San Ildefonso boundary as compared with the regional statistical reference level (RSRL) and screening level (SL).

Selenium in wax current:	0.090 µg/g dry × 0.19 (dry to wet weight conversion ratio) = 0.017 µg/g wet × 112 g (one cup) = 1.9 µg ÷ 70 µg (FDA daily value) = 0.027 × 100 = 3% (%DV).
Manganese in lambsquarters:	120 µg/g dry × 0.17 (dry to wet weight conversion ratio) = 20 µg/g wet × 180 g (one cup chopped) = 3600 µg ÷ 2000 µg (FDA daily value) = 1.8 × 100 = 180% (%DV).

(Note: The levels of manganese are still below the upper limit level for consumption (e.g. <11,000 µg or 550% DV) (Nutrition ATC 2008) so the risk of toxicity to humans is small. Also, as a matter of comparison, the %DV of a background lambsquarter plant containing 55 µg/g dry of manganese (Fresquez et al. 2007b, Table S8-2) would be about 80%. So, the amounts of manganese in wild edible plants appear to be normally high.)

B. BIOTA MONITORING

1. Introduction

DOE Orders 450.1 (DOE 2003) and 5400.5 (DOE 1993) mandate the monitoring of biota (plants and animals not normally ingested by humans) for the protection of ecosystems. Monitoring of biota, mostly in the form of facility-specific or site-specific studies, began in the 1970s with the Environmental Surveillance Program, while site-wide native vegetation monitoring started in 1994. Presently, in addition to native vegetation, we also monitor small mammals, amphibians, reptiles, birds, and bees within and around LANL on a systematic basis or for special studies. Detection of contaminants in biota may indicate that these animals may be entering contaminated areas (e.g., burrowing in waste burial grounds) or that material is moving out of contaminated areas (e.g., blowing dust, transported soil/sediment via storm water, or food-chain transport).

The three objectives of the biota program are to determine the following:

1. Determine radionuclide and chemical concentrations in biota from on-site (LANL property) and perimeter areas and compare these results to regional (background) areas,

2. Determine concentration trends over time, and

3. Estimate potential dose to plants and animals.

Chapter 3 presents the results of the 2007 biota dose assessments at LANL.

2. Biota Comparison Levels

Like the foodstuffs biota data, Laboratory impacts from radionuclides and inorganic elements in biota were first compared to RSRLs. If the levels exceed RSRLs, we compared the concentrations with SLs, if available, and then to standards, if available. Comparison levels are summarized below and presented in Table 8-2:

- Regional background levels: RSRLs are the upper-level background concentrations (mean plus three standard deviations) for radionuclides and chemicals calculated from biota data collected from regional locations away from the influence of the Laboratory (>nine miles away) (DOE 1991) over the past five sampling periods. RSRLs represent natural and fallout sources, are calculated annually, and are presented in Table S8-3 through Table S8-25 of this report.

- Screening Levels: SLs are set below federal regulatory standards so that potential concerns may be identified in advance of potential ecological health problems—that is, they are a "yellow flag." If a constituent exceeds an SL, then the reason for that exceedance is thoroughly investigated. For radionuclides in biota biota, SLs were set at 10% of the standard by the dose assessment team at the Laboratory to identify the potential contaminants of concern (McNaughton 2006). Chemicals are compared with toxicity values (TVs) obtained from the literature.

- Standards: Based on the concentrations of radionuclides in biota, we calculate a dose and compare it with the 1 rad/d DOE dose standard for terrestrial plants and aquatic biota and 0.1 rad/d for terrestrial animals (DOE 2002).

Table 8-2
Standards and Other Reference Levels Applied to Biota

Constituent	Sample Location	Media	Standard	Screening Level	Background Level
Radionuclides	On-site and perimeter	Terrestrial plants	1 rad/d	0.1 rad/d	RSRLs
	DARHT	Terrestrial plants	1 rad/d	0.1 rad/d	RSRLs/BSRLs[a]
	On-site and perimeter	Terrestrial animals	0.1 rad/d	0.01 rad/d	RSRLs
	DARHT	Terrestrial animals	0.1 rad/d	0.01 rad/d	BSRLs
Chemicals	On-site and perimeter	Biota	NA	TVs	RSRLs
	DARHT	Biota	NA	TVs	RSRLs/BSRLs

[a] Baseline Statistical Reference Levels (BSRL) and a discussion of these levels can be found in Section 4.b.i.

3. Institutional Monitoring

No institutional monitoring of native vegetation was performed in 2007. Native understory (grasses and forbs) and overstory (trees) vegetation is collected on a triennial basis at the same time and at the same locations as the soil monitoring program (17 on-site, 11 perimeter, and six regional locations) described in Chapter 7, Section C.1 (Figure 7-1). The next sampling period for the collection of native vegetation is in the year 2009. For a discussion of past results, see Gonzales et al. (2000) for 1998 sampling results, Fresquez and Gonzales (2004) for 2002 and 2003 sampling results, and Fresquez et al. (2007a) for a discussion of 2006 sampling results.

In general, all radionuclide and other inorganic chemical concentrations in native understory and overstory vegetation sampled from Laboratory and perimeter areas are very low and most are indistinguishable from regional background areas.

4. Facility Monitoring

a. Area G at TA-54

i. Monitoring Network

The Laboratory conducts facility-specific vegetation monitoring on an annual basis at Area G (Lopez 2002). A description of the area and the types of waste disposed of at Area G is presented in Chapter 7 Section D.1. This year, 10 locations at designated sites spaced equally around the perimeter of Area G were sampled for both understory and overstory vegetation (see Chapter 7, Figure 2, for sample locations). One set of samples was also collected at the LANL/Pueblo de San Ildefonso boundary downwind and northeast of Area G.

Historically, plants collected around the southern portions of Area G contain higher amounts of tritium than background and plants collected around the east and northeastern perimeter sections of Area G contain higher amounts of plutonium and americium than background (Fresquez and Lopez 2004, Fresquez et al. 2004, 2005a). Vegetation samples were processed and analyzed by Paragon Analytics, Inc., for tritium, cesium-137, strontium-90, americium-241, plutonium-238, plutonium-239/240, uranium-234, uranium-235, and uranium-238, and for 23 TAL elements. Results for tritium are reported on a pCi/mL basis; results for the other radionuclides are reported on a pCi/g ash basis; and the results for the TAL elements are reported on an mg/kg dry basis.

ii. Vegetation Results for Area G

Most radionuclides, with the exception of tritium, plutonium-238, and plutonium-239/240 in overstory vegetation (Table S8-6) and understory vegetation (Table S8-7) were not detected or were detected below RSRLs. The highest amounts of tritium were detected in understory (5750 pCi/mL compared with the RSRL of 0.56 pCi/mL) and overstory (1420 pCi/mL compared with the RSRL of 0.71 pCi/mL) plants on the southern portion of Area G near the tritium shafts (see Chapter 7, Figure 7-2, near location # 29-03). Concomitantly, the highest amounts of plutonium-238 and plutonium-239/240 were detected in understory vegetation collected on the northeastern and eastern side of Area G; the concentrations of plutonium-239/240 in understory vegetation at site # 38-01, in particular, were over four times higher than the RSRL (0.082 pCi/g ash compared with the RSRL of 0.017 pCi/g ash). Both tritium and plutonium-239/240 concentrations in understory and overstory vegetation correlate well with the soil data (Table S7-3). Also, concentrations of tritium and plutonium-239/240 are similar to previous years and although these radionuclides in vegetation at Area G are higher than the RSRLs, the amounts are still very far below the SLs (e.g., for tritium it is <345,000 pCi/mL and for plutonium it is <578 pCi/g ash) (Figures 8-5 and 8-6). Therefore these radionuclides do not pose a potential unacceptable dose to the vegetation growing around Area G.

With respect to the native understory and overstory plants collected at the LANL/Pueblo de San Ildefonso boundary in Cañada del Buey northeast of Area G, most of the radionuclides, with the exception of plutonium-238 in understory vegetation, were either not detected or were detected below RSRLs (Table S8-6 and S8-7). The differences between the reported value for plutonium-238 and the RSRL, however, were small and the amounts were far below the SL.

b. DARHT at TA-15

i. Monitoring Network

The Laboratory conducts facility-specific biota monitoring on an annual basis at DARHT (Nyhan et al. 2001) (DOE 1996). In 2007, the biota samples collected at DARHT included vegetation, small mammals, bees, and birds (see Chapter 7, Figure 7-7). Open air detonations occurred from 2000-2006; foam mitigation was used from 2002-2006; and closed steel containment vessels were used starting in 2007. Since May 2007, four hydrodynamic test shots at DARHT were accomplished within steel containment vessels.

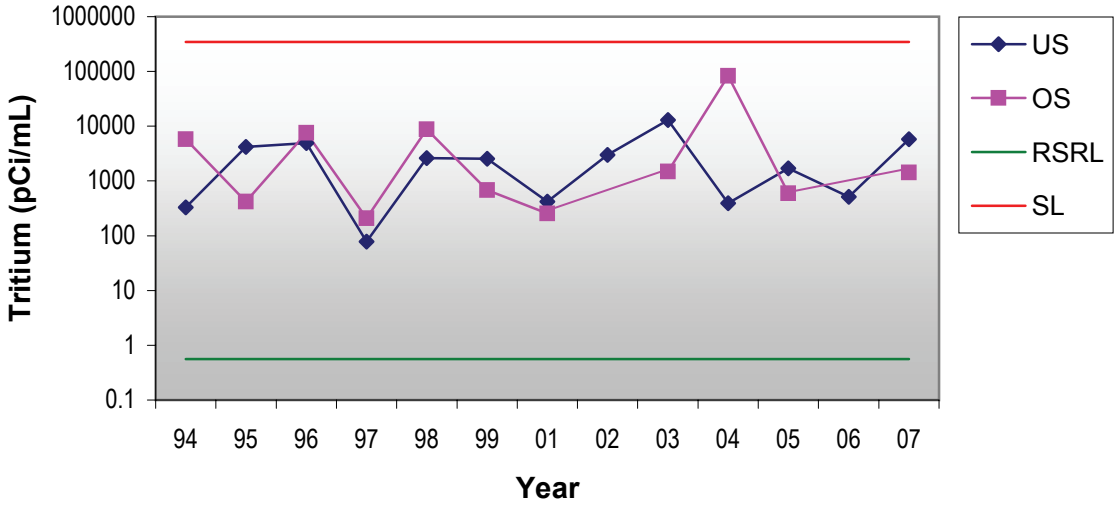


Figure 8-5. **Tritium in understory (US) and overstory (OS) vegetation collected from the south side (see Chapter 7, Figure 7-4 for location information associated with site[s] near #29-03) of Area G at TA-54 from 1994 through 2007 compared with the regional statistical reference level (RSRL) and the screening level (SL). Note the logarithmic scale on the vertical axis.**

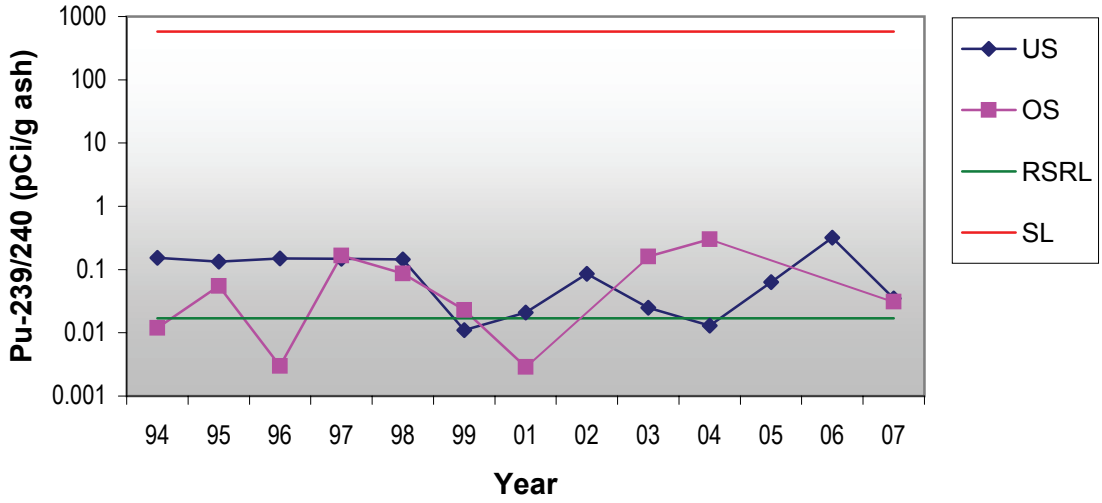


Figure 8-6. **Plutonium-239,240 in understory (US) and overstory (OS) vegetation collected from the northeast side (see Chapter 7, Figure 7-4 for location information associated with site[s] near #41-02) of Area G at TA-54 from 1994 through 2007 compared with the regional statistical reference level (RSRL) and the screening level (SL). Note the logarithmic scale on the vertical axis.**

Overstory and understory vegetation samples are collected on the north, south, west, and east sides of the complex. Small mammals, mostly deer mice (*Peromyscus* spp.), are collected using traps from two sample grids located on the north and northeast side of the DARHT facility. Bird samples were collected using 12 mist capture net traps spaced about 200 ft to 1,600 ft outward from the west side of the DARHT facility. Spacing of the nets was about 150 ft from one another. Finally, we collected honey bees from four hives located just northeast of the DARHT facility.

All biota samples were submitted to Paragon Analytics, Inc., where they were processed and analyzed for concentrations of tritium, plutonium-238, plutonium-239/240, strontium-90, americium-241, cesium-137, uranium-234, uranium-235, uranium-238, and TAL inorganic chemicals. Results for tritium are reported on a pCi/mL basis; results for the other radionuclides are reported on a pCi/g ash basis; and the results for the TAL elements in vegetation are reported on an mg/kg dry basis whereas the TAL elements in field mice, bees and birds are reported on an mg/kg wet basis.

Results of the vegetation, small mammals, bees, and bird samples were compared with either RSRLs or baseline statistical reference levels (BSRLs). BSRLs are the upper-limit baseline data established over a four-year period (1996–1999) prior to the start-up of DARHT operations in 2000. The BSRLs, at the three sigma level, are based on data from Fresquez et al. (2001a) for vegetation, Haarmann (2001) for bees, and Bennett et al. (2001) for small mammals. The bird samples collected from DARHT were compared with bird samples collected from regional background locations and the RSRLs can be found in the present data. Also, RSRLs were used in other media where BSRLs were not available.

i. Vegetation Results at DARHT

Most of the understory vegetation results for radionuclides, with the exception of tritium, were lost in analysis (i.e., inadvertently destroyed by the analytical laboratory) (Table S8-8). However, no significant detections of radionuclides above RSRLs in understory vegetation at DARHT have been found in the past, and the concentrations of radionuclides are usually higher in overstory vegetation than in understory vegetation (Fresquez et al. 2007c; Figure 8-6). (Note: A possible explanation for this observation is that after a DARHT shot, the dust may become elevated and is probably caught on the sticky sap of the tree shoots.)

With respect to overstory vegetation, all radionuclide concentrations, with the exception of uranium-238, were either not detected or were detected below BSRLs. The highest concentrations of uranium-238 were detected in overstory vegetation collected from the north, east, and west sides of the DARHT perimeter, and the isotopic distribution of uranium-234 to uranium-238 indicates that the uranium in vegetation was made up of depleted uranium. Depleted uranium, which is used as a substitute for enriched uranium in weapon components tested at LANL, has also been detected in soil (Fresquez 2004), bees (Hathcock and Haarmann 2004), small mammals (Fresquez 2005), and birds (Fresquez et al. 2007a) at DARHT in previous years.

Although concentrations of uranium-238 appear to be increasing over time up to 2006, particularly on the north and east sides (principal wind directions), the 2007 results show a slight downward turn (Figure 8-7). These results correlate well with the soil data (Table S7-5) and may be associated with the change in contaminant mitigation from foam to the use of steel containment vessels during 2007. Nevertheless, all concentrations of uranium-238 in overstory vegetation at DARHT were still far below the SL (<889 pCi/g ash) and do not pose a potential unacceptable dose to the plants.

The results for the 23 TAL elements in both understory and overstory vegetation collected from around the DARHT facility is summarized in Table S8-9. All of the elements were either below the detection limits or detected below the BSRLs (or below the RSRLs when BSRL data were not available).

Last year, arsenic was detected in an overstory sample collected on the south side of the DARHT facility that measured 2.3 mg/kg; this was over six times the BSRL and above the SL of 2.1 mg/kg. This year, an analysis of the same trees showed normal concentrations of arsenic (<0.34 mg/kg). Since there is no history of arsenic contamination in soil, sediment, vegetation, or small mammals from within or around the DARHT facility, the abnormally high arsenic level in an overstory plant sample from the south side in 2006 may have been due to an analytical error. Nonetheless, we will continue to monitor.

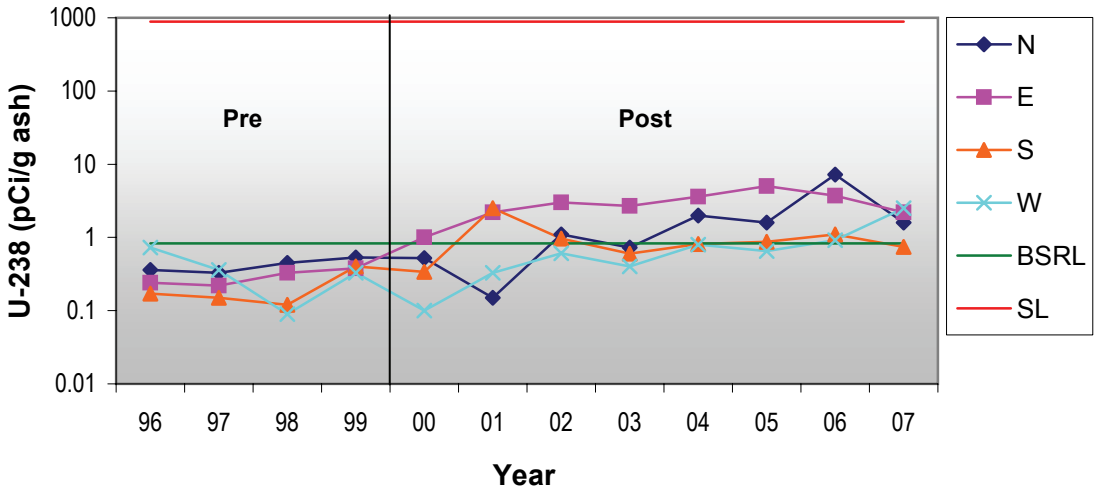


Figure 8-7. **Uranium-238 in overstory vegetation collected from the north (N), east (E), south (S), and west (W) side of the DARHT facility at TA-15 from 1996 (pre-operation) through 2007 (during operations) compared with the baseline statistical reference level (BSRL) and the screening level (SL). Note the logarithmic scale on the vertical axis.**

ii. Small Mammal Results at DARHT

All radionuclides were either not detected or below the BSRLs (Table S8-10), with the exception of uranium-238 in a composite mouse sample (five mice per sample) that was collected on the north side of the DARHT facility. Similarly, there were no other TAL inorganic chemicals in field mice that were higher than the RSRLs (Table S8-11).

The highest level of uranium-238 (2.4 pCi/g compared with the BSRL of 0.75 pCi/g ash) was far below the SL (<46 pCi/g ash) and does not pose a potential unacceptable dose to the mice. Like the soil and vegetation collected around certain sections of DARHT, the uranium in field mice was depleted uranium and uranium-238 concentrations appear to be increasing over time from preoperational levels (Figure 8-8).

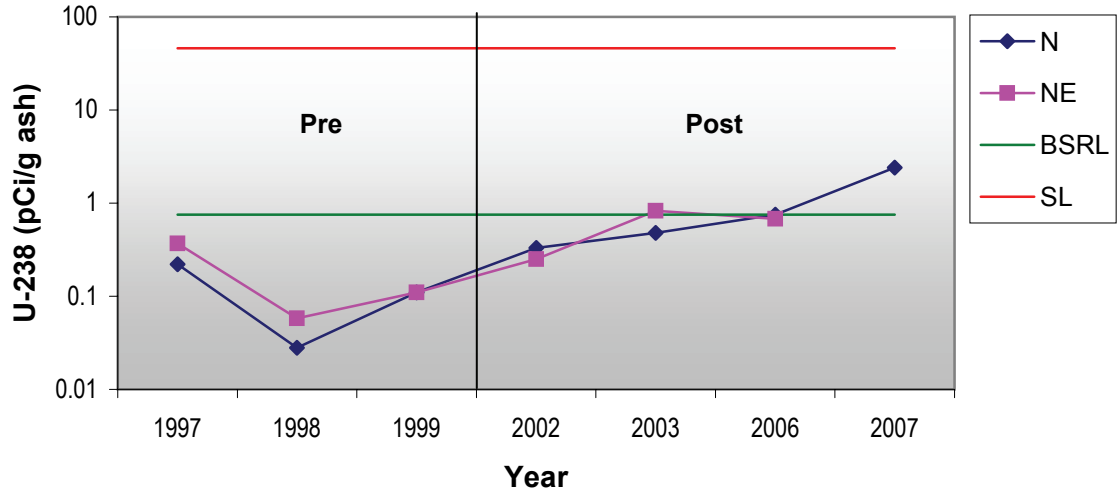


Figure 8-8. **Uranium-238 in concentrations in (whole body) mice collected from the north (N) and northeast (NE) side of the DARHT facility at TA-15 from 1997 (pre-operation) through 2007 (during operations) compared with the baseline statistical reference level (BSRL) and the screening level (SL). Note the logarithmic scale on the vertical axis.**

iii. Bird Results at DARHT

The work associated with bird sampling at DARHT during 2007 consisted of the following: (1) the analysis of three spotted towhee birds for TAL elements and (2) the comparison of species abundance and composition and trace element concentrations in birds (including the three birds collected in 2007) collected before (1999) and during operations (2002 through 2007) (Fresquez et al. 2007c).

Abundance and composition results show that the number and diversity of bird species generally increased over pre-operational levels with the greatest number of birds (412) and species (46) occurring in 2005. The most common bird species collected regardless of time periods were the chipping sparrow (*Spizella passerina*), the Virginia's warbler (*Vermivora virginiae*), the western bluebird (*Sialia mexicana*), the broad-tailed hummingbird (*Selasphorus platycercus*), the sage sparrow (*Amphispiza belli*), and the western tanager (*Piranga ludoviciana*).

Most radionuclides, with the exception of uranium-234 and uranium-238, in (whole body) birds collected after operations began were either not detected or were detected below RSRLs. Uranium-234 and uranium-238 concentrations (depleted uranium) in a few samples were far below screening levels and do not pose a potential unacceptable dose to the birds.

Many inorganic chemicals, particularly arsenic and silver, in birds collected before and after operations began were found in higher concentrations than RSRLs. Because birds (skin plus feathers) collected in the years before operations began contained higher levels of arsenic and silver than RSRLs and because there was no evidence of these metals in soil and sediment directly around the DARHT facility, the elevated levels of these metals in birds during early operations are probably not related to DARHT operations. Mean arsenic and silver concentrations in birds, however, have decreased over time to RSRLs in 2007 (Figure 8-9).

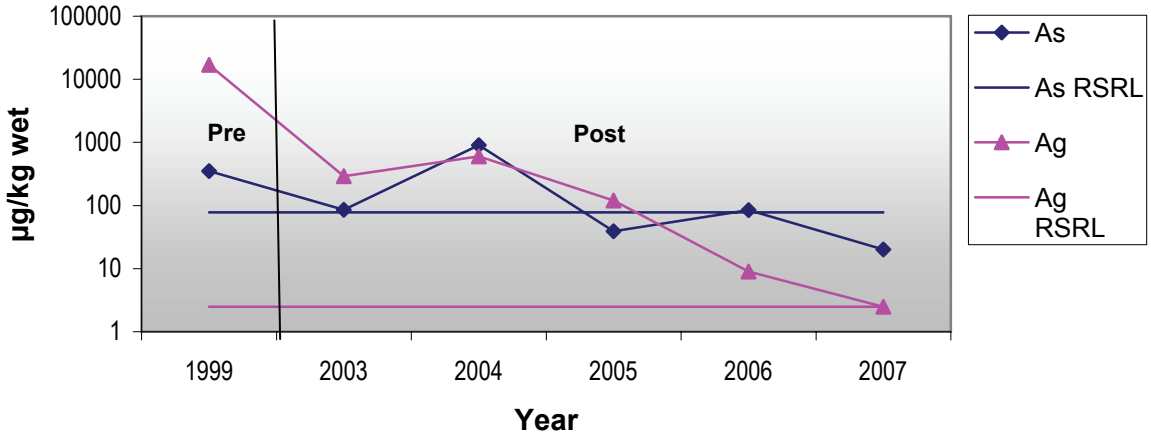


Figure 8-9. Mean arsenic (As) and silver (Ag) concentrations in birds collected near the DARHT facility at TA-15 from 1996 (pre-operations) through 2007 (during operations) compared with the regional statistical reference levels (RSRL). Note the logarithmic scale on the vertical axis.

iv. Bee Result

Most concentrations of radionuclides (Table S8-12) and TAL elements (Table S8-13) in bees sampled from four hives located northeast of the DARHT facility were below the BSRLs. The exceptions included uranium-234 and uranium-238 in three out of the four bee samples and barium and copper in all of the samples. The distribution of uranium-234 to uranium-238 indicated the presence of depleted uranium in two of the four samples. However, all concentrations of uranium-234 and uranium-238 were below SLs and, therefore, not a significant hazard to the bees.

C. SPECIAL STUDIES OF BIOTA

1. Characterization of Biotic and Abiotic Media Upstream of the Los Alamos Canyon Weir and the Pajarito Flood Control Retention Structure

In May 2000, a prescribed burn at Bandelier National Monument went out of control and burned nearly 50,000 acres of federal and pueblo land, including approximately 7,500 acres on LANL property. Because the Cerro Grande fire burned substantial amounts of vegetative cover, the Laboratory became concerned about increased sediment (and potential contaminant) transport from LANL to off-site locations. As a preventive measure, the US Army Corps of Engineers constructed two large erosion control structures to control storm water and sediment runoff from burned areas. These structures consist of (1) a low-head, rock-filled gabion weir that lies across the stream bed in Los Alamos Canyon near the junction of SR 4 and SR 502, and (2) a large cement flood retention structure located downstream of the confluence of Two-Mile and Pajarito Canyons.

As part of the Special Environmental Analysis of actions taken in response to the Cerro Grande Fire at LANL (DOE 2000), the DOE identified various mitigation measures that must be implemented under the Mitigation Action Plan as an extension of the fire suppression, erosion, and flood control actions. One of the tasks identified in the Mitigation Action Plan Section 2.1.7, "Mitigation Action for Soil, Surface and Ground Water, and Biota," mandates the monitoring of soil, surface water, groundwater, and biota at areas of silt or water retention behind (upstream from) flood control structures, within silt retention basins, and within sediment traps to determine if there has been an increase in contaminant concentrations in these areas. To this end, we collected samples of sediment (0- to 6-in. depth), native grasses and forbs (unwashed), and deer mice (Peromyscus sp.) in the areas behind the Los Alamos Canyon Weir (LACW) and behind the Pajarito Canyon Flood Retention Structure (PCFRS). Samples were analyzed for some or all of the following constituents: radionuclides, TAL elements, HEs, SVOCs and polychlorinated biphenyls (PCBs). Paragon Analytics, Inc., processed and analyzed the sediment, vegetation, and field mice (whole body) samples for radionuclides and TAL elements; and HEs, SVOCs, and PCBs in sediments. The form of PCBs analyzed in sediment were mixtures (or "formulations") of individual PCBs (congeners) called Aroclors. Specifically, Aroclors 1016, 1221, 1232, 1142, 1248, 1254, and 1260 were analyzed in sediment. Alta Analytical, Inc., analyzed the field mice (whole body) for individual PCB congeners. A congener is a specific PCB compound with a certain number of chlorine atoms in certain positions; theoretically, there are 209 possible congeners based on the possible number and position of chlorine atoms, but only about 120 congeners have ever been measured. The analytical method used by Alta was EPA Method 1668A—high resolution gas chromatography (GC) and high resolution mass spectrometry (MS). (Note: For additional clarification of the make-up of Aroclors and PCB congeners, see reports by the US Environmental Protection Agency and the Agency for Toxic Substances and Disease Registry (USEPA 2002, USEPA 1996, ATSDR 2000).

The following two sections report the 2007 results of this monitoring.

a. Los Alamos Canyon Weir Results

Concentrations of cesium-137, plutonium-238, plutonium-239/240, and americium-241 (Table S8-14); zinc, cadmium, lead, silver, and mercury (Table S8-15); and Aroclor 1260 (Table S8-16) in sediment upgradient of the LACW in 2007 were detected above the RSRLs. Although many of these constituents appear to be increasing in concentration since 2005 (Figure 8-10 and 8-11), they are still all below SLs and do not pose a potential unacceptable dose or risk to the public.

The results of the radionuclides and inorganic chemical analysis in understory vegetation collected upgradient of the LACW in 2007 are presented in Table S8-17 and Table S8-18, respectively. Most radionuclides and all of the TAL elements were either not detected or were detected below the RSRLs. The only radionuclides that were detected above the RSRLs in understory vegetation growing upgradient of the LACW were strontium-90, plutonium-239/240, and americium-241 (Figure 8-11). However, all concentrations of radionuclides detected in plants growing upgradient of the LACW were still far below SLs and do not pose an unacceptable dose to the plants.

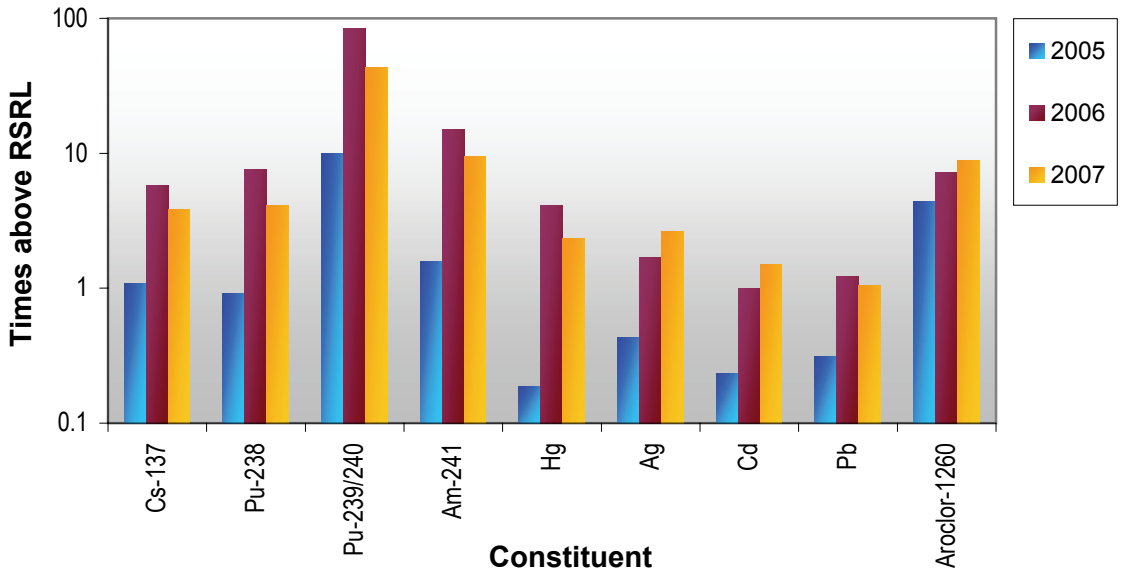


Figure 8-10. **Times above the regional statistical reference levels (RSRL) for radionuclides, metals, and PCBs in sediments collected upgradient (upstream) of the Los Alamos Canyon Weir from 2005 through 2007. Note the logarithmic scale on the vertical axis.**

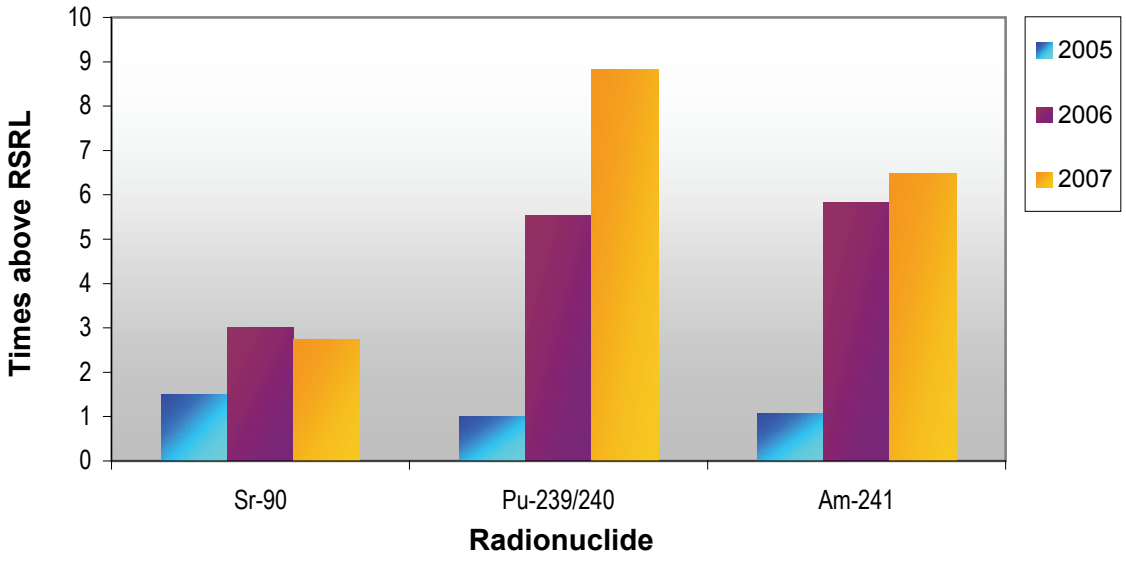


Figure 8-11. **Times above the regional statistical reference level (RSRL) for radionuclides in vegetation collected upgradient (upstream) of the Los Alamos Canyon Weir from 2005 through 2007.**

The concentrations of radionuclides, TAL elements, and PCBs in whole body mice samples upgradient of the LACW can be found in Tables S8-19, S8-20, and S8-21, respectively. Most concentrations of radionuclides and TAL elements in whole body mice samples were either not detected or below the RSRLs. The only radionuclides that were higher than the RSRLs included uranium-234, uranium-235, and uranium-238. However, the distribution of uranium-234 to uranium-238 indicates naturally occurring uranium and the amounts were below SLs. Thus, the dose to the mice is minimal and not a concern.

Of the TAL elements analyzed in the three field mice samples, only a few were detected above RSRLs. These elements include beryllium and thallium in one sample and cadmium in another sample. Because the amounts of these elements were just above the RSRLs and were not detected consistently across samples, the extent of contamination of these elements in field mice is probably minimal and not a risk to the animals.

Total PCBs (all congeners added) in all three mice samples collected upgradient of the LACW were in higher concentrations than the control sample. (Note: The control sample was collected from the TA-15 area near DARHT. Samples representing regional concentrations of PCBS, particularly from ephemeral stream bottoms containing deposited sediments, will be collected in the coming years to better characterize background; so caution is advised in the interpretation of this year's control data.). A comparison of the homologue classes (groups of biphenyls with the same number of chlorine atoms) show that the mice contained higher levels of total hexa and hepta chlorinated biphenyls than the other homologue groups (Figure 8-12), and the average distribution as a percentage of the total most closely matches the formulation of Aroclor 1260 (Figure 8-13) (EPA 1996). Aroclor 1260 was the only PCB detected in the sediment sample collected upgradient of the LACW (Table S8-16) and for animals of lower trophic levels there is a strong correlation between the sum of Aroclors and the total PCBs obtained from full congener determinations (i.e., it more closely matches the initial formulation in lower trophic level species) (Sather et al. 2001).

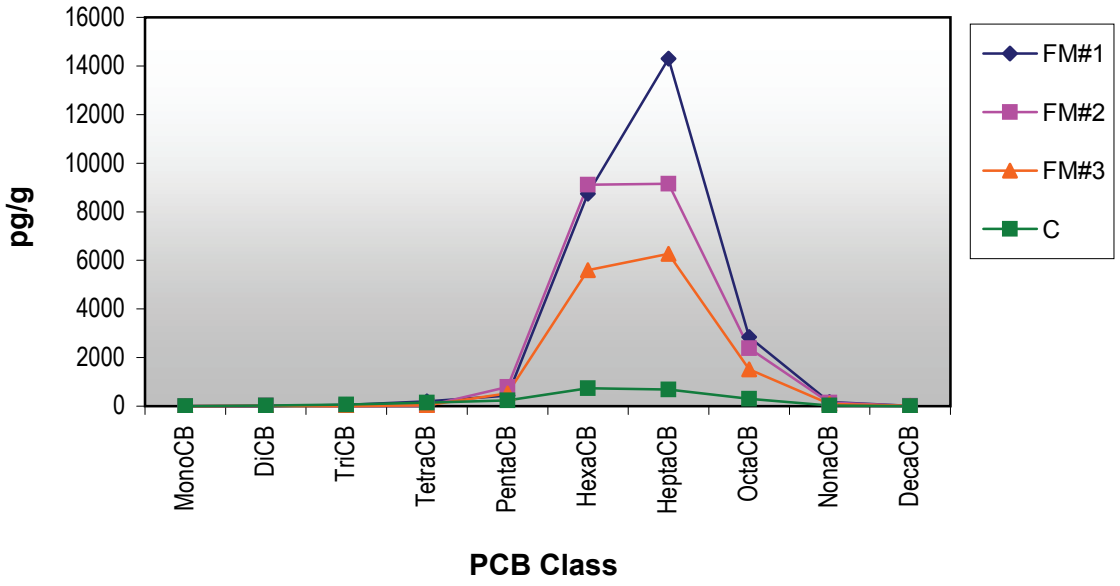


Figure 8-12. PCB homologue distribution for three field mice (FM) samples collected upgradient (upstream) of the Los Alamos Canyon Weir in 2007 with respect to the control (C) concentrations.

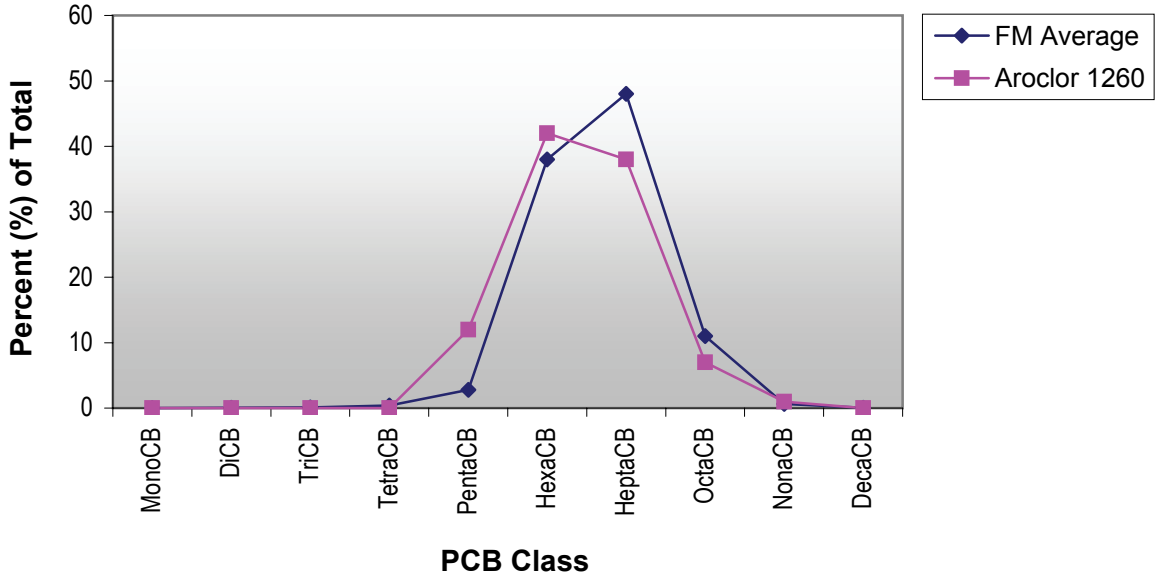


Figure 8-13. PCB homologue distribution for the average of three field mice (FM) collected upgradient (upstream) of the Los Alamos Canyon Weir in 2007 with respect to the formulation of Aroclor 1260 (EPA 1996).

Although the total PCB concentrations in the field mice samples collected upgradient of the LACW were higher than the control sample, the toxicity equivalency quotients (TEQ) in all three of the samples were generally comparable to each other. TEQs are a measure of the degree of toxicity based on the similarity of the 12 dioxin-like PCB congeners (# 77, 81, 105, 114, 118, 123, 126, 156, 157, 167, 169, and 189) to the most toxic dioxin, tetrachlorodibenzodioxin (TCDD). The total TEQ for each sample was derived by multiplying the concentration of each of the 12 dioxin-like PCBs by a TCDD equivalency factor (TEF) and then summing the values (Van den Berg et al. 2006). So there was generally no difference in the toxicity of PCBs in mice above the LACW compared with the control.

Overall, the concentrations of all radionuclides, TAL elements, and PCBs in all biotic and abiotic media sampled upgradient of the LACW were below SLs and do not pose a potential unacceptable dose from radionuclides or risk from chemicals to humans (sediment) or to the biota sampled.

b. Pajarito Canyon Flood Retention Structure Results

Radionuclides, TAL elements, and PCB results from sediment, vegetation, and small mammal samples collected upgradient (upstream) of the PCFRS in 2007 are presented in Table S8-22 through Table S8-29. In general, most concentrations of radionuclides, TAL elements, and/or PCBs in biotic and abiotic media collected upgradient of the PCFRS were either not detected or below the RSRLs. The few exceptions included the following: plutonium-239/240, uranium-238, cadmium, silver, and mercury in sediment (Figure 8-14); sodium in understory vegetation; and uranium-234, uranium-235, and uranium-238 in field mice (Figure 8-15). All of the detected constituents were just above the RSRL and far below SLs (for the radionuclides) and did not change significantly in concentrations from the year before; many, in fact, have decreased.

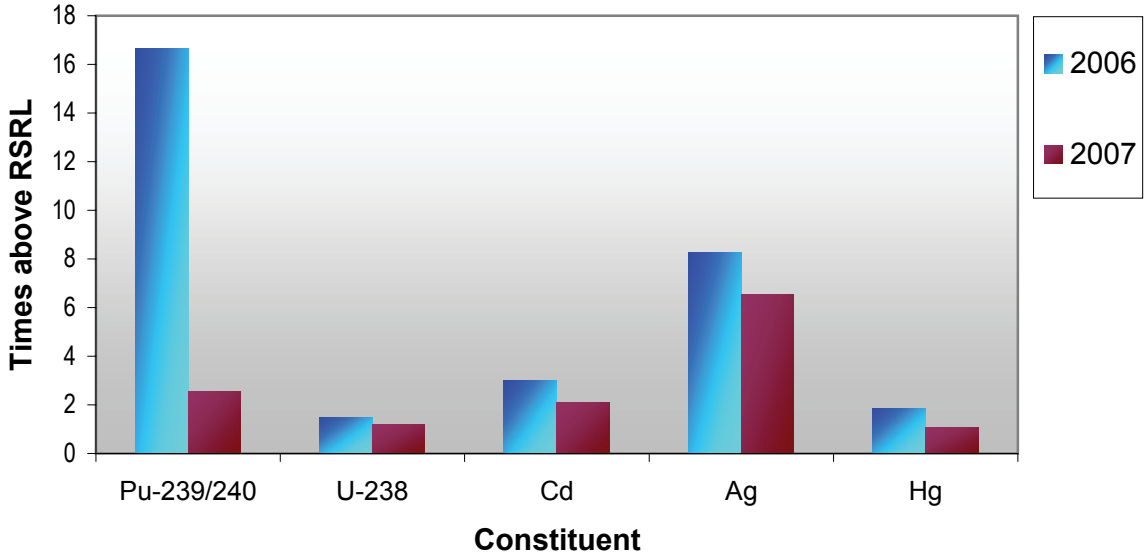


Figure 8-14. Times above the regional statistical reference levels (RSRLs) for radionuclides, and metals in sediments collected upgradient (upstream) of the Pajarito Canyon Flood Retention Structure in 2006 and 2007.

PCBs in field mice samples can be found in Table S8-29. Samples of field mice analyzed for PCBs show mixed results; one sample was similar to the control sample, one sample was slightly above the control sample, and the other sample was quite higher than the control sample (Figure 8-16). (Note: The control sample was collected from the TA-15 area near DARHT and more regional samples, particularly from ephemeral stream bottoms containing deposited sediments, will be collected in the coming years to better characterize background; so caution is advised.) Although there were no Aroclors detected in the sediments upgradient of the PCFRS

in 2007 (Table S8-24) and no detections in storm water runoff within this canyon system (Gallaher 2007, Figure 6-14), we will continue to collect and analyze field mice from this area, including background, to get a better understanding of the extent of PCB contamination, if any, from this area of potential concern. At present, it appears that one out of the three field mice sampled for PCBs may be an outlier, possibly a result of cross contamination during sampling or within the analytical laboratory.

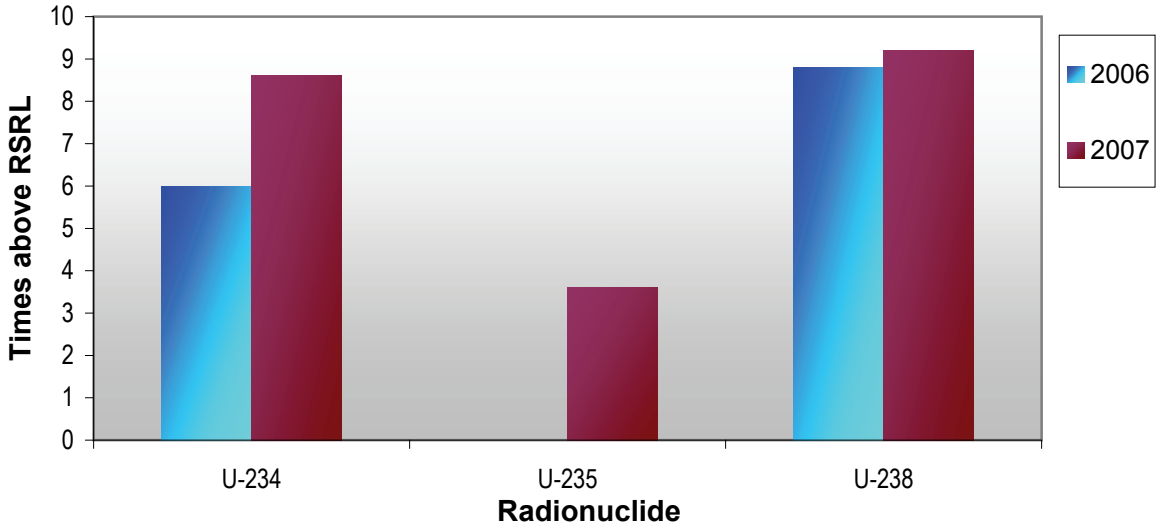


Figure 8-15. Times above the regional statistical reference levels (RSRLs) for uranium-234, uranium-235 and uranium-238 in field mice collected upgradient (upstream) of the Pajarito Canyon Flood Retention Structure in 2006 and 2007.

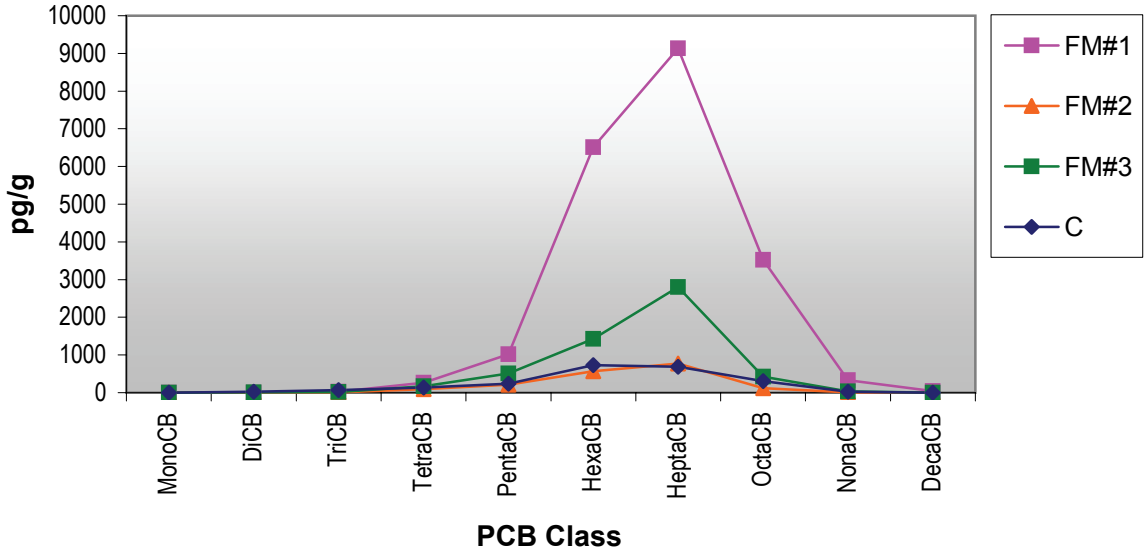


Figure 8-16. PCB homologue distribution for three field mice (FM) samples collected upgradient (upstream) of the Pajarito Canyon Flood Retention Structure in 2007 with respect to control (C) concentrations.

D. QUALITY ASSURANCE FOR THE SOIL, FOODSTUFFS AND BIOTA PROGRAM

This program uses the same quality assurance (QA) protocols and analytical laboratories described in Chapter 7.

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9. Environmental Restoration

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A. INTRODUCTION

The environmental programs at Los Alamos National Laboratory (LANL or the Laboratory) address the problems caused by current and past LANL operations by bringing together multi-disciplinary, world-class science, engineering, and state-of-the-art management practices. The Laboratory's goals are to protect human health and the environment and to meet environmental clean-up requirements. The Environmental Programs (EP) Directorate is leading the Laboratory's effort to clean up sites and facilities formerly involved in weapons research and development.

The New Mexico Environment Department (NMED) regulates the cleanup of hazardous wastes and hazardous constituents under the New Mexico Hazardous Waste Act. Corrective actions for the releases of hazardous waste and hazardous constituents at the Laboratory are subject to the March 1, 2005 Compliance Order on Consent (the Consent Order). The Consent Order was issued pursuant to the New Mexico Hazardous Waste Act (New Mexico Statutes Annotated [NMSA] 1978, § 74-4-10) and the New Mexico Solid Waste Act (NMSA 1978, §74-9-36[D]).

The US Department of Energy (DOE) regulates the cleanup of radioactive contamination. Radionuclides are regulated under DOE Order 5400.5, "Radiation Protection of the Public and the Environment," and DOE Order 435.1, "Radioactive Waste Management." DOE is implementing corrective actions pursuant to the Atomic Energy Act for releases of radionuclides in conjunction with the activities required under the Consent Order.

1. Projects

LANL manages investigation and remediation activities under three projects: the Corrective Actions Project, the Water Stewardship Project, and the Technical Area (TA)-21 Closure Project. The sites under investigation in these projects are designated as consolidated units, solid waste management units (SWMUs), or areas of concern (AOCs). The projects collect, manage, and report environmental data and utilize the data to support site decisions.

a. Corrective Action Project

This project includes the investigation and possible remediation of consolidated units, SWMUs, and AOCs intermixed with active Laboratory operations as well as sites located within the Los Alamos townsite (property currently owned by private citizens, businesses, or Los Alamos County) and on property administered by the US Forest Service (USFS), the National Park Service, and the DOE.

b. Water Stewardship Project

This project includes the canyons investigations, the groundwater monitoring program (implemented through the Interim Facility-Wide Groundwater Monitoring Plan [LANL 2007a]), storm water monitoring, and the implementation of best management practices to minimize erosion.

The purpose of the Water Stewardship Project is to:

- Integrate what is known about sources, pathways, and monitoring data into clean-up decisions and the evaluation and optimization of the groundwater monitoring network
- Protect drinking water

c. TA-21 Closure Project

This project includes the investigation and the implementation of corrective actions for Material Disposal Areas (MDAs) A, B, T, U, and V; various process waste lines; a radioactive waste treatment system; and the Delta Prime (DP) Site Aggregate Area that includes sumps, outfalls, leach fields, historic container storage areas, and other former facilities.

Sites at TA-21 will be stabilized to reduce or eliminate radioactive and hazardous materials releases and the property will remain under institutional control and monitored as part of the environmental surveillance and stewardship process. Properties on the west end adjacent to DP Road will be remediated and, where possible, released for transfer to Los Alamos County or the school district to create a community development corridor.

2. Work Plans and Reports

The three projects wrote and/or revised 23 work plans and 23 reports and submitted them to NMED during calendar year 2007. The work plans propose investigation activities designed to characterize SWMUs, AOCs, consolidated units, aggregates, canyons, and watersheds. The data, which are presented in remedy completion or investigation reports, are used to determine if the nature and extent of contamination are defined and determine the potential risks to human health and the environment posed by contaminants. Depending on the data and the assessment results, sites may require additional investigation, remediation, monitoring, or no further action.

Tables 9-1 and 9-2 summarize the work plans and reports submitted and approved in 2007, the work plans and reports submitted prior to 2007 but approved in 2007, and the work plans and reports submitted in 2007 but not yet approved. Table 9-3 summarizes other reports, plans, and documents submitted in 2007. Table 9-4 summarizes the eight SWMUs and AOCs that have been completed and for which NMED granted Certificates of Completion under the Consent Order during 2007. The remainder of this chapter presents summaries of the investigations for which activities were started, continued, and/or completed in 2007 and those investigations for which reports were submitted in 2007. Figures 9-1 and 9-2 show the locations where significant environmental characterization or remediation work was performed in 2007.

Table 9-1
Work Plans Submitted and/or Approved in 2007

Document Title	Date Submitted	Date Approved	Status
Pajarito Canyon Biota Investigation Work Plan	8/1/2006	5/29/2007	Work to be completed in 2008
Investigation Work Plan for South Canyons	9/28/2006	3/28/2007[a]	Sampling scheduled to start in 2008
Cañon de Valle Aggregate Area Investigation Work Plan	9/29/2006	2/9/2007[a]	Sampling scheduled to start in 2009
Investigation/Remediation Work Plan for Material Disposal Area B, Solid Waste Management Unit 21-015, at TA-21, Revision 1	10/23/2006	1/31/2007[a]	Site preparation underway
Addendum to the Work Plan for Sandia Canyon and Cañada del Buey	1/30/2007	3/3/2007[a]	Work is ongoing
Phase 2 Investigation Work Plan for MDA T	2/15/2007	4/9/2007[a]	Phase 2 report submitted
Material Disposal Area C Phase 2 Investigation Work Plan	4/23/2007	n/a[b]	Work plan revised
MDA C Phase 2 Investigation Work Plan, Revision 1	7/30/2007	8/13/2007[a]	Work is ongoing
Corrective Measures Implementation Plan, Consolidated Unit 16-021(c)-99	5/11/2007	n/a	Work plan revised
Corrective Measures Implementation Plan, Consolidated Unit 16-021(c)-99, Revision 1	7/30/2007	8/17/2007	Implementation of corrective measures scheduled
Corrective Measures Evaluation Plan for MDA G at TA-54, Revision 1	7/13/2007	n/a	Work plan revised
Corrective Measures Evaluation Plan for MDA G at TA-54, Revision 2	10/15/2007	10/29/2007[a]	Proceeding with corrective measures evaluation
Sampling Data for Area of Elevated Radioactivity Near Location ID 21-02523 and North of Absorption Bed 3, Consolidated Unit 21-018(a)-99, Material Disposal Area V, at TA-21	7/3/2007	8/9/2007	Remediation and sampling conducted in 2007
Interim Subsurface Vapor Monitoring Plan for MDA L at TA-54	8/31/2007	n/a	Work plan revised
Interim Subsurface Vapor Monitoring Plan for MDA L at TA-54, Revision 1	10/30/2007	11/8/2007[a]	Vapor monitoring is ongoing
Sandia Canyon Biota Investigation Work Plan	9/19/2007	—[c]	Under review in 2007
S-Site Aggregate Area Investigation Work Plan	9/30/2007	n/a	Work plan revised
S-Site Aggregate Area Investigation Work Plan, Revision 1	12/21/2007	—	Under review in 2007
S-Site Aggregate Area Historical Investigation Report	9/30/2007	n/a	n/a
North Ancho Canyon Aggregate Area Investigation Work Plan	9/30/2007	n/a	Work plan revised
North Ancho Canyon Aggregate Area Investigation Work Plan, Revision 1	12/14/2007	—	Under review in 2007
North Ancho Canyon Aggregate Area Historical Investigation Report	9/30/2007	n/a	n/a
Subsurface Vapor Monitoring Plan MDA T at TA-21	10/19/2007	10/31/2007[a]	Vapor monitoring is ongoing
Work Plan for Implementing SVE Pilot Test for MDA G	10/25/2007	11/19/2007[a]	Soil vapor extraction test to start in 2008

Table 9-1 (continued)

Document Title	Date Submitted	Date Approved	Status
Middle Cañada del Buey Aggregate Area Investigation Work Plan	10/31/2007	n/a	Work plan revised
Middle Cañada del Buey Aggregate Area Investigation Work Plan, Revision 1	12/21/2007	—	Under review in 2007
Middle Cañada del Buey Aggregate Area Historical Investigation Report	10/31/2007	n/a	n/a
Investigation Work Plan for Non-Nuclear Environmental Sites at TA-49	10/31/2007	—	Under review in 2007
Historical Investigation Report for Non-Nuclear Environmental Sites at TA-49	10/31/2007	n/a	n/a
Investigation Work Plan for Nuclear Environmental Sites at TA-49	10/31/2007	—	Under review in 2007
Historical Investigation Report for Nuclear Environmental Sites at TA-49	10/31/2007	n/a	n/a

[a] Work plans approved with modifications and/or directions.

[b] n/a = Not applicable.

[c] "—" = Approval not received in 2007.

Table 9-2
Reports Submitted and/or Approved in 2007

Document Title	Date Submitted	Date Approved	Status
Corrective measures Report for Material Disposal Area H, Solid Waste Management Unit 54-004, at TA-54, Revision 1	6/1/2005	11/5/2007	NMED selected corrective measures/remedies for MDA H pending public comment
Interim Measures Completion Report Solid Waste Management Unit 73-001(a) at TA-73	3/1/2004	5/21/2007[a]	Work completed
Los Alamos and Pueblo Canyons Supplemental Investigation Report (revised risk assessment)	12/15/2005	8/30/2007[a]	Additional activities required
Investigation Report for Solid Waste Management Units 03-010(a) and 03-001(e) at TA-3	4/20/2006	5/14/2007	Additional investigation required
Status Report for the Solid Waste Management Units 03-010(a) and 03-001(e) at TA-03	7/16/2007	8/30/2007	Interim measures and monitoring implemented
Investigation Report for Material Disposal Area T, Consolidated Unit 21-016(a)-99, at TA-21	9/18/2006	2/15/2007[a]	Phase 2 Work Plan submitted and work completed
MDA T Phase 2 Investigation Report	11/15/2007	—[b]	Under review in 2007
Investigation Report for Material Disposal Area A, Solid Waste Management Unit 21-014, at TA-21	11/9/2006	2/12/2007[a]	Collected additional pore gas samples, abandoned boreholes, and submitted status report
Final Status Report for Supplemental Sampling at MDA A, TA-21 Table 9-2 (continued)	12/5/2007	—	Under review in 2007
Remedy Completion Report for Area of Concern 16-024(v) and Solid Waste Management Units 16-026(r) and 16-031(f)	3/9/2007	n/a[c]	Report revised
Remedy Completion Report for Area of Concern 16-024(v) and Solid Waste Management Units 16-026(r) and 16-031(f), Revision 1	6/19/2007	6/27/2007	Work completed

Table 9-2 (continued)

Document Title	Date Submitted	Date Approved	Status
Summary of North Canyons Phase 1 Sediment Investigations	3/12/2007	5/7/2007	Phase 2 sampling completed
Summary of North Canyons Phase 1 Sediment Investigations Addendum 1	4/11/2007	5/7/2007	Phase 2 sampling completed
Summary of Pajarito Canyon Phase 2 Sediment Investigations	3/26/2007	5/29/2007	Phase 3 sampling ongoing
Remedy Completion Report for SWMU 61-002	5/3/2007	n/a	Report revised
Remedy Completion Report for SWMU 61-002, Revision 1	11/30/2007	—	Under review in 2007
Addendum to the Investigation Report for Material Disposal Area G, Consolidated Unit 54-013(b)-99, at TA-54	5/16/2007	6/8/2007[a]	Proceeding with CME
Addendum to the Investigation Report for MDA L	5/31/2007	7/18/2007[a]	Proceeding with CME
Remedy Completion Report DOE-LASO Airport landfill SWMUs 73-001(a) and 73-001(d)	4/15/2007	8/8/2007	Work completed
Mortandad Canyon Investigation Report	10/27/2006	2/23/2007[a]	Risk assessments revised
Revised Risk Assessments for Mortandad Canyon Investigation Report	7/2/2007	n/a	Approved response
Investigation Report for Consolidated Unit 73-002-99 and Corrective Action of Solid Waste Management Unit 73-002 at TA-73	7/6/2007	8/13/2007	Work completed
Investigation Report for Consolidated Unit 21-018(a)-99, Material Disposal Area V, at TA-21, Revision 1	7/16/2007	8/13/2007	Additional investigation activities required
Investigation Report for Mortandad/Ten Site Canyons Aggregate Area, Revision 1	7/20/2007	—	Under review in 2007
Investigation Report for Intermediate and Regional Groundwater, Consolidated Unit 16-021(c)-99	8/31/2006	11/29/2006[c]	Additional drilling and sampling activities required
CME Report for Intermediate and Regional Groundwater Associated with Consolidated Unit 16-021(c)-99	8/31/2007	—	Under review in 2007
Investigation Report for Guaje, Barrancas, Rendija Canyons Aggregate Areas	8/31/2007	n/a	Report revised
Summary of Sandia Canyon Phase 1 Sediment Investigations	9/14/07	n/a	Under review in 2007
Investigation Report for Guaje, Barrancas, Rendija Canyons Aggregate Areas, Revision 1	11/29/2007	—	Under review in 2007
Investigation Report for DP Site Aggregate Area	11/7/2007	—	Under review in 2007
Investigation Report for Consolidated Units 16-007(a)-99 and 16-008(a)-99	11/15/2007	—	Under review in 2007
Investigation Report for the TA-16-340 Complex	1/31/2006	10/25/2006[c]	Additional sampling to be implemented in FY 2008
Interim Measures Investigation Report for Chromium Contamination in Groundwater	11/30/2006	12/27/2006[c]	Additional investigation activities required; Drilling, modeling and geochemistry studies implemented

[a] Reports approved with modifications and/or directions.

[b] "—" = Approval not received in 2007.

[c] n/a = Not applicable.

Table 9-3
Additional Plans and Reports Submitted in 2007

Document Title	Date Submitted
Periodic Monitoring Reports	
Los Alamos Watershed	1/25/2007
Pajarito Watershed	3/12/2007
White Rock Watershed	6/8/2007
Sandia Watershed	6/8/2007
Ancho Watershed	8/16/2007
Water Canyon/ Cañon de Valle Watershed	9/19/2007
Mortandad Watershed	10/22/2007
Sandia Watershed	10/22/2007
Ancho Watershed	11/30/2007
White Rock Watershed	11/30/2007
Water Canyon/ Cañon de Valle Watershed	11/30/2007
Los Alamos Watershed	11/30/2007
Pajarito Watershed	11/30/2007
Monthly Groundwater Data Reviews	Monthly
Vapor Sampling MDA H	11/30/2007
Vapor Sampling MDA L	12/10/2007
Well Work Plans and Reports	
Well Screen Analysis Report, Revision 1	2/20/2007
Pilot Well Rehabilitation Study Summary Report	3/16/2007
Amendment to Drilling Methodology for Regional Groundwater Monitoring Well R-28	3/23/2007
Final Completion Report for Intermediate Well R-3i	4/30/2007
Plan for Screen Isolation/Abandonment and Well Replacement (R-25)	4/30/2007
Evaluation of Suitability of Wells near TA-16 for Monitoring Contaminant Releases from SWMU 16-021(c)-99	4/30/2007
Well Screen Analysis Report, Revision 2	5/10/2007
Work Plan for R-Well Rehabilitation and Replacement, Revision 1	6/13/2007
Mortandad Canyon Well Evaluation and Network Recommendations	6/28/2007
Drilling Work Plan for Regional Aquifer Well R-25b	6/29/2007
Drilling Work Plan for Regional Well R-36	6/29/2007
Summary Report on Potential Sources of Perchlorate Found in Perched-Intermediate and Regional Groundwater Beneath the Los Alamos and Pueblo Canyon Watershed	7/9/2007
Well Evaluation and Network Recommendations, TA-54	7/31/2007
Work Plan for R-Well Rehabilitation and Replacement, Revision 2	7/31/2007
Evaluation of Sampling Systems for Multiple-Completion Regional Aquifer Wells at LANL	8/27/2007
Work Plan for R-Well Rehabilitation and Replacement, Revised Table	9/7/2007
Completion Report for Regional Aquifer Wells R-35a and R-35b	9/14/2007
Evaluation of Suitability of Wells near TA-16 for Monitoring Contaminant Releases from SWMU 16-021(c)-99, Revision 1	9/28/2007

Table 9-4
SWMUs and AOCs Granted Certificates of Completion in 2007

Site	Corrective Action Complete with Controls	Corrective Action Complete without Controls	Date Approved
SWMU 54-007(a)	X		5/29/2007
AOC 16-024(v)		X	6/29/2007
SWMU 16-031(f)		X	6/29/2007
SWMU 73-002	X		8/13/2007
AOC 73-003	X		8/13/2007
SWMU 73-004(a)	X		8/13/2007
SWMU 73-004(b)	X		8/13/2007
SWMU 73-006	X		8/13/2007

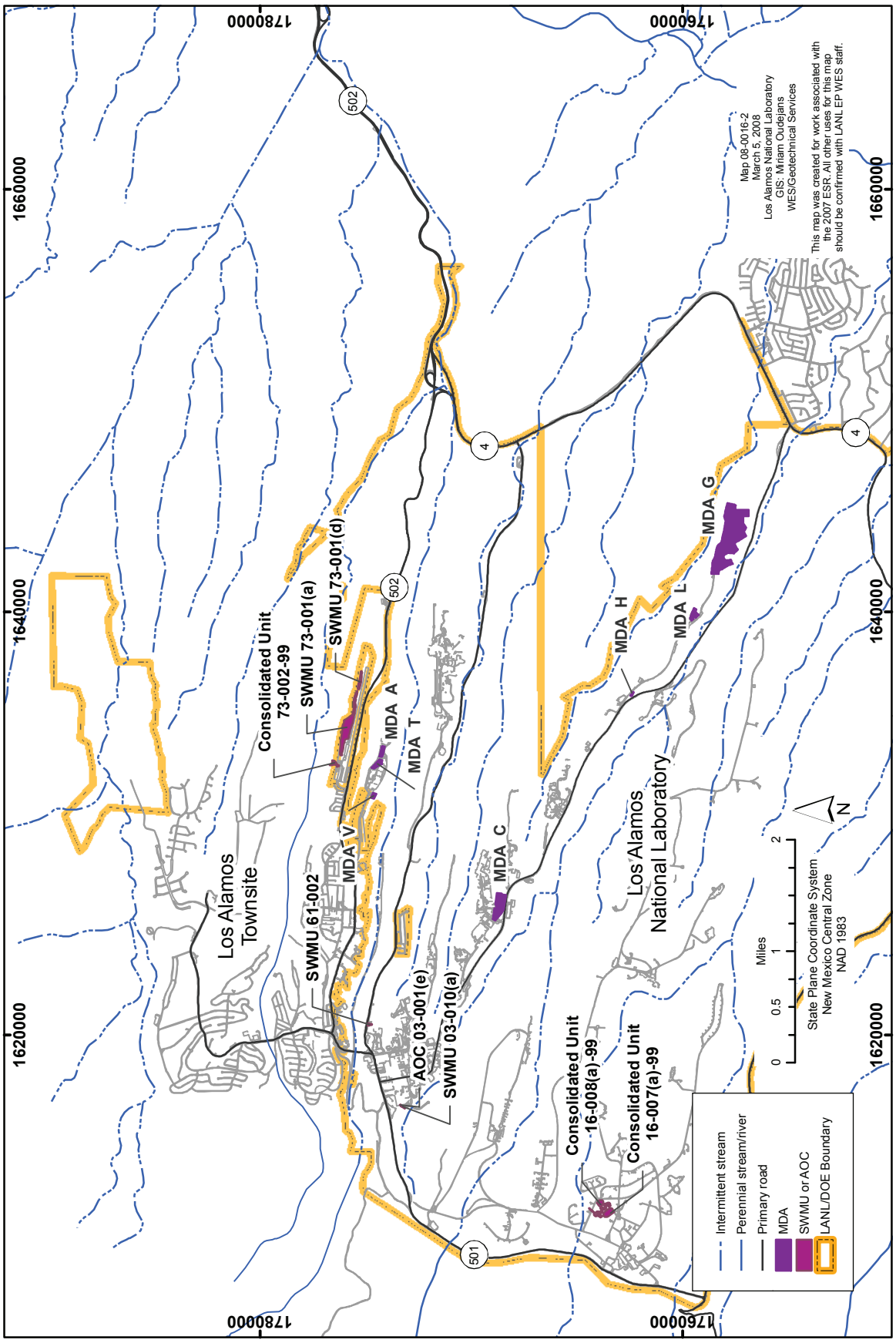

Figure 9-1. Location of MDAs and other SWMUs or AOCs where remediation and/or characterization work was performed in 2007.

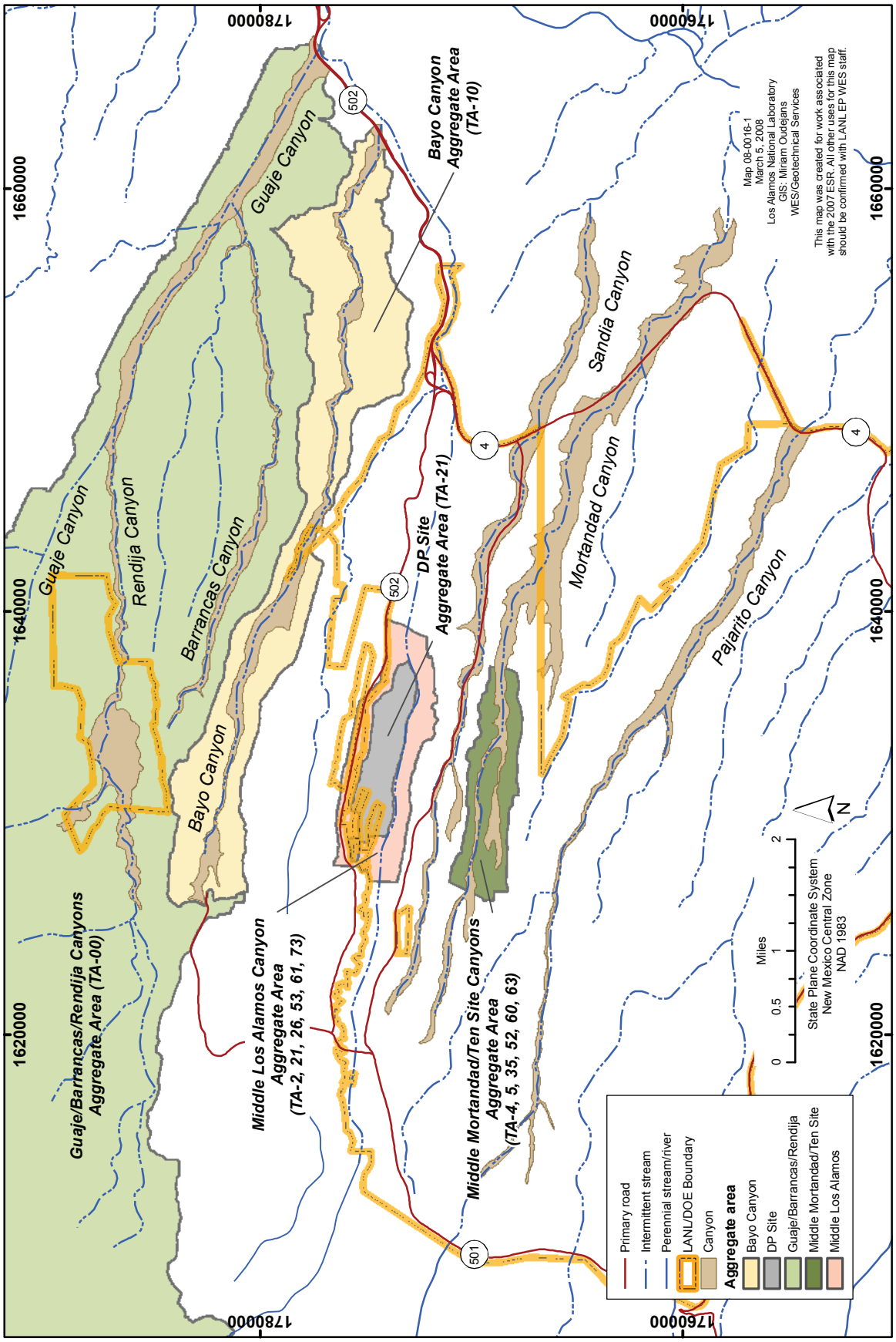

Figure 9-2. Location of canyons and aggregate areas where remediation and/or characterization work was performed in 2007.

B. CORRECTIVE ACTION PROJECT

The Laboratory and DOE conducted the following investigations and activities in 2007:

- Investigation of SWMU 61-002 was completed, and the remedy completion report was submitted.
- Phase 2 work plan for MDA C was submitted and approved; required additional sampling was started.
- Investigations for the Guaje, Barrancas, Rendija Canyons Aggregate Areas were completed, and the investigation report was submitted.
- The remedy completion report for AOC 16-024(v) and SWMUs 16-026(r) and 16-031(f) was submitted and approved.
- Field investigations were concluded for Consolidated Units 16-007(a)-99 (30s Line) and 16-008(a)-99 (90s Line), and the investigation report was submitted.
- Field investigations were completed for the Bayo Canyon Aggregate Area and the Middle Los Alamos Canyon Aggregate Area.
- Interim measures and monitoring at SWMUs 03-010(a) and 03-001(e) were implemented. The status report was submitted.
- Supplemental sampling at MDA G was completed. An addendum to the investigation report for MDA G was submitted and approved.
- Supplemental sampling at MDA L was completed. An addendum to the investigation report for MDA L was submitted and approved.
- A vapor monitoring plan for MDA L and revision 1 was submitted and approved. Vapor monitoring activities are ongoing.
- Investigation/remediation at Consolidated Unit 73-002-99 (Airport Ashpile) was completed. The investigation report was submitted and approved.
- Additional sampling and remediation for the Middle Mortandad/Ten Site Canyons Aggregate Area was conducted, and the revised investigation report was submitted.
- Vapor monitoring at MDAs H and L was conducted, and periodic monitoring reports were submitted.

In addition, the NMED approved the corrective measures study report for MDA H (LANL 2006a) and selected proposed remedies for MDA H pending public comment (NMED 2007a). The remedies include the complete encapsulation of the disposal shafts, the installation of an engineered evapotranspiration cover, and a soil vapor extraction system.

The following sections summarize the investigations started, continued, and/or completed in 2007.

1. SWMU 61-002

a. Site Description and History

SWMU 61-002 is a former storage area located east of the Radio Repair Shop on the south side of Jemez Road. The SWMU was historically used to store capacitors, transformers, oil-filled containers, and unmarked containers. Before 1985, used oil contaminated with polychlorinated biphenyls (PCBs) was stored in containers within the fenced area. The area was also used to store large spools of wire and cable.

b. Remediation and Sampling Activities

The Laboratory initially conducted corrective action activities at SWMU 61-002 because this site was in the path of the security perimeter road and would be inaccessible after construction (LANL 2005a). During the 2005 investigation, the Laboratory discovered an area of petroleum-contaminated soil and buried fuel lines in the northwest portion of the SWMU.

Additional sampling was conducted to characterize the extent of the petroleum contamination (LANL 2006b; NMED 2006a). Fifteen samples were collected from eight borehole locations in and around the area of petroleum hydrocarbon contamination.

c. Conclusions and Recommendations

The Laboratory completed additional fieldwork at SWMU 61-002 in 2006 and submitted the remedy completion report in 2007, describing all the activities conducted in 2005 and 2006 and presenting the results (LANL 2007b).

Data confirmed that the residual petroleum hydrocarbon contamination is limited to a small subsurface area. The site is characterized and the nature and extent of contamination are defined. The risk screening assessments indicate there is no potential unacceptable risk to human health for the industrial and construction worker scenarios as well as ecological receptors. In addition, a Tier One Evaluation conducted in accordance with Title 20, Chapter 5, Part 12 of the New Mexico Administrative Code (20.5.12 NMAC) shows that the residual contamination does not pose a potential future hazard to groundwater.

The Laboratory requested a Certificate of Completion for Corrective Action Complete with Controls for SWMU 61-002 based on the results of the investigation and remediation activities. The recommendation for Corrective Action Complete with Controls is appropriate because the cleanup levels and goals under an industrial scenario were met; controls are required to restrict land use of the property. The Laboratory intends to retain ownership of the property indefinitely and will continue to restrict the property to industrial use only. Controls on future construction activities will be implemented to ensure protection of construction workers through LANL's Permits and Requirements Identification System and Excavation Permit System.

Following NMED review, a revised remedy completion report was submitted (LANL 2007c). The site recommendation is pending NMED review.

2. AOC 16-024(v) and SWMUs 16-026(r) and 16-031(f)

a. Site Description and History

AOC 16-024(v) and SWMUs 16-026(r) and 16-031(f) are located on a mesa top of the Pajarito Plateau in the western portion of TA-16.

AOC 16-024(v) is the location of a former high explosive (HE) storage magazine constructed in 1944 and located approximately 100 ft east of the TA-16 steam plant. The structure was used as an HE magazine until 1946 and then used for general storage until it was removed in 1968.

SWMU 16-026(r) is an inactive drainline and outfall from the oil-water separator at fire station #5. The oil-water separator and discharge line are inactive and the floor drains are rerouted to the sanitary sewer.

SWMU 16-031(f) is the former outfall from a decommissioned drinking water chlorination station. The building was constructed in 1944, stripped of all usable equipment in 1953 when the new chlorination station was brought online, and removed in 1992.

b. Remediation and Sampling Activities

The Laboratory conducted an accelerated corrective action at AOC 16-024(v) and SWMU 16-026(r) in 2006 according to the approved work plan (LANL 2006c; NMED 2006b). Investigation activities at AOC 16-024(v) and SWMU 16-026(r) included collection of samples and removal of contaminated soil. Characterization or remediation activities were not conducted at SWMU 16-031(f) because historical operating information indicated there have been no activities conducted at the former chlorination facility that would warrant an environmental investigation.

c. Conclusions and Recommendations

The Laboratory reported the results of the investigations in a remedy completion report submitted in early 2007 (LANL 2007d).

The Laboratory requested a Certificate of Completion Corrective Action Complete without Controls for SWMU 16-031(f) and AOC 16-024(v). Although the current and reasonably foreseeable future land use for SWMU 16-031(f) and AOC 16-024(v) is industrial, the sites do not pose potential unacceptable risks to human health for the residential scenario or to the environment. Therefore, it is appropriate to conclude that no site controls and future actions are necessary.

The Laboratory will conduct additional sampling within the outfall area of SWMU 16-026(r) to determine the extent of contamination as part of the Cañon de Valle Aggregate Area investigation. All the sampling results will be reported in the Cañon de Valle Aggregate Area investigation report. In addition, the roof drainline and outfall will be rerouted pursuant to Title 20, Chapter 6, Part 2, Section 1203 – Notification of Discharge Removal of NMAC of the New Mexico WQCC regulations.

Following NMED review, a revised remedy completion report was submitted (LANL 2007e), which was then approved (NMED 2007b). NMED determined that the corrective action is complete, and the requirements of the Consent Order have been satisfied for AOC 16-024(v) and SWMU 16-031(f) and issued Certificates of Completion for Corrective Action Complete without Controls for these sites (NMED 2007b). NMED also agreed with the recommendation of completing the investigation for SWMU 16-026(r) as part of the Cañon de Valle Aggregate Area investigation.

3. Guaje/Barrancas/Rendija Canyons Aggregate Area

a. Site Description and History

The Guaje/Barrancas/Rendija Canyons Aggregate Area consists of SWMU 00-011(a), a mortar impact area; SWMU 00-011(c), a possible mortar impact area; SWMU 00-011(d), a bazooka firing area; SWMU 00-011(e), an ammunition impact area; AOC C-00-020, a possible mortar impact area; AOC C-00-041, an asphalt batch plant and tar remnant site; and AOC 00-015, the Sportsmen's Club small-arms firing range.

b. Remediation and Sampling Activities

The Laboratory conducted field investigations in 2006 based on the approved work plan (LANL 2005b; NMED 2006c). The investigation of AOC 00-015 is deferred until the site is no longer active. Munitions and explosives surveys were completed at the sites to verify similar surveys conducted in the early 1990s. Both munitions and explosives of concern and geophysical surveys were used to identify and remove any remaining mortar, small arms ammunition, or munitions debris from former impact/firing areas. Soil samples were collected at sites with past and current munitions and explosives of concern and munitions debris recovery.

c. Conclusions and Recommendations

The Laboratory completed investigation activities and submitted the investigation report in 2007 (LANL 2007f).

The munitions-debris surveys did not locate any munitions or explosives of concern at SWMU 00-011(c) or AOC C-00-020. Because no munitions debris was found during this survey or in previous surveys, no further investigation was conducted, per the approved work plan. The Laboratory requested Certificates of Completion for Corrective Action Complete without Controls for these sites because no site controls and future actions are necessary.

Based on the characterization data from the 2006–2007 investigation, the nature and extent of surface and subsurface contamination are defined for SWMUs 00-011(a), 00-011(d), and 00-011(e). Asphalt remains at AOC C-00-041, but the nature and extent of total petroleum hydrocarbon contamination are defined for this site. SWMUs 00-011(a), 00-011(d), and 00-011(e) and AOC C-00-041 do not pose potential unacceptable risks

to human health under the residential scenario and to ecological receptors. Therefore, the Laboratory requested Certificates of Completion for Corrective Action Complete without Controls for these sites.

Following NMED review, a revised investigation report was submitted (LANL 2007g); site recommendations did not change. However, semiannual inspections of the drainage below AOC C-00-041, coinciding with the end of snowmelt and the monsoon season, will be conducted to evaluate the need to remove additional tar and asphalt. A more detailed plan for evaluating and removing tar and asphalt from AOC C-00-041 will be submitted in 2008; no further sampling for asphalt-related contaminants is needed.

The Sportsmen's Club (AOC 00-015) is being evaluated as part of the NPDES permitting process. If AOC 00-015 has the potential to discharge pollutants to surface water, it will be included in the NPDES permit and will be subject to requirements for storm water monitoring, sampling, and erosion control.

The recommendations are pending NMED review.

4. Consolidated Units 16-007(a)-99 (30s Line) and 16-008(a)-99 (90s Line)

a. Site Description and History

TA-16 is located in the southwest corner of the Laboratory and covers approximately 2,410 acres (3.8 mi^2). Consolidated Units 16-007(a)-99 (the 30s Line) and 16-008(a)-99 (the 90s Line) are located near the western end of TA-16. These consolidated units consist of former HE processing buildings, former materials storage buildings, production facilities, sumps, drainlines, and outfall systems (drainages) associated with the 30s and 90s Lines. Historically, the 30s Line and the 90s Line were used for HE-processing operations, including electroplating and machining. The settling ponds were used to store wastewater generated in the nearby buildings during HE-processing operations. All the ponds were/are unlined and likely received wastes contaminated with HE and barium and possibly uranium, organic cleaning agents, and machining oils.

Consolidated Unit 16-007(a)-99 operated from 1944 to the early 1950s, and Consolidated Unit 16-008(a)-99 operated from 1950 to 1970. The 90s Line Pond is all that remains of the 30s Line and 90s Line production facilities. Buildings associated with the discharge to the 30s Line Ponds were destroyed by intentional burning. The buildings associated with the discharge to the 90s Line Pond were decommissioned, which included the demolition of buildings and the removal of sumps, blast shields, drainlines, earthen berms, and asphalt roadways.

b. Remediation and Sampling Activities

NMED approved the investigation work plan that addressed Consolidated Units 16-007(a)-99 (the 30s Line) and 16-008(a)-99 (the 90s Line) (LANL 2005c; NMED 2005a). Field investigations began in 2006. Boreholes were drilled at the 30s Line and 90s Line ponds and in areas associated with former structures and discharge areas. A total of 90 boreholes were drilled: six intermediate-depth boreholes drilled to approximately 150 ft and 84 shallower boreholes drilled approximately 9 ft to 65 ft below ground surface (bgs). Surface and shallow subsurface samples were collected within the 90s Line drainages and from all borehole drilling locations as well as from the 30s Line and 90s Line areas associated with the former structures.

Perched water was encountered in one intermediate borehole near the 90s Line Pond. A groundwater sample was collected from the undeveloped well and submitted for analyses. A monitoring well was installed and the well design was approved before the well was constructed.

Surface-water samples were collected quarterly from the 90s Line Pond as part of the corrective measures evaluation for Consolidated Unit 16-021(c)-99. Additionally, a sample of surface water from the 90s Line Pond was collected in August 2007.

c. Conclusions and Recommendations

Data from investigations conducted in 1995, 1996, and 2004 were combined with the 2006–2007 investigation data (LANL 2007h) to provide a comprehensive understanding of site contamination and potential human health and ecological risks. Based on the sampling results, the vertical and lateral extent of contamination is not defined for all contaminants at Consolidated Units 16-007(a)-99 (30s Line) and 16-008(a)-99 (90s Line). The risk screening assessments indicate that the sites do not pose potential unacceptable risks to human health under the industrial and construction worker scenarios or to ecological receptors.

The following actions were recommended (LANL 2007h):

- For Consolidated Unit 16-008(a)-99, one deep borehole (300-ft depth) is proposed. Remediation is recommended at one location due to hexavalent chromium.
- For Consolidated Unit 16-007(a)-99, a single location with an elevated concentration of research department explosive (RDX) (also referred to as hexahydro-1,3,5-trinitro-1,3,5-triazine) is proposed for removal.
- Perched groundwater will be sampled once per quarter for four quarters. A pressure transducer to monitor water level fluctuations on a continuous basis will be installed.
- Best management practices will be installed in the drainages to the pond to reduce runoff from the former 90s Line building footprints. Periodic sampling of the pond sediment will be conducted.

The recommendations are pending NMED review.

5. Bayo Canyon Aggregate Area

a. Site Description and History

The Bayo Canyon Aggregate Area consists of TA-10 in the lower central portion of Bayo Canyon, between Kwage Mesa to the south and Otowi Mesa to the north, approximately 0.5 mi west of the Los Alamos County Sewage Treatment Plant. TA-10 was used as a firing test site from 1943 through 1961, and the area and related structures were constructed to test assemblies that contained conventional HE, including components made from depleted or natural uranium. TA-10 also included ancillary facilities associated with waste disposal, particularly for the radiochemistry laboratory. Associated facilities included sanitary and radioactive liquid waste sewage lines, manholes, septic tanks, seepage pits, and solid radioactive waste disposal pits.

TA-10 consists of Consolidated Unit 10-001(a)-99 [SWMUs 10-001(a–e) and 10-005, and AOCs 10-001(e) and 10-008], Consolidated Unit 10-002(a)-99 [SWMUs 10-002(a, b), 10-003(a–o), 10-004(b), and 10-007], SWMU 10-004(a), and AOCs C-10-001 and 10-009. The SWMUs and AOCs include firing sites, disposal pits, industrial waste manholes and lines, septic tanks and drainlines, a leach field, soil contamination areas, and landfills. The area underwent extensive decontamination and decommissioning (D&D) from 1960 to 1963; all explosive testing ceased in 1961. After D&D, the site was released to Los Alamos County in 1967 but remains under DOE administrative control.

b. Remediation and Sampling Activities

The Laboratory conducted field investigations in 2007 based on the approved work plan (LANL 2005d; LANL 2005e; NMED 2005b). A geodetic survey, a site-wide radiological survey, and geophysical surveys were conducted before the start of characterization and remediation activities. Both drilling and surface and shallow subsurface sampling activities were conducted.

Borehole sampling was conducted to characterize SWMUs 10-005 and 10004(a), Consolidated Unit 10-002(a)-99, and AOC 10-009. The approved work plan included a total of 53 boreholes to be drilled to a minimum of 25 to 30 ft bgs and sampled at 5-ft intervals.

Surface and shallow subsurface samples were collected at Consolidated Unit 10-001(a)-99 and AOC C-10-001 from 0 to 0.5 ft bgs and 1.5 to 2.0 ft bgs. Samples were to be collected from 22 locations across Consolidated Unit 10-001(a)-99 and from five locations at AOC C-10-001.

c. Conclusions and Recommendations

The results of the investigation for the Bayo Canyon Aggregate Area will be provided in an investigation report in 2008.

6. Middle Los Alamos Canyon Aggregate Area

a. Site Description and History

The Middle Los Alamos Canyon Aggregate Area includes TAs 2, 21, 26, and 61 and is located on the northern boundary of the Laboratory, immediately east-southeast of the Los Alamos townsite. The aggregate area extends from the mesa top to the stream channels in two adjacent canyons: DP Canyon to the north and Los Alamos Canyon to the south.

TA-2 is located in Los Alamos Canyon at the western end of the aggregate area. A small, intermittent stream (Los Alamos Creek) passes through the bottom of the canyon. TA-2 was used to house a series of research reactors from 1943 through 2003. The main reactor building was constructed in 1943 and housed five separate nuclear reactors: three iterations of water-boiler-type reactors located on the east side of the building, one plutonium-fueled reactor (the Clementine reactor) followed by an enriched uranium reactor, and the Omega West Reactor (OWR). The facility was active from 1943 through 1993 (LANL 2003a). The OWR was put on standby status in 1993 and remained inactive until decommissioned in 2003 (LANL 2003a).

All TA-2 facilities remaining on-site underwent D&D in September 2003. The site was cleared, the material disposed of in an appropriate off-site disposal facility, and the land returned to original contour and reseeded (LANL 2003a). The former reactor site is fenced, and access is controlled by the Laboratory.

TA-21 is located on DP Mesa on the northern boundary of the Laboratory, immediately east-southeast of the Los Alamos townsite. DP West operations began in September 1945, primarily to produce metal and alloys of plutonium. Other operations performed at DP West included nuclear fuel reprocessing. In 1977, a transfer of work to the new plutonium facility at TA-55 began, and much of the DP West complex was vacated. DP East operations also began in September 1945. These facilities were used to process polonium and actinium and to produce initiators.

TA-26 is a former technical area located south of State Highway 502, to the east and south of the Los Alamos County airport, and to the west of the East Gate Industrial Park. TA-26 consists of four SWMUs: SWMU 26-001 (a disposal area); SWMU 26-002(a) (an acid sump system); SWMU 26-002(b) (equipment room drainage system); and SWMU 26-003 (sanitary septic system). The area was demolished in 1965 and 1966.

b. Remediation and Sampling Activities

Samples were collected in 2007 at TA-2 as described in the approved investigation work plan (LANL 2006d; NMED 2006d). A total of 336 boreholes were drilled at TA-2 with samples collected from the surface and at several depths. Total depth of the boreholes ranged from 2 ft bgs to 39 ft bgs.

The investigations of the TA-21 sites were coordinated with other investigations at TA-21. Specifically, the proposed sampling activities at Consolidated Unit 21-006(e)-99 and AOC 21-028(c) were performed concurrently with the investigations of the DP Site Aggregate Area.

Samples at Consolidated Unit 21-006(e)-99 were collected from around the perimeter of the former building and within the building footprint. The building footprint was previously excavated and backfilled. Samples were collected in 2007 from 15 locations at three depths starting at approximately 2.0 to 3.0 ft bgs with a maximum sample depth of 13.0 ft bgs.

Samples at AOC 21-028(c) were collected from the approximate locations of the four satellite container storage areas and from 10 ft laterally around these locations. The building footprint was previously excavated and backfilled. Samples were collected in 2007 from 17 locations from three depths starting at approximately 2.0 to 3.0 ft with a maximum sample depth of 13.0 ft bgs.

Samples at TA-26 were collected on the mesa top at the former locations of the excavated structures and along the excavated pipelines as directed by the approved work plan (LANL 2006d; NMED 2006d). Samples were collected in 2007 from a minimum of three depths at 39 locations, with a maximum sample depth of 13.5 ft bgs. In addition, samples were collected on the topographical bench beneath the cliff from three depths.

c. Conclusions and Recommendations

The results of the investigation for the Middle Los Alamos Canyon Aggregate Area will be provided in an investigation report in 2008.

7. Consolidated Unit 73-002-99 (Airport Ashpile)

a. Site Description and History

Consolidated Unit 73-002-99 is located at the Los Alamos County Airport on the eastern end of the Los Alamos townsite. Consolidated Unit 73-002-99 consists of four inactive SWMUs and one inactive AOC.

- SWMU 73-002, a former waste incinerator, located in Building 73-02, and the ash surface disposal area located on the canyon slope north of the former waste incinerator building. The Laboratory operated the incinerator from 1947 to 1948 to destroy classified Laboratory documents, after which time it was used to burn municipal trash.
- AOC 73-003, a former steam-cleaning facility (former Structure 00-1123) for garbage trucks, cans, and dumpsters used to collect municipal waste from the Los Alamos townsite. The Laboratory used the steam-cleaning facility from 1949 to 1970 and demolished it in 1971.
- SWMU 73-004(a), a former septic system (septic tank, drainline, and outfall) that received sanitary waste from toilets and showers in the incinerator building (Building 73-02). The inlet drainline and septic tank were removed in 1996.
- SWMU 73-004(b), a former septic system (septic tank, drainline, and outfall) that received wash water from the steam-cleaning facility (AOC 73-003).
- SWMU 73-006, two former drainlines that discharged to Pueblo Canyon from floor drains in the incinerator building (Building 73-02). The drains are presumed to have handled wash water and to have operated concurrently with the incinerator.

b. Remediation and Sampling Activities

The primary objective of this investigation was to complete characterization of Consolidated Unit 73-002-99. Work was conducted in accordance with the approved investigation work plan (ITSI 2005; NMED 2005c). Remediation of contaminated soil and tuff at SWMUs 73-002, 73-004(b), and 73-006 continued into 2007. Remediation resulted in 36 yd^3 of PCB-contaminated soil removed from the outfall associated with SWMU 73-004(b) and 25 yd^3 of contaminated soil removed from SWMU 73-006 (LANL 2007i). Approximately 3,544 yd^3 of ash, debris, and contaminated soil was removed from the hillside at SWMU 73-002 (LANL 2007i). Confirmation samples were collected in 2007 following the removal of the contaminated material to define the extent of contamination and to verify that cleanup levels were met.

c. Conclusions and Recommendations

Based on the characterization data from the 2005, 2006, and 2007 investigations and from previous investigations conducted at the site, the nature and extent of contamination in surface and subsurface media are defined for Consolidated Unit 73-002-99 (LANL 2007i).

The risk screening assessments indicate no potential unacceptable risks or doses to human health under a residential scenario at SWMUs 73-002, 73-004(a), 73-004(b), and 73-006 and AOC 73-003 (LANL 2007i). The results of the ecological risk screening assessments indicate no potential risk to ecological receptors (LANL 2007i). Therefore, further investigation and corrective action are not warranted based on potential risks/doses to human health and the environment.

Following NMED review, the investigation report was approved (NMED 2007c). NMED granted Certificates of Completion for Corrective Action Complete with Controls for each of the sites within the consolidated unit based on the intended use of the land by Los Alamos County (NMED 2007c). NMED determined that the corrective measures at the sites are protective of human health and the environment and concurred with the transfer of property to Los Alamos County under the current land use (i.e., industrial).

8. MDA C

a. Site Description and History

MDA C (SWMU 50-009) is an inactive 11.8-acre landfill located within TA-50 at the head of Ten Site Canyon. MDA C consists of seven disposal pits and 108 shafts; the depths of the pits range from 12 to 25 ft and the depth of the shafts range from 10 to 25 ft below the original ground surface. Ten shafts in Shaft Group 3 (Shafts 98–107) are lined with 12-in.-thick concrete, while the rest of the pits and shafts are unlined. MDA C operated from May 1948 to April 1974 but received waste only intermittently from 1968 until it was decommissioned in 1974. Wastes disposed of at MDA C consisted of liquids, solids, and containerized gases generated from a broad range of nuclear energy research and development activities conducted at the Laboratory. These wastes included uncontaminated classified materials, metals, hazardous materials, and radioactively contaminated materials.

b. Remediation and Sampling Activities

Investigation activities at MDA C began in 2005 and continued in 2006 and 2007 according to the approved MDA C investigation work plan (LANL 2005f; NMED 2005d; NMED 2005e). The field activities, data review, and risk assessments conducted through 2006 are presented in the *Investigation Report for Material Disposal Area C, Solid Waste Management Unit 50-009, at Technical Area 50* (LANL 2006e).

Additional characterization activities at MDA C were conducted in 2007. The Laboratory drilled four vertical boreholes between Pits 2 and 3. Samples of fill and tuff as well as pore gas were collected.

c. Conclusions and Recommendations

The analytical results from the four vertical boreholes between Pits 2 and 3 are consistent with the data from the other 36 boreholes drilled at MDA C as presented in the report (LANL 2006e). Submission of these data completed the requirements in the approved MDA C work plan (LANL 2005f; NMED 2005d; NMED 2005e).

The Laboratory developed and submitted a Phase 2 investigation work plan (LANL 2007j), which was approved (NMED 2007d) and is scheduled to be implemented in 2008.

9. SWMUs 03-010(a) and 03-001(e)

a. Site Description and History

SWMUs 03-010(a) and 03-001(e) are located within TA-3 next to the general warehouse (Building 03-0030). SWMU 03-010(a) is located about 30 ft west of Building 03-0030 and SWMU 03-001(e) is immediately adjacent to the western edge of Building 03-0030. Both SWMUs are operationally inactive.

SWMU 03-010(a) was a surface disposal site for vacuum-pump oil containing mercury and radionuclides, generated from a vacuum repair shop located in Building 03-0030. During the 1950s, it is estimated that the Laboratory discarded more than 100 lbs of mercury-contaminated vacuum-pump oil onto the canyon edge.

SWMU 03-001(e) was an active storage area for vacuum-pump repair waste from 1957 to 1992. The Laboratory stored waste oil in drums on the ground, and the drums periodically overflowed.

b. Remediation and Sampling Activities

A status report presenting the results to date of four interim-measure activities conducted at SWMUs 03-010(a) and 03-001(e) was submitted in 2007 (LANL 2007k). The objective of the interim-measure activities is to obtain sufficient information to determine an effective control for the groundwater recharge system, thereby supporting a final remedy for the site.

The results of the video-logging of the culvert leading from the roof drains on the southern half of the building show a significant break near the building foundation. This break may be the pathway that allows precipitation from the roof drains to recharge the perched groundwater.

c. Conclusions and Recommendations

The Laboratory repaired the culvert and provided written certification that such repairs were completed (LANL 2007l). In addition, the Laboratory continued to monitor groundwater in two of the three sampling wells (wells B-10 and B-13) on a quarterly basis.

10. MDA L

a. Site Description and History

MDA L (SWMU 54-006) is located at TA-54 in the east-central portion of the Laboratory on Mesita del Buey, within an 1,100 ft by 3,000 ft (2.5-acre) fenced area known as Area L. MDA L is a decommissioned (removed from service) area established for disposing of nonradiological liquid chemical waste, including containerized and uncontainerized liquid wastes; bulk quantities of treated aqueous waste; batch-treated salt solutions; electroplating wastes, including precipitated heavy metals; and small-batch quantities of treated lithium hydride.

The MDA consists of one inactive subsurface disposal pit (Pit A); three inactive subsurface treatment and disposal impoundments (Impoundments B, C, and D); and 34 inactive disposal shafts (Shafts 1 through 34) excavated into the overlying soil and unit 2 of the Tshirege Member of the Bandelier Tuff. Upon decommissioning, the pit and impoundments were filled and covered with clean, crushed, consolidated tuff. When the shafts were filled to within approximately 3 ft of the surface, they were capped with a 3-ft concrete plug.

b. Remediation and Sampling Activities

The Laboratory submitted the investigation report for MDA L (LANL 2005g) and in 2006 submitted a revised investigation report (LANL 2006f). A supplemental investigation work plan (LANL 2006g) was submitted per NMED direction and approval (NMED 2006e; NMED 2006f). The work plan presents the scope of work for drilling three new vertical boreholes. The three boreholes were completed as vapor-phase monitoring boreholes, allowing continued monitoring of the volatile organic compound (VOC) plume. Tuff samples were also collected from the boreholes and analyzed to confirm that the nature and extent of contamination are defined.

c. Conclusions and Recommendations

An addendum to the investigation report (LANL 2007m) was submitted, which summarizes the results of the additional activities conducted at MDA L. The tuff and pore-gas sample results from the newly installed and existing boreholes confirm the results from the Phase I Resource Conservation and Recovery Act (RCRA) facility investigation (RFI) (LANL 2003b), the 2004–2005 investigation (LANL 2005g; LANL 2006f), and the quarterly pore-gas monitoring.

NMED approved the investigation report and the addendum to the investigation report for MDA L with direction (NMED 2007e). The Laboratory will develop a corrective measures report and continues to monitor VOCs and tritium in subsurface pore gas at MDA L.

An interim subsurface vapor monitoring plan was submitted and approved with modifications (LANL 2007n; NMED 2007f); it describes proposed subsurface monitoring activities and the frequencies at which sampling is conducted within the vadose zone beneath MDA L. The eight boreholes drilled in 2004–2005 and the three boreholes drilled in 2007 provide complete coverage across the site and encompass all the subsurface rock units down to and including the basalt. Pore-gas monitoring data are reported in a quarterly periodic monitoring report.

11. MDA G

a. Site Description and History

MDA G, Consolidated Unit 54-013(b)-99, is located in the east-central portion of the Laboratory at TA-54, Area G, on Mesita del Buey. Portions of the disposal units at MDA G are covered with concrete to house ongoing waste-management activities conducted at Area G, Surface runoff from the site is controlled and discharges into drainages to the north (towards Cañada del Buey) and the south (towards Pajarito Canyon).

MDA G is a decommissioned (removed from service) subsurface site at TA-54 established for disposition of low-level waste, certain radioactively contaminated infectious waste, asbestos-contaminated material, and PCBs. It was also used for the retrievable storage of transuranic waste. It consists of inactive subsurface units that include 32 pits, 194 shafts, and four trenches. When operations ceased, the remaining capacity of the pits, shafts, and trenches was backfilled with clean, crushed, compacted tuff and closed. The disposal shafts were capped with a concrete plug.

b. Remediation and Sampling Activities

The Laboratory submitted the investigation report for MDA G (LANL 2005h) in 2005. A supplemental investigation work plan (LANL 2006h) was subsequently submitted per NMED direction (NMED 2006g; NMED 2006h) and approval (NMED 2006i). The supplemental work plan is designed to complete additional investigation activities to determine the vertical extent of vapor-phase VOC contamination in the eastern and northern portions of MDA G. The additional investigation activities included the advancement of four pre-existing boreholes approximately 13 ft to 21.5 ft into the Cerros del Rio basalt, resulting in total depths ranging from 201 ft to 306.5 ft. In addition, a new borehole was installed 21.5 ft into the basalt, with a final depth of 191.5 ft. Pore-gas samples were collected from each vapor-sampling port and submitted for VOC analysis. Pore-gas samples were collected from each vapor sampling port in the new borehole and submitted for tritium analysis.

c. Conclusions and Recommendations

An addendum to the investigation report (LANL 2007o) was submitted, which summarizes the results of additional investigation activities conducted at MDA G. The results of pore-gas sampling from boreholes extended into the basalt confirm the results of the RFI (LANL 2000), previous quarterly monitoring, and the 2005 site investigation (LANL 2005h).

NMED approved the investigation report (LANL 2005h) and the addendum to the investigation report for MDA G (LANL 2007o) with direction (NMED 2007g).

The Laboratory continues to monitor VOCs and tritium in subsurface pore gas at MDA G. In addition, the Laboratory submitted a work plan for the implementation of a soil-vapor extraction pilot study in 2007 at MDA G (LANL 2007p), which may be implemented as a remedial option. The work plan was approved with direction (NMED 2007h), and work is scheduled to be conducted in 2008. A corrective measure evaluation plan for MDA G was submitted, revised (LANL 2007q), and approved by NMED with direction (NMED 2007i). The corrective measure report was submitted in early 2008 (LANL 2008).

12. Middle Mortandad/Ten Site Canyons Aggregate Area

a. Site Description and History

The Middle Mortandad/Ten Site Canyons Aggregate Area consists of consolidated units, SWMUs, and AOCs in TAs 4, 5, 35, 52, 60, and 63. The SWMUs and AOCs occupy a narrow mesa (Ten Site Mesa) and adjacent slopes between Mortandad and Ten Site Canyons, the floor of a small tributary canyon to Ten Site Canyon (named Pratt Canyon) and adjacent Mesita del Buey and Sigma Mesa as well as part of the floor of Ten Site Canyon. The aggregate area was divided into seven subareas for ease of investigation and presentation. The subareas are Mesa Top, Ten Site Slope, Mortandad Slope, Pratt Canyon, Ten Site Canyon, East Ten Site Slope, and Sigma Mesa.

b. Remediation and Sampling Activities

Characterization activities were initially conducted in 2004–2005 (LANL 2002; LANL 2004a). A complete description of the field activities, data review, and risk assessments for this site were presented in the *Investigation Report for the Middle Mortandad/Ten Site Aggregate* (LANL 2005i).

Investigation activities in 2007 included sampling for the nature and extent of the contamination at SWMUs 35-016(o), 35-016(p), 05-001(c), and Consolidated Units 35-003(d)-00, 35-016(k)-00, and 05-001(a)-99; excavation of contaminated soil at SWMUs 35-016(o) and 35-016(p) and collection of confirmation samples (LANL 2007r). An additional 74 samples were collected from the Mortandad Slope, Pratt Canyon, and East Ten Site Slope Subareas, and approximately 0.23 yd^3 of soil was excavated from SWMUs 35-016(o) and 35-016(p) (LANL 2007r).

c. Conclusions and Recommendations

A revised investigation report was submitted in 2007 (LANL 2007r). The nature and extent of contamination for the subareas are defined. None of the SWMUs, AOCs, and consolidated units (except for AOC 35-018[a]) in the seven subareas pose a potential unacceptable risk/dose under either a residential, industrial, or recreational scenario. Ecological risk screening was also conducted for all seven subareas within the Middle Mortandad/Ten Site Aggregate Area, and no potential unacceptable ecological risk was found in any of the subareas.

The Laboratory requested Certificates of Completion for Corrective Action Complete without Controls from NMED for those sites that do not pose potential unacceptable risks or doses to human health under the residential scenario (LANL 2007r). Because these sites pose no unacceptable risk to human health under the residential scenario and no risk to the environment, neither site controls nor future actions are necessary.

The Laboratory requested Certificates of Completion for Corrective Action Complete with Controls from NMED for those sites that do not pose potential unacceptable risks or doses to human health under either an industrial or recreational scenario (LANL 2007r). Based on the results of the human health risk-screening assessments, controls are required to restrict residential use of those properties. The Laboratory intends to retain ownership of the properties indefinitely and will continue to maintain current site conditions and restrict the properties to industrial or recreational use only.

The recommendations are pending NMED review.

C. WATER STEWARDSHIP PROJECT

The Laboratory conducted the following investigations and activities in 2007:

- A summary of the North Canyons Phase 1 sediment investigation was submitted and approved. Phase 2 investigations were completed.
- A summary of the Phase 2 sediment investigation in Pajarito Canyon was submitted and approved. Phase 3 sediment investigations were approved and are ongoing.

- A summary of the Sandia Canyon Phase 1 sediment investigation was submitted. Phase 2 investigations are ongoing.
- The investigation report of the Mortandad Canyon watershed was approved. The revised risk assessments were submitted. Additional work is scheduled to start in 2008.
- The addendum to the work plan for Sandia Canyon and Cañada del Buey was submitted, approved, and implemented. Additional drilling, modeling, and geochemistry studies for the chromium investigations are being implemented under the addendum.
- The Pajarito Canyon Biota Investigation Work Plan was approved and implemented.
- Additional information and reports were submitted, including periodic monitoring reports, well completion reports, other well work plans and reports, the General Facility Information (annual update), the Interim Facility-Wide Groundwater Monitoring Plan (annual update), and the Groundwater Background Investigation Report, Revision 3.

The following sections include brief summaries of the investigation activities started, continued, or completed in 2007.

1. North Canyons

a. Site Description and History

The Bayo, Barrancas, Rendija, and Guaje Canyon systems are referred to as the "north canyons systems." These canyons head in the northern part of the Pajarito Plateau north of the Laboratory and are addressed by one work plan because of similarities common to all four canyons.

- Bayo Canyon is located north of Pueblo Canyon and extends across Los Alamos County land and Pueblo de San Ildefonso land to its confluence with Los Alamos Canyon.
- Barrancas Canyon is located north of Bayo Canyon and extends across Los Alamos County land, USFS land, Laboratory property, and Pueblo de San Ildefonso land to its confluence with Guaje Canyon.
- Rendija Canyon is located north of the Los Alamos townsite and extends across USFS land, private land, Los Alamos County land, and General Services Administration land to its confluence with Guaje Canyon.
- Guaje Canyon is located north of Rendija Canyon and Barrancas Canyon and extends across USFS land and Pueblo de San Ildefonso land to the confluence with Los Alamos Canyon.

SWMUs and AOCs associated with TA-10 within the Bayo Canyon Aggregate Area and the SWMUs and AOCs associated with Rendija Canyon have been addressed in separate investigation work plans and reports (see previous text under Corrective Action Project).

b. Remediation and Sampling Activities

The Laboratory performed a Phase 1 field investigation of sediment deposits in Barrancas, Bayo, Guaje, and Rendija Canyons in 2006 following the *Work Plan for the North Canyons* (LANL 2001), as modified by agreements with the NMED (LANL 2005j; NMED 2005f; LANL 2006i). Following NMED review, additional sampling was conducted in 2007 in reach R-3 in Rendija Canyon to define the nature and extent of inorganic chemicals and radionuclides (LANL 2007s).

c. Conclusions and Recommendations

With the additional samples collected, no additional sediment characterization is necessary at this time; the goals of the sediment sampling and analysis plan presented in the work plan (LANL 2001) and in subsequent agreements with NMED (LANL 2005j; NMED 2005f; LANL 2006i) have been met. NMED agrees that the Laboratory should proceed with preparation of the north canyons investigation report.

2. Pajarito Canyon

a. Site Description and History

Pajarito Canyon is located in the central part of the Laboratory. The canyon heads in the Santa Fe National Forest west of the Laboratory boundary and empties into the Rio Grande in White Rock Canyon. The main channel is approximately 14.8 miles long and the watershed area is approximately 8 mi^2. Twomile Canyon and Threemile Canyon are major tributaries that join Pajarito Canyon and have watershed areas of 3.1 mi^2 and 1.7 mi^2, respectively. Sites within the Pajarito Canyon watershed are located at TAs 3, 8, 9, 12, 15, 18, 23, 27, 48, 54, 55, 59, 64, and 69.

b. Remediation and Sampling Activities

The Laboratory conducted a Phase 2 field investigation of sediment deposits in the Pajarito Canyon watershed in 2006 according to the Pajarito Canyon Phase 1 summary report (LANL 2006j; NMED 2006j). A Phase 2 summary report of the sediment investigation, which included proposed Phase 3 sampling, was submitted in 2007 (LANL 2007t).

The proposed Phase 3 sediment investigation in the Pajarito Canyon watershed is focused on improving estimates of average concentrations of contaminants that are important for evaluating potential human health risk, the extent of contamination, and the effects of a large flood in August 2006.

The *Pajarito Canyon Biota Investigation Work Plan* (LANL 2006k) was submitted in 2006 and approved by NMED (NMED 2007j). A number of biota studies are proposed for the Pajarito Canyon watershed. The proposed studies are based on assessment endpoints developed to protect the terrestrial and aquatic ecosystems within canyons in the watershed. The proposed studies complement previous studies conducted in the Los Alamos and Pueblo Canyons, Cañon de Valle, and Mortandad Canyon watersheds.

c. Conclusions and Recommendations

NMED reviewed the summary report and approved the Phase 3 sediment investigations proposed by the Laboratory (NMED 2007k). The results of all of the sediment investigations conducted will be included in the Pajarito Canyon investigation report.

The Pajarito Canyon biota studies were implemented in 2007 according to the approved work plan and will continue into 2008. The results of the biota investigation will be reported as part of the Pajarito Canyon investigation report.

3. Sandia Canyon and Cañada del Buey

a. Site Description and History

Sandia Canyon is located in the central part of the Laboratory, heads within TA-3, trends east-southeast across the Laboratory, Bandelier National Monument, and Pueblo de San Ildefonso land, and empties into the Rio Grande in White Rock Canyon. The main channel is approximately 9.4 miles long and the watershed area is approximately 5.5 mi^2. Sandia Canyon on Laboratory property extends for a distance of 5.6 mi and has a watershed area of 2.65 mi^2. Sites within the Sandia Canyon watershed are located at TAs 3, 53, 60, 61, and 72 and former TA-20.

Cañada del Buey, located in the central part of the Laboratory, is the largest tributary to Mortandad Canyon. The canyon heads within TA-52 and TA-36 and trends east-southeast across the Laboratory, Pueblo de San Ildefonso land, and Los Alamos County, and ends at the confluence with Mortandad Canyon. The main channel is approximately 8.2 miles long, and the watershed area is approximately 4.3 mi^2. Cañada del Buey on Laboratory property extends for a distance of 5 mi and has a watershed area of 2.1 mi^2. On Laboratory property, Cañada del Buey has one main tributary (south fork of Cañada del Buey) and a smaller tributary referred to as the TA-46 tributary or the Sanitary Wastewater Consolidation System Canyon tributary. Sites within the Cañada del Buey watershed are located at TAs 18, 46, 51, 52, and 54 and former TA-4.

b. Remediation and Sampling Activities

The Phase 1 field investigation of potentially contaminated sediment deposits in Sandia Canyon was performed in 2007 as proposed in the *Work Plan for Sandia Canyon and Cañada del Buey* (LANL 1999), as modified by several subsequent documents (LANL 2003c; LANL 2005k), and approved by NMED (NMED 2005g).

Sediment samples were collected in six reaches in Sandia Canyon, as specified in the approved work plan (LANL 1999) and in the *Addendum to the Work Plan for Sandia Canyon and Cañada del Buey* (LANL 2007v). Prior to sampling, field investigations included detailed geomorphic mapping and associated geomorphic characterization in these six reaches. Samples selected for off-site analysis included the location in each reach with the highest chromium concentration based on x-ray fluorescence measurements. A subset of the Phase 1 samples included a geochemical characterization to help evaluate the presence of trivalent chromium (Cr[III]) and hexavalent chromium (Cr[VI]) in the sediment deposits.

Most contaminants have maximum concentrations in the uppermost part of the watershed (TAs 3, 60, and/or 61). Specific sources for some of these contaminants include releases of cooling water from the power plant at TA-3 and from SWMU 03-056(c), a former transformer storage area. Only nine contaminants have maximum concentrations in downcanyon reaches. The spatial distribution of contamination indicates that contaminants have been transported along the full length of Sandia Canyon from TA-3 at least as far east as New Mexico State Road 4.

The inventory of chromium in sediment deposits was estimated in each sampled reach in Sandia Canyon and was interpolated between reaches to provide a canyon-scale estimate. Paired total chromium and Cr(VI) analyses indicate that the chromium in Sandia Canyon sediment deposits is dominated by Cr(III). Simulations indicate that approximately 65% to 90% of the total chromium inventory in Sandia Canyon sediment deposits is in the uppermost part of the watershed.

Additional activities specified in the approved addendum to the work plan (LANL 2007v; NMED 2007l) include a review of sites in Los Alamos, Sandia, and Mortandad Canyons to identify the potential source(s) of chromium, water balance investigations, surface water and groundwater sampling, fate and transport modeling, testing of regional well R-28, supply well PM-3 zonal sampling, and installation of vadose-zone characterization core holes approximately a mile upstream of station SCC-1.

A biota investigation work plan for Sandia Canyon investigation reaches was submitted in 2007 (LANL 2007w). A number of biota studies are proposed for the Sandia Canyon watershed. The proposed studies are based on assessment endpoints developed to protect the terrestrial and aquatic ecosystems within the watershed. The proposed studies complement previous studies conducted in the Los Alamos and Pueblo Canyons, Cañon de Valle, and Mortandad Canyon watersheds.

c. Conclusions and Recommendations

A Phase 1 summary report of the sediment investigation, which included proposed Phase 2 sampling, was submitted in 2007 (LANL 2007u). Proposed Phase 2 sediment investigations in Sandia Canyon will be focused on evaluating the source and extent of contamination and on improving estimates of average concentrations of contaminants. Sampling in each Phase 2 reach will include both surface and subsurface sediment layers, depending on the thickness of historical (post-1942) sediment in each reach.

The fate and transport report was submitted in 2007 (LANL 2007x), which is part of an ongoing investigation to address the chromium and other contaminants detected in surface water and groundwater beneath Sandia and Mortandad Canyons. Also submitted was the *Completion Report for Regional Aquifer Wells R-35a and R-35b* (LANL 2007y) and the *Work Plan for Geochemical Characterization and Drilling for Fate and Transport of Contaminants Originating in Sandia Canyon* (LANL 2007z). The latter work plan describes geochemistry experiments and analyses intended to further characterize long-term fate and transport of contaminants (particularly chromium) from Sandia Canyon.

The biota investigation work plan for Sandia Canyon is pending NMED review and will be implemented in 2008.

4. Mortandad Canyon

a. Site Description and History

The investigation encompassed Mortandad, Effluent, and Ten Site Canyons and an unnamed tributary canyon that heads in TA-5. This area is collectively referred to as the Mortandad Canyon watershed. Mortandad Canyon is located in the north-central part of the Laboratory and extends for approximately 10 mi from Diamond Drive in TA-3 east-southeast to the Rio Grande. Mortandad Canyon has a total watershed area (excluding Cañada del Buey) of about 6.0 mi^2. Primary tributary drainages on Laboratory land are Effluent Canyon, which heads in TA-48, and Ten Site Canyon, which heads in TA-50. Cañada del Buey, a major tributary of Mortandad Canyon, joins with Mortandad Canyon upstream of the Rio Grande and has a watershed area of 4.3 mi^2; Cañada del Buey will be the subject future investigations and reported on under the Sandia Canyon and Cañada del Buey investigations. The Mortandad Canyon watershed reported on here includes that portion west of State Road 4, which has a drainage area of 3.3 mi^2 of which 60% is on Laboratory land and 40% is on Pueblo de San Ildefonso land. Technical areas in the watershed include TAs 3, 4, 5, 35, 42, 48, 50, 52, 55, 60, and 63.

b. Remediation and Sampling Activities

The investigation report for Mortandad Canyon was submitted in 2006 (LANL 2006l). Following NMED review, additional actions were required and a revised risk assessment was requested.

Additional activities included conducting a comprehensive assessment and evaluation of each well and well screen intersecting intermediate and regional groundwater in the Mortandad Canyon watershed; replacing gage station E202 to ensure that it is capable of measuring flood events; removing damaged permeable reactive membrane and returning the canyon to pre-permeable reactive membrane conditions; and collecting four rounds of groundwater samples from wells used to support any proposed actions in the upcoming corrective measures evaluation.

c. Conclusions and Recommendations

The Laboratory submitted the revised risk assessments for the Mortandad Canyon investigation (LANL 2007aa). The other required investigation activities will be implemented in 2008.

D. TA-21 CLOSURE PROJECT

Investigations and activities conducted in 2007 included the following:

- Additional investigation sampling at MDA V was conducted and a revised investigation report was submitted.
- Sampling and remediation of an area of elevated radioactivity near absorption bed 3 within and around MDA V was conducted.
- Supplemental sampling at MDA A was conducted and a status report submitted.
- Phase 2 sampling at MDA T was conducted and a Phase 2 investigation report submitted.
- Investigation and removal activities for sites within the DP Site Aggregate Area were conducted and an investigation report submitted.

The following sections summarize the investigations started, continued, and completed in 2007.

1. MDA V

a. Site Description and History

Consolidated Unit 21-018(a)-99 is a 0.88-acre fenced area located on the south side of DP Road west of the TA-21 main gate. The consolidated unit is comprised of four SWMUs and one AOC.

- SWMU 21-018(a) (MDA V) received radioactive liquid waste derived from the TA-21 laundry facility (SWMU 21-018[b]). The Laboratory constructed the absorption beds in 1945 and operated them until 1961.
- SWMU 21-018(b), the former laundry facility, was located south of DP Road. The Laboratory operated the laundry facility from 1945 to 1961.
- SWMU 21-023(c), a former septic system that consisted of a tank, inlet and outlet lines, and an outfall served a waste treatment laboratory. The Laboratory put the septic system into service in 1948 and removed it from service in 1965.
- SWMU 21-013(b) and AOC 21-013(g) are surface debris disposal sites located on the south-facing slope above BV Canyon. It is not known how long these sites received building debris; however, they did not receive wastes later than 1994.

b. Remediation and Sampling Activities

The Laboratory submitted the investigation report for MDA V in 2006 (LANL 2006m). Following NMED review, additional investigations were warranted. Additional confirmatory sampling was completed in 2007 on the northwest slope of SWMU 21-013(b). The results of the SWMU 21-013(b) sampling are provided in revision 1 of the investigation report (LANL 2007bb), which was submitted in 2007.

Investigation and remediation of an area of elevated radioactivity identified north of former absorption bed 3 (SWMU 21-018[a]) during the post-remediation walkover survey are in progress.

c. Conclusions and Recommendations

The nature and extent of contamination are defined for this consolidated unit, with the exception of low levels of tritium in subsurface pore gas. The human health risk screening assessments indicated no potential risks or doses under a residential scenario. The ecological risk screening assessment indicated no potential risk to ecological receptors.

The revised human health risk assessment included an evaluation of the potential inhalation risk from pore gas via an indoor air pathway for residential receptors. All of the chemicals evaluated are carcinogens; the cumulative cancer risks do not exceed 1×10^{-5} for any of the indoor air model site conditions evaluated (LANL 2007bb).

The results of the investigation and remediation of the area of elevated radioactivity north of former absorption bed 3 will be provided in a supplemental investigation report in 2008.

2. MDA T

a. Site Description and History

MDA T, Consolidated Unit 21-016(a)-99, is an area of approximately 2.2 acres located within TA-21 on DP Mesa. MDA T includes 25 SWMUs and AOCs associated with decommissioned radioactive liquid waste treatment facilities and various storage areas. The SWMUs and AOCs associated with MDA T were operational from 1945 to 1986. The Laboratory discharged approximately 18.3 million gallons of wastewater to the MDA T absorption beds between 1945 and 1967. The SWMUs and AOCs include inactive absorption beds, a retrievable waste storage area, asphalt-lined disposal shafts, sumps, acid holding tanks, acid sumps, effluent holding tanks, sodium hydroxide storage tank, an americium raffinate storage tank, acid valve pit manholes, underground steel

tanks, a septic tank, grit chamber or settling tank, and airborne releases from incinerators used to burn waste oils and organics after testing (oil spills from the incinerators are known to have occurred). Also included are eight AOCs that are not part of Consolidated Unit 21-016(a)-99 but are within the footprint of the consolidated unit. These sites consist of four unintentional releases or one-time spills and four former storage and treatment tanks.

b. Remediation and Sampling Activities

Recent investigation activities at MDA T began in 2005 and concluded in 2006 according to the approved work plan (LANL 2004b; NMED 2005h). The Laboratory submitted the investigation report for MDA T in 2006 (LANL 2006n). Following NMED review, additional investigations were warranted and a Phase 2 investigation work plan was submitted and approved (LANL 2007cc, NMED 2007m). The objectives of the 2007 investigation were to (1) continue characterization of tritium and VOC vapors beneath MDA T; (2) define the extent of americium-241, plutonium-238, and plutonium-239 at locations on the DP Canyon slope; (3) assess if americium-241, plutonium-238, and plutonium-239 activities in surface soil has been impacted by recent storm runoff and the December 2006 water main leaks at TA-21; and (4) acquire nitrate and supplemental perchlorate data on the DP Canyon slope.

The additional activities included the installation of three permanent vapor-monitoring wells in the three deepest boreholes and a vapor monitoring work plan (LANL 2007cc). The Laboratory submitted a vapor monitoring plan (LANL 2007dd), which was approved with modifications (NMED 2007n). Each of the three vapor monitoring wells will be sampled and analyzed quarterly for VOCs and tritium for one year, after which the need for additional sampling will be evaluated.

c. Conclusions and Recommendations

The Phase 2 investigation report was submitted in 2007 (LANL 2007ee).

Pore-gas results from the first round of quarterly sampling confirm low concentrations of VOCs and low activities of tritium. Three additional quarters of pore-gas monitoring data will be collected. The nature and extent of pore gas will be comprehensively evaluated and presented in a report following completion of planned vapor-monitoring activities.

The DP Canyon slope data indicate that the nature and extent of americium-241, plutonium-238, plutonium-239, nitrate, and perchlorate are defined. The extent of contamination beyond the toe of the slope into DP Canyon is defined and presented in the Los Alamos and Pueblo Canyons investigation report (LANL 2004c). Migration of radionuclides into DP Canyon is being monitored as part of the Laboratory's storm water and sediment monitoring programs.

Doses from americium-241, plutonium-238, and plutonium-239/240 under the recreational and residential scenarios are slightly lower or equivalent to the doses presented in the investigation report (LANL 2007dd).

3. MDA A

a. Site Description and History

MDA A, SWMU 21-014, is comprised of a 1.25-acre, fenced, and radiologically controlled area situated on the eastern end of DP Mesa between DP Canyon to the north and Los Alamos Canyon to the south. The Laboratory used MDA A between 1945 and 1978 to store solid and liquid wastes.

MDA A currently contains the following features:

- Two 50,000-gal. cylindrical steel storage tanks (referred to as the General's Tanks) are buried at the western end of MDA A. The tanks received waste solutions containing plutonium-239/240 and americium-241 from 1947 to 1974. Liquid waste was removed from the tanks in 1975 and 1976, but an unknown volume of sludge remains in the bottom of the tanks.

- Two 4-ft diameter, 65-ft deep vertical shafts located south of the General's Tanks. The shafts were constructed in 1975 but never used and were filled with soil in 1977.
- Two eastern disposal pits were excavated to receive radioactive solid waste from DP East in 1945. In 1946, crushed Bandelier Tuff was used to backfill and cover the pits.
- One central pit was excavated in the center of MDA A to receive and store TA-21 decontamination and decommissioning debris potentially contaminated with radionuclides. This pit received waste from 1969 to 1977. The pit was decommissioned in 1978, and a cover (crushed tuff) was placed over the pit.

Several hundred 55-gal drums containing iodide waste were stored on the surface at the eastern end of MDA A. These drums contained sodium hydroxide solution and stable iodine. The drum storage area was used from the late 1940s until 1960.

b. Remediation and Sampling Activities

The Laboratory began and concluded investigation activities in 2006 at MDA A according to the approved work plan (LANL 2005l; LANL 2006o; NMED 2005i). The Laboratory submitted the investigation report for MDA A in 2006 (LANL 2006p). Following review of the report, NMED requested additional drilling and sampling for pore-gas (NMED 2007o). The objectives of the 2007 supplemental investigation were to (1) assess the vertical extent of tritium pore gas beneath MDA A, (2) further characterize tritium and VOC extent in pore gas beneath MDA A with additional sampling, and (3) plug and abandon open boreholes. One borehole was extended to 115 ft bgs, sampled for pore gas, and analyzed for tritium and VOC from 15 ft bgs to 115 ft bgs in. In addition, a second round of vapor-phase VOCs and tritium samples were collected from previously sampled depths in four other boreholes.

c. Conclusions and Recommendations

A status report of the supplemental sampling at MDA A was submitted in 2007 (LANL 2007ff). The 2007 supplemental sampling field activities included deepening one sample and sampling pore gas from it, collecting an additional round of pore-gas samples from five other existing boreholes, and plugging and abandoning twelve open boreholes.

VOC pore-gas results from 2007 indicate fewer VOCs detected and at lower concentrations. The vertical extent of pore-gas VOCs is defined by the two deeper boreholes. Lateral extent of VOCs in pore gas is defined.

Tritium results from 2007 are over an order of magnitude lower than the levels measured at the same locations in 2006. The vertical and lateral extent of tritium in pore gas is defined at MDA A.

The VOCs in subsurface pore gas at MDA A are not a potential source of groundwater contamination. The maximum detected level of tritium was approximately 5% of the EPA drinking water standard (20,000 pCi/L) for tritium. Therefore, the tritium detected in the subsurface at MDA A is not a potential source of groundwater contamination.

The report is pending NMED review.

4. DP Site Aggregate Area

a. Site Description and History

TA-21 is located on DP Mesa on the northern boundary of LANL and is immediately east-southeast of the Los Alamos townsite. From 1945 to 1978, TA-21 was used primarily for plutonium research, metal production, and related activities. Since 1978, various administrative and research activities have been conducted at TA-21. The DP Site Aggregate Area consists of SWMUs and AOCs located throughout TA-21. The SWMUs and AOCs consist of container storage areas, surface disposal areas, a PCB storage area, septic systems, sumps, drainlines, outfalls, a waste treatment laboratory, a sewage treatment plant, and seepage pits.

b. Remediation and Sampling Activities

Site characterization and remediation activities were conducted in 2006 and 2007 based on the approved work plan (LANL 2004d; LANL 2005m; LANL 2006q; NMED 2005j). Sites were identified as (1) investigation sites; (2) facility-unimpacted corrective action sites; and (3) facility-impacted corrective action sites (corrective actions and sampling are ongoing). Because utilities and structures are present and significant planning is needed to address health and safety hazards, the facility-impacted sites will be addressed only after utility location, isolation, and health and safety clearance are completed.

The scope of activities at the investigation sites included surface and shallow subsurface sampling and excavation of the septic tank and drainline at one site. Scope of activities for the facility-unimpacted corrective action sites included surface and subsurface sampling as well as the removal of the blowdown pits, the seepage pits, the blowdown tank, and pipelines at one site; removal of several septic tanks and the associated pipelines; the removal of sumps and all pipelines; the removal of a dosing siphon chamber and the main pipeline extending to the outfall; and the removal of several pipelines.

c. Conclusions and Recommendations

The vertical and lateral extent of contamination at three of the investigation sites and all of the facility-unimpacted corrective action sites are not defined (LANL 2007gg). All of these sites require additional sampling to determine the vertical and lateral extent of contamination. Facility-impacted corrective action field activities will be reported on when completed and the data become available.

PCB concentrations are above the Toxic Substances Control Act (TSCA) cleanup level of 1 mg/kg at two investigation sites. Remediation of the PCBs under TSCA is recommended at both sites. Data collected at the suspected PCB-contaminated outfall are collected to facilitate the determination of the source of PCBs in storm water.

E. QUALITY ASSURANCE PROGRAM

1. Quality Assurance Program Development

The EP Directorate's quality assurance objectives are to perform work in a quality manner while minimizing potential hazards to the environment, public, or workers. All work is performed by using approved instructions, procedures, and other appropriate means that implement regulatory or contractual requirements for technical standards, administrative controls, and other hazard controls. The Quality Management Plan establishes the principles, requirements, and practices necessary to implement an effective quality assurance program.

The use of a graded approach determines the scope, depth, and rigor of implementing the quality assurance criteria for a specific activity. Activities are managed through systems that are commensurate with the quality requirements, risk, and hazards involved in the activity. Such a selective approach allows the Laboratory to apply extensive controls to certain elements of activities and limited controls to others. The control measures applied to any particular activity are covered in documents such as procedures, statements of work, project-specific work plans, and procurement contracts associated with the activity.

2. Field Sampling Quality Assurance

Overall quality is maintained through the rigorous use of carefully documented procedures that govern all aspects of the sample collection activities.

Soil, water, vapor, and biota samples are (1) collected under common EPA chain-of-custody procedures using field notebooks and sample collection logs and (2) prepared and stored in certified pre-cleaned sampling containers in a secure and clean area for shipment. Samples are delivered to analytical laboratories under full chain-of-custody, including secure FedEx shipment to all external vendors, and tracked at all stages of their collection and analysis.

3. Analytical Laboratory Quality Assessment

The Laboratory writes specific statements of work to govern the acquisition and delivery of analytical chemistry services after the Data Quality Objective process defines the project needs. These statements of work are sent to potentially qualified suppliers who are National Environmental Laboratory Accreditation Conference (NELAC)-certified and Department of Energy Consolidated Audit Program (DOECAP) for a pre-award assessment by experienced and trained quality systems and chemistry laboratory assessors. Statement of work specifications, professional judgment, and quality system performance at each laboratory (including recent past performance on nationally conducted performance-evaluation programs) are the primary criteria used to award contracts for specific types of radiochemical, organic chemical, and inorganic chemical analyses.

Each analytical laboratory conducts its chain-of-custody and analytical processes under its own quality plans and analytical procedures. The analytical laboratory also submits a full set of hard copy records that serves as the legally binding copy of the data. Each set of samples contains all the internal quality assurance/quality control data the analytical laboratory generates during each phase of chemical analysis (including laboratory control standards, process blanks, matrix spikes, duplicates, and replicates, when applicable). The electronic data are uploaded into the database and verified and validated according to its corresponding variety of quality and consistency checks. All parts of the data-management process are tracked electronically, and periodic reports to management are prepared.

4. Analytical Laboratory Assessments

The EP Directorate has eight contracts with external analytical laboratories. The laboratories are audited as long as they keep their NELAC and DOE Contract Audit Program certifications. During 2007, external laboratory audits were performed for the following six laboratories: General Engineering, Test America St. Louis, Assaigai, Paragon Analytics, Inc., American Radiation Services and Vista Analytical. All laboratories participated in national performance-evaluation studies during 2007 and the results are included in the assessment report. Overall, the study sponsors judged the analytical laboratories to have acceptable performance for almost all analytes attempted in all matrices.

5. Program Audits and Assessments

The Laboratory's Performance Assurance Division–Operations Support and the Facilities Division performed internal audits of the Sample Management Office (SMO). The Performance Assurance audit found no issues, while the Facilities audit required postings for radioactivity and quarterly radiological surveys of the SMO.

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NMED 2007m: "Approval with Modifications, Phase II Investigation Work Plan for Consolidated Unit 21-016(a)-99, Material Disposal Area T, at Technical Area 21, Los Alamos National Laboratory, EPA ID #NM0890010515, HWB-LANL-06-017" (June 7, 2007).

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NMED 2007o: "Approval with Modifications Investigation Report for Material Disposal Area A, Solid Waste Management Unit 21-014 at Technical Area 21, Los Alamos National Laboratory, EPA ID #NM0890010515, HWB-LANL-06-023" (February 12, 2007).