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# **Investigation Report for Technical Area 57 Aggregate Area (Fenton Hill), Revision 1**



Prepared by the Environmental Programs Directorate

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# Investigation Report for the Technical Area 57 Aggregate Area (Fenton Hill), Revision 1

December 2015

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## EXECUTIVE SUMMARY

This investigation report presents the investigation activities at two areas of concern (AOCs) in the Technical Area 57 (TA-57) Aggregate Area, located at Fenton Hill, which lies on the western side of the Jemez Mountains, approximately 12 mi west of Los Alamos National Laboratory (LANL or the Laboratory). Two AOCs within the TA-57 Aggregate Area were addressed during the 2014 investigation because these sites are potentially contaminated with hazardous chemicals and/or radionuclides, and final assessments of site contamination, associated risks, and recommendations for additional corrective actions were incomplete.

The objectives of this investigation were to define the nature and extent of contamination associated with AOCs 57-006 and 57-007 and to obtain data to support decisions regarding the need to remediate or remove contamination at these sites. This report presents the results of site characterization activities conducted during the 2014 investigation, as directed by the approved investigation work plan for the TA-57 Aggregate Area.

The 2014 investigation activities included surface and subsurface characterization sampling at AOCs 57-006 and 57-007. Analysis of sampling data identified two locations of arsenic-contaminated soil above the residential soil screening level at AOC 57-007. Soil removal was completed at two locations, and additional step-out characterization samples were collected to define extent.

Based on the evaluation of the data, the extent of contamination has been defined or no further sampling for extent is warranted at AOCs 57-006 and 57-007. After soil removal, human health and ecological risk assessments were performed for both AOCs, and no potential unacceptable risks exist for any receptors.

Based on the evaluation of the sampling data and risk assessments, the Laboratory recommends corrective action complete without controls for both sites.



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## **1.0 INTRODUCTION**

Los Alamos National Laboratory (LANL or the Laboratory) is a multidisciplinary research facility owned by the U.S. Department of Energy (DOE) and managed by Los Alamos National Security, LLC. The Laboratory is located in north-central New Mexico, approximately 60 mi northeast of Albuquerque and 20 mi northwest of Santa Fe. The Laboratory site covers 36 mi<sup>2</sup> of the Pajarito Plateau, which consists of a series of fingerlike mesas that are separated by deep canyons containing perennial and intermittent streams running from west to east. Mesa tops range in elevation from approximately 6200 ft to 7800 ft above mean sea level (amsl).

The Laboratory is participating in a national effort by DOE to clean up sites and facilities formerly involved in weapons research and development. The goal of the Laboratory's efforts is to ensure past operations do not threaten human or environmental health and safety in and around Los Alamos County, New Mexico. To achieve this goal, the Laboratory is currently investigating sites potentially contaminated by past Laboratory operations. These sites are designated as either solid waste management units (SWMUs) or areas of concern (AOCs).

This investigation report addresses AOCs 57-006 and 57-007 within the Technical Area 57 (TA-57) Aggregate Area. These sites are potentially contaminated with hazardous constituents and radionuclides. The New Mexico Environment Department (NMED), pursuant to the New Mexico Hazardous Waste Act, regulates cleanup of hazardous wastes and hazardous constituents. DOE regulates cleanup of radioactive contamination, pursuant to DOE Order 458.1, Administrative Change 3, Radiation Protection of the Public and the Environment, and DOE Order 435.1, Radioactive Waste Management. Information on radioactive materials and radionuclides, including the results of sampling and analysis of radioactive constituents, is voluntarily provided to NMED in accordance with DOE policy.

Corrective actions for hazardous constituents at the Laboratory are subject to the March 2005 Compliance Order on Consent (the Consent Order). This investigation report describes work activities completed in accordance with the Consent Order and the approved TA-57 Aggregate Area investigation work plan (LANL 2012, 214550; NMED 2012, 520936).

### **1.1 General Site Information**

The TA-57 Aggregate Area is located at Fenton Hill, which lies on the western side of the Jemez Mountains, approximately 12 mi west of the Laboratory, at an elevation of approximately 8700 ft amsl (Figure 1.1-1). The TA-57 Aggregate Area is located on property owned by the U.S. Forest Service and has been used by DOE pursuant to agreements with the Forest Service. Laboratory operations have been conducted in the aggregate area since 1974. The TA-57 Aggregate Area consists of 10 AOCs, 8 of which have previously been approved for no further action (NFA) or closed under another regulatory program. Three AOCs were approved for NFA by the U.S. Environmental Protection Agency (EPA). The 5 AOCs used to manage geothermal exploration wastes were not subject to regulation under the Resource Conservation and Recovery Act (RCRA). These sites were closed under a discharge plan issued by the New Mexico Oil Conservation Division (NMOCD). Following termination of the discharge plan by NMOCD, no additional corrective actions are required for NMOCD-regulated sites and activities. As indicated in the approval with modifications for the investigation work plan for TA-57 Aggregate Area (LANL 2012, 214550; NMED 2012, 520936), supporting documentation related to past investigations and corrective actions at the closed sites is provided in this report (on CD in Appendix H).

The remaining two AOCs were addressed in the approved TA-57 Aggregate Area investigation work plan (LANL 2012, 214550; NMED 2012, 520936). This investigation report describes the investigation status and results from sampling activities conducted at the two sites. Table 1.1-1 lists the sites included in the investigation report with a brief description and summary of the investigation activities conducted in 2014 for each site.

## **1.2 Purpose of the Investigation**

Two AOCs within the TA-57 Aggregate Area were addressed during the 2014 investigation because these sites are potentially contaminated with hazardous chemicals and/or radionuclides, and final assessments of site contamination, associated risks, and recommendations for additional corrective actions are incomplete. The objectives of the 2014 investigation were to (1) define the nature and extent of contamination associated with historical waste management activities at AOCs 57-006 and 57-007, and (2) obtain data to support decisions regarding the need to remediate or remove contamination at these sites.

The process for evaluating the data collected during the 2014 TA-57 Aggregate Area investigation is as follows:

- Initially identify chemicals of potential concern (COPCs) to focus efforts on the constituents of most concern.
- Screen COPCs against soil screening levels (SSLs) and screening action levels (SALs) during determination of extent to focus efforts on characterizing contamination potentially posing a risk/dose and requiring corrective action.
- Perform risk/dose screening level evaluations on all sites to incorporate risk/dose reduction into recommendations for further actions.

All analytical data collected during the 2014 investigation activities are presented and evaluated in this report.

## **1.3 Document Organization**

This report is organized into nine sections, including this introduction, with multiple supporting appendixes. Section 2 provides details on the aggregate area site conditions (surface and subsurface). Section 3 provides an overview of the scope of the activities performed during the implementation of the work plan. Section 4 describes the regulatory criteria used to evaluate potential risk to ecological and human receptors. Section 5 describes the data review methods. Section 6 presents an overview of the operational history of the sites, historical releases, summaries of previous investigations, results of the field activities performed, site contamination, and evaluation of the nature and extent of contamination. Section 7 presents the conclusions of the nature and extent evaluations and risk-screening assessments. Section 8 discusses recommendations based on the nature and extent discussions and the risk-screening assessments. Section 9 includes a list of references cited and the map data sources used in all figures.

The appendixes include acronyms, a metric conversion table, and definitions of the data qualifiers used in this report (Appendix A); field methods (Appendix B); investigation-derived waste (IDW) management (Appendix C); analytical program descriptions and summaries of data quality (Appendix D); analytical suites and results and analytical reports (Appendix E on CD); box plots and statistical comparisons (Appendix F); risk-screening assessments (Appendix G); and NFA documentation for other sites from NMOCD (Appendix H).

## **2.0 AGGREGATE AREA SITE CONDITIONS**

### **2.1 Surface Conditions**

#### **2.1.1 Soil**

No site-specific soil surveys have been performed at TA-57. Undisturbed soil at TA-57 is probably typical of the soil described by Nyhan et al. (1978, 005702) for the plateau tops and edges in the Los Alamos area (LANL 1994, 034757, p. 3-17). The parent material is the Bandelier Tuff, and the processes-forming soil are expected to be very similar to the processes-forming soils in the Los Alamos area. For most of TA-57, no undisturbed soil remains because of site development activities. Much of the TA-57 site has been filled and regraded. The depth to bedrock noted during previous investigations at TA-57 ranged from 3.5–16 ft.

A thin veneer of physically weathered bedrock colluvium is the only surficial material left in the few undisturbed areas of TA-57. The residual material is thicker on the top of the plateau and thins along the edges to bedrock outcrops on the steep portions of the canyon walls. Some fine-grained to coarser material was observed in the two small alluvial channels draining the site to the southeast and northwest; however, these channels have been considerably altered by activities related to site construction and operations.

#### **2.1.2 Surface Water**

The major surface water drainage near TA-57 is the Jemez River and its tributaries. The East Fork of the Jemez River drains the Valle Grande. Base flow is from discharge of groundwater to the stream from the near-surface water table in the Valle Grande and from the relatively large amount of precipitation that occurs in the high mountains around the Valles Caldera. San Antonio Creek drains the Valle Toledo to the north of the Valle Grande as well as an area along the west side of the Valles Caldera and is a tributary to the Jemez River at the confluence with the East Fork of the Jemez River. Several thermal springs discharge into the creek. Base flow in San Antonio Creek is from the discharge of groundwater from the near-surface water table in Valle Toledo and from precipitation. At the confluence of the East Fork of the Jemez River and San Antonio Creek, approximately 10 mi south of TA-57, the combined streams become the Jemez River.

The Rio Guadalupe drains the area west of TA-57 and includes the tributaries Rio de las Vacas and Rio Cebolla. The Rio de las Vacas drains an area west of the Valles Caldera. Base flow to the Rio Cebolla is from groundwater discharge from the shallow alluvial aquifers along numerous tributaries and from springs on the canyon walls.

The TA-57 site slopes gently south so the major part of the run-off is into Lake Fork Creek, a tributary to the Rio Cebolla below Fenton Lake. The land immediately northwest of TA-57 drains into an unnamed tributary that joins the Rio Cebolla at Fenton Lake. The land immediately northeast of TA-57 drains toward San Antonio Creek but is diverted by a low divide into Lake Fork Creek (Figure 2.1-1).

#### **2.1.3 Land Use**

Currently, land use at TA-57 is industrial. The TA-57 site is fenced and locked and is accessible only to authorized workers. A portion of the area immediately adjacent to TA-57 is used by the U.S. Forest Service as a seasonal support area for firefighters. The area around TA-57 is within the Santa Fe National Forest and is used recreationally. Current land uses are not expected to change in the foreseeable future.

## **2.2 Subsurface Conditions**

### **2.2.1 Stratigraphic Units**

This section summarizes the stratigraphy of the bedrock beneath the TA-57 Aggregate Area. The stratigraphy includes, in descending order, the Bandelier Tuff, the Paliza Canyon Formation, the Abiquiu Tuff, the Abo Formation, the Madera limestone, the Sandia Formation, and Precambrian granite (LANL 1994, 034757, pp. 3-12–3-14).

#### **2.2.1.1 Bandelier Tuff**

The Bandelier Tuff is a nonwelded to densely welded rhyolite tuff that ranges from light to dark gray. It is composed of quartz and sanadine crystals, lithic fragments of latite and rhyolite, and fragments of glass shards and rare mafic minerals in a fine-grained ash matrix. This tuff layer thins to the west and southwest away from its source at the Valles Caldera (Rea 1977, 005713; Kaufman and Siciliano 1979, 005941). The Bandelier Tuff is approximately 350 ft thick under the TA-57 Aggregate Area (Purtymun et al. 1974, 005483).

#### **2.2.1.2 Paliza Canyon Formation**

The Paliza Canyon Formation underlies the Bandelier Tuff and is composed of andesite and basaltic andesite breccias interbedded with sand and gravels and is approximately 50 ft thick under the site (Purtymun et al. 1974, 005483).

#### **2.2.1.3 Abiquiu Tuff**

The Abiquiu Tuff underlies the Paliza Canyon Formation and is a light gray, friable tuffaceous sandstone and is approximately 50 ft thick under the TA-57 site (Purtymun et al. 1974, 005483).

#### **2.2.1.4 Abo Formation**

The Permian redbeds of the Abo Formation underlie the Abiquiu Tuff. The lithologies are typically arkosic siltstone, sandstone, and shale with small inclusions of calcareous gray clay. Particles include granules of quartz and feldspar and pieces of igneous rock. The thickness is highly variable because of erosion before Cenozoic volcanism (Rea 1977, 005713; Kaufman and Siciliano 1979, 005941).

#### **2.2.1.5 Magdalena Group**

The Magdalena group consists of Madera limestone over the Sandia Formation. The Madera limestone is an arkosic limestone containing both gray and red arkosic shale overlying a dark gray limestone with insets of gray shale and beds of sandstone. The Sandia Formation has an upper clastic member of sandstone, shale, and limestone. The lower part is a discontinuous dark gray siliceous limestone (Rea 1977, 005713; Kaufman and Siciliano 1979, 005941).

#### **2.2.1.6 Precambrian Granite**

The Precambrian granite is a coarse basement rock beneath the Sandia Formation and consists of large microcline crystals, quartz-feldspar lenticular gneiss, schists, amphibolites, and pegmatites. Veins include quartz and hornblende. Minerals include quartz and microcline, oligoclase-andesine, hornblende, biotite, epidote, sphene, apatite, zircon, and magnetite (Rea 1977, 005713; Kaufman and Siciliano 1979, 005941).

## **2.2.2 Hydrogeology**

### **2.2.2.1 Groundwater**

Groundwater in the area of TA-57 occurs as (1) water in saturated alluvium, (2) perched aquifers, and (3) the regional aquifer.

#### **Saturated Alluvium**

Burns Swale, a dry tributary of Lake Fork Canyon at the south side of TA-57, has a 2.0–6.0-ft depth of alluvium in its upper reaches and more than a 40-ft depth of alluvium at the confluence with Lake Fork Canyon (Figure 2.1-1). In May 1979, water was encountered in four holes bored in the alluvium. Later that year, these holes were dry (Kaufman and Siciliano 1979, 005941). After a release of water into Burns Swale in September 1979, the two holes closest to the site again contained water. Releases to Burns Swale were observed to infiltrate the alluvium and then either moved downstream along the alluvium/Cenozoic volcanic bedrock interface or infiltrated the underlying bedrock.

#### **Perched Aquifers**

The water supply for TA-57 is furnished by a well completed in a perched aquifer at a depth of about 450 ft below ground surface (bgs). The aquifer is in the Abiquiu Tuff and is perched on the clays and siltstones of the Abo Formation. The aquifer is of limited extent, terminating to the east along the canyon cut by San Antonio Creek. Water movement in the aquifer is to the southwest, where a part is discharged through springs and seeps in the lower part of Lake Fork Canyon and along the Rio Cebolla.

Other perched aquifers were identified beneath the site as part of an evaluation of alternate water supplies. Four saturated zones were identified in the Abo Formation at depths of 780–800 ft, 970–995 ft, 1005–1015 ft, and 1100–1120 ft bgs. These zones were described as fine-grained sandstones underlain by shales. Six perched zones were also identified in the Madera limestone.

#### **Regional Aquifer**

The regional aquifer is at the base of the Madera formation. Many of the hot springs in the region appear at outcrops of this horizon. These are generally hot mineral springs. The regional aquifer is encountered at a depth of 1750 ft bgs below TA-57. All the aquifers above this depth are perched. Within the regional aquifer, a permeable horizon was found in the depth interval 1770–1800 ft bgs. It consisted of 30 ft of arkosic sandstone or granite wash. Geophysical log data indicate the zone is “only fair” as an aquifer (LANL 1994, 034757). Water in the granitic basement is primarily contained in fracture porosity.

### **2.2.2.2 Vadose Zone**

The unsaturated zone from the mesa surface to the top of the regional aquifer is referred to as the vadose zone. The vadose zone underlying TA-57 is in thin surficial soil deposits and in the underlying volcanic tuff. Flow and transport in the vadose zone will be mainly downward to the perched water at the base of the volcanic tuff. The source of moisture for the vadose zone is precipitation, but much of it runs off, evaporates, or is absorbed by plants. The subsurface vertical movement of water is influenced by properties and conditions of the materials that make up the vadose zone.

The Bandelier Tuff is generally dry and does not readily transmit moisture. Most of the pore spaces in the tuff are of capillary size and have a strong tendency to hold water against gravity by surface-tension forces. Vegetation is very effective at removing moisture near the surface. During the summer rainy season, when rainfall is highest, near-surface moisture content is variable because of higher rates of evaporation and transpiration by vegetation, which flourishes at this time.

The various units of the Bandelier Tuff tend to have relatively high porosities. Porosity ranges between 30% and 60% by volume, generally decreasing for more highly welded tuff. Permeability varies for each cooling unit of the Bandelier Tuff. The moisture content of tuff beneath the mesa tops is low, generally less than 5% by volume throughout the profile (Kearl et al. 1986, 015368; Purtymun and Stoker 1990, 007508).

### **3.0 SCOPE OF ACTIVITIES**

This section presents an overview of field activities performed during the implementation of the TA-57 Aggregate Area approved investigation work plan (LANL 2012, 214550; NMED 2012, 520936). The field investigation results and observations are presented in detail in section 6 and in the appendixes. The scope of activities for the 2014 investigation included site access and premobilization activities; geodetic and field-screening surveys; surface and subsurface sampling; soil removal; site restoration; health and safety monitoring; and waste management activities.

When possible, all field activities were conducted following the approved investigation work plan (LANL 2012, 214550; NMED 2012, 520936). The applicable field methods are summarized below and are discussed in Appendix B. Any deviations from the approved investigation work plan are noted in section 6 and are described in detail in Appendix B.

#### **3.1 Site Access and Premobilization Activities**

The area encompassing TA-57 is behind a locked fence and is currently used to operate a fully automated observatory in support of the Thinking Telescopes project overseen by the Laboratory's Intelligence and Space Research Division. A portion of the area immediately adjacent to TA-57 is used by the U.S. Forest Service as a seasonal support area for firefighters. Before field mobilization, the issue of Laboratory worker access (e.g., health and safety documents, notifications) was reviewed as part of the management self-assessment process. All efforts were made to provide a secure and safe work area and to reduce impacts to any site operations, cultural resources, and the environment.

#### **3.2 Field Activities**

The following subsections describe the field activities conducted during the 2014 investigation, including geodetic surveys, field screening, surface and subsurface sampling, and soil removal. Details regarding the field methods and procedures used to perform these field activities are presented in Appendix B.

##### **3.2.1 Geodetic Survey**

Geodetic surveys were conducted during the TA-57 Aggregate Area investigation to locate surface and subsurface sampling locations. Initial geodetic surveys were performed to establish and mark the planned sampling locations in the field in accordance with the most current version of Standard Operating Procedure (SOP) 5028, Coordinating and Evaluating Geodetic Surveys, using a Trimble 5700 differential global positioning system. The surveyed coordinates for all sampling locations at sites included in this report are presented in Table 3.2-1. All geodetic coordinates are expressed as State Plane Coordinate System 1983, New Mexico Central, U.S.



### 3.2.2 Field Screening

Environmental samples were analyzed for organic vapors with a MiniRAE 2000 photoionization detector equipped with an 11.7 electronvolt lamp before they were submitted to the Sample Management Office (SMO). Calibration was performed in accordance with the manufacturer's specifications and the most current version of SOP-06.33, Headspace Vapor Screening with a Photoionization Detector, and recorded on the corresponding sample collection logs (SCLs), chain-of-custody (COC) forms, and the field logbook. The SCLs and COC forms are provided on CD in Appendix E. The organic vapor screening results for the sites are presented Table 3.2-2.

All samples collected were field-screened for radioactivity before they were submitted to the SMO. A Laboratory radiological control technician conducted radiological screening using an Eberline E-600 radiation meter with an SHP-380AB alpha/beta scintillation detector held within 1 in. of the sample. The SCLs and COC forms are provided on CD in Appendix E. The radiological screening results for the sites are presented in Table 3.2-2.

### 3.2.3 Surface and Subsurface Soil Investigation

Samples were collected according to the approved investigation work plan (LANL 2012, 214550; NMED 2012, 520936). Table 3.2-3 lists the proposed sampling locations for the sites crosswalked with actual location identifiers. Surface samples were collected using the spade-and- scoop method in accordance with SOP-06.09, Spade and Scoop Method for Collection of Soil Samples, or with a hand auger in accordance with SOP-06.10, Hand Auger and Thin-Wall Tube Sampler. The samples were collected in stainless-steel bowls and transferred to sample collection bottles with a stainless-steel spoon.

All surface and shallow subsurface samples were placed in appropriate sample containers and submitted to the laboratory for the analyses specified by the approved work plan. Samples for volatile organic compound (VOC) analysis were collected immediately to minimize the loss of subsurface VOCs during the sample collection process. Standard quality assurance (QA)/quality control (QC) samples (field duplicates, field trip blanks, and rinsate blanks) were also collected in accordance with SOP-5059, Field Quality Control Samples.

All sample collection activities were coordinated with the SMO. After the samples were collected, they remained in the controlled custody of the field team at all times until they were delivered to the SMO. Sample custody was then relinquished to the SMO for delivery of samples to a preapproved off-site analytical laboratory (SCLs and COC forms are included on CD in Appendix E).

### 3.2.4 Soil Removal

Analytical data collected from AOC 57-007 identified levels of arsenic above the residential SSL in surface samples (0.0–1.0 ft bgs) at locations 57-4011 and 57-4020. Specifically, arsenic was detected at concentrations of 13.8 mg/kg and 18.6 mg/kg at locations 57-4011 and 57-4020, respectively. The Laboratory conducted soil removal of the arsenic-contaminated soil using hand tools. A 2-ft radius was removed around locations 57-4011 and 57-4020 to a depth of 2.0 ft and 2.5 ft bgs, respectively. Confirmation samples were not necessary because samples collected at depth at both locations defined the extent of soil removal.

The remediated areas were backfilled to original grade using clean fill, reseeded using an approved native seed mix, and raked. Straw wattles were placed on the downslope side of each area to prevent run off.

### **3.2.5 Equipment Decontamination**

All field equipment that had the potential to contact sample material (e.g., hand augers, sampling scoops, bowls, shovels, picks) was decontaminated between sample collection and between sampling locations to prevent cross-contamination. Decontamination was performed in accordance with the current version of SOP-5061, Field Decontamination of Equipment. Rinsate blanks on sampling equipment were collected to check the effectiveness of decontamination. The dry decontamination methods used are described in Appendix B.

### **3.2.6 Chemical and Radiological Sample Analyses**

All investigation samples were shipped by the SMO to off-site contract analytical laboratories for the requested analyses. The analyses requested were as specified by the approved work plan (LANL 2012, 214550; NMED 2012, 520936). The samples were analyzed for the following; target analyte list (TAL) metals, total cyanide, nitrate, perchlorate, VOCs, semivolatile organic compounds (SVOCs), and isotopic uranium. Four samples were analyzed for arsenic only.

### **3.2.7 Health and Safety Measures**

All 2014 investigation activities were conducted in accordance with an integrated work document that detailed work steps, potential hazards, hazard controls, and required training to conduct work. These health and safety measures included using Level-D personal protective equipment.

### **3.2.8 IDW Storage and Disposal**

All IDW generated during the TA-57 Aggregate Area field investigations was managed in accordance with SOP-10021, Characterization and Management of Environmental Program Waste. This procedure incorporates the requirements of all applicable EPA and NMED regulations, DOE orders, and Laboratory implementation requirements, policies, and/or procedures. IDW was also managed in accordance with the approved waste characterization strategy form (WCSF). Details of IDW management for the TA-57 Aggregate Area investigation are presented in Appendix C.

The waste streams associated with the investigation included arsenic-contaminated soil, contact waste, and solid waste. Each waste stream was containerized and placed in an accumulation area appropriate for the regulatory classification of the waste, in accordance with the approved WCSF.

## **3.3 Deviations**

Deviations occurred while conducting field activities as defined in the approved work plan (LANL 2012, 214550; NMED 2012, 520936). The deviations did not adversely affect the completion or results of the investigation. Specific deviations are described in Appendix B, section B-9.0.

## **4.0 REGULATORY CRITERIA**

This section describes the criteria used for evaluating potential risk to ecological and human receptors. Regulatory criteria identified by medium in the Consent Order include cleanup standards, risk-based screening levels, and risk-based cleanup goals.

Human health risk-screening evaluations were conducted for the TA-57 Aggregate Area using NMED guidance (NMED 2014, 600115). Ecological risk-screening assessments were performed using Laboratory guidance (LANL 2012, 226715).

#### 4.1 Current and Future Land Use

The specific screening levels used in the risk evaluation and corrective action decision process at a site depend on the current and reasonably foreseeable future land use(s). The current and reasonably foreseeable future land use(s) for a site determines the receptors and exposure scenarios used to select screening and cleanup levels. The land use within and surrounding the TA-57 Aggregate Area is currently industrial and is expected to remain industrial for the reasonably foreseeable future. The residential scenario is evaluated for comparison purposes per the Consent Order and is the decision scenario for sites that do not require future controls.

#### 4.2 Screening Levels

Human health and ecological risk-screening evaluations were conducted for the COPCs detected in solid media at the sites within the TA-57 Aggregate Area. The human health risk-screening assessments (Appendix G) were performed on inorganic and organic COPCs using NMED SSLs for the industrial and residential scenarios (NMED 2014, 600115). When an NMED SSL was not available for a COPC, SSLs were obtained from EPA regional tables ([http://www.epa.gov/earth1r6/6pd/rcra\\_c/pd-n/screen.htm](http://www.epa.gov/earth1r6/6pd/rcra_c/pd-n/screen.htm)) (adjusted to a risk level of  $10^{-5}$  for carcinogens). Radionuclides were assessed using the Laboratory SALs for the same scenarios (LANL 2014, 600064).

Total chromium now has NMED SSLs (NMED 2014, 600115). Because the toxicity of chromium strongly depends on its oxidation state, NMED and EPA have SSLs for trivalent chromium and hexavalent chromium. For screening purposes, the NMED SSLs for total chromium are used for comparison unless there is a known or suspected source of hexavalent chromium at the site. Total chromium screening levels are appropriate for low-level releases to soil from sources not associated with hexavalent chromium. However, NMED and EPA recommends collecting valence-specific data for chromium when it is likely to be an important contaminant at a site and when hexavalent chromium may exist (NMED 2014, 600115; [http://www.epa.gov/reg3hwmd/risk/human/rb-concentration\\_table/usersguide.htm](http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm)). Otherwise, total chromium data are used.

Based on the site operational history and email correspondence with an individual who worked in the on-site chemistry trailer (former structure 57-23), no sources of hexavalent chromium are associated with AOCs 57-006 and 57-007 (Haagenstad 2015, 600266). The chemistry trailer was used until 1989 and was removed from the site in 1994. Two potential oxidizing agents were used at the site that could have potentially converted trivalent chromium to hexavalent chromium: nitric acid (<1% solution) was used to preserve water samples, and dilute potassium permanganate was also used occasionally in very small quantities. However, even if some of the chromium had been oxidized to the hexavalent form in the presence of these oxidants, site conditions for decades following the operational activity at the site strongly favor stability of chromium in the trivalent form. The soil pH is circumneutral, which tends to stabilize chromium as trivalent chromium and form insoluble chromium hydroxide. The redox conditions of the soil from the organic matter concentrated in the vegetation and plant litter enhance and maintain the stability of trivalent chromium and prevent oxidation to hexavalent chromium. Furthermore, iron and manganese are present at background concentrations, and the iron concentrations are greater than the manganese concentrations, which favors reducing conditions for chromium and the formation of trivalent chromium. Based on these lines of evidence, chromium is present in the environment in the stable trivalent form. Total chromium results for these AOCs are screened for potential risk using the NMED total chromium SSLs, and no additional sampling and analysis for hexavalent chromium are warranted. The sampling and analysis approach was presented in the investigation work plan and approved by NMED (LANL 2012, 214550; NMED 2012, 520936).

### **4.3 Ecological Screening Levels**

The ecological risk-screening assessments (Appendix G) were conducted using ecological screening levels (ESLs) obtained from the ECORISK Database, Version 3.2 (LANL 2014, 262559). The ESLs are based on similar species and are derived from experimentally determined no observed adverse effect levels, lowest observed adverse effect levels (LOAELs), or doses determined lethal to 50% of the test population. Information relevant to the calculation of ESLs, including concentration equations, dose equations, bioconcentration factors, transfer factors, and toxicity reference values, are presented in the ECORISK Database, Version 3.2 (LANL 2014, 262559).

### **4.4 Cleanup Standards**

As specified in the Consent Order, SSLs for inorganic and organic chemicals (NMED 2014, 600115) are used as soil cleanup levels unless they are determined to be impracticable or values do not exist for the current and reasonably foreseeable future land uses. SALs are used as soil cleanup levels for radionuclides (LANL 2014, 600064). Screening assessments compare COPC concentrations for each site with industrial and residential SSLs and SALs.

The cleanup goals specified in Section VIII of the Consent Order are a target risk of  $10^{-5}$  for carcinogens or a hazard index (HI) of 1 for noncarcinogens. For radionuclides, the target dose is 25 mrem/yr as authorized by DOE Order 458.1. The SSLs/SALs used for the risk-screening assessments in Appendix G are based on these cleanup goals.

## **5.0 DATA REVIEW METHODOLOGY**

The purpose of the data review is to define the nature and extent of contaminant releases for AOCs 57-006 and 57-007 in the TA-57 Aggregate Area. The nature of a contaminant release refers to the specific contaminants that are present, the affected media, and associated concentrations. The nature of contamination is defined through identification of COPCs, as discussed in section 5.1. The extent of contamination refers to the spatial distribution of COPCs, with an emphasis on the distribution of COPCs potentially posing a risk or requiring corrective action. The process for determining the extent of contamination and for concluding no further sampling for extent is warranted is discussed in section 5.2.

### **5.1 Identification of COPCs**

COPCs are chemicals and radionuclides that may be present as a result of releases from sites. Inorganic chemicals and some radionuclides occur naturally, and inorganic chemicals and radionuclides detected because of natural background are not considered COPCs. Similarly, some radionuclides may be present as a result of fallout from historical nuclear weapons testing, and these radionuclides are also not considered COPCs. The Laboratory has collected data on background concentrations of many inorganic chemicals, naturally occurring radionuclides, and fallout radionuclides. These data have been used to develop media-specific background values (BVs) and fallout values (FVs) (LANL 1998, 059730). For inorganic chemicals and radionuclides for which BVs or FVs are available, identification of COPCs involves background comparisons, which are described in sections 5.1.1 and 5.1.2. If no BVs or FVs are available or if samples are collected where FVs are not appropriate (i.e., greater than 1.0-ft depth or in rock), COPCs are identified based on detection status (i.e., if the inorganic chemical or radionuclide is detected, it is identified as a COPC).

Organic chemicals may also be present as a result of anthropogenic activities unrelated to the AOC or, to a lesser extent, from natural sources. Because there are no background data for organic chemicals, background comparisons cannot be performed in the same manner as for inorganic chemicals or radionuclides. Therefore, organic COPCs are identified on the basis of detection status (i.e., if an organic chemical is detected, it is identified as a COPC). When assessing the nature of contamination, the history of site operations may be evaluated to determine whether an organic COPC is present because of a release from a site or is present from a non-site-related source. Organic chemicals that are clearly present from sources other than releases from a site (e.g., polycyclic aromatic hydrocarbons) may be eliminated as COPCs.

### 5.1.1 Inorganic Chemical and Radionuclide Background Comparisons

The COPCs are identified for inorganic chemicals and radionuclides following EP-SOP-10071, Background Comparisons for Inorganic Chemicals, and EP-SOP-10073, Background Comparisons for Radionuclides. Inorganic COPCs are identified by comparing site data with BVs and maximum concentrations in a background data set and using statistical comparisons, as applicable (LANL 1998, 059730). Radionuclides are identified as COPCs based on background comparisons and statistical methods if BVs or FVs are available or based on detection status if BVs or FVs have not been established.

Background data are generally available for inorganic chemicals in soil, sediment, and tuff (LANL 1998, 059730). However, some analytes (e.g., nitrate, perchlorate, and hexavalent chromium) have no BVs. A BV may be either a calculated value from the background data set (upper tolerance limit [UTL] or the 95% upper confidence bound on the 95th quantile) or a detection limit (DL). When a BV is based on a DL, there is no corresponding background data set for that analyte/media combination.

For inorganic chemicals, data are evaluated by sample media to facilitate the comparison with media-specific background data. To identify inorganic COPCs, the first step is to compare the sampling result with BVs. If sampling results are above the BV and sufficient data are available (eight or more sampling results and five or more detections), statistical tests are used to compare the site sampling data with the background data set for the appropriate media. If statistical tests cannot be performed because of insufficient data or a high percentage of nondetections, the sampling results are compared with the BV for the appropriate media. If at least one sampling result is above the BV, the inorganic chemical is identified as a COPC unless lines of evidence can be presented to establish the inorganic chemical is not a COPC. Such lines of evidence include, but are not limited to, comparison to the maximum background concentration, number of detects below or above the BV(s), number of nondetects in the data set, and site history. The same evaluation is performed using DLs when an inorganic chemical is not detected but has a DL above the BV. If no BV is available, detected inorganic chemicals are identified as COPCs.

Radionuclides are identified as COPCs based on comparisons to BVs for naturally occurring radionuclides or to FVs for fallout radionuclides. Thorium-228, thorium-230, thorium-232, uranium-234, uranium-235/236, and uranium-238 are naturally occurring radionuclides. Americium-241, cesium-137, plutonium-238, plutonium-239/240, strontium-90, and tritium are fallout radionuclides.

Naturally occurring radionuclides detected at activities above their respective BVs are identified as COPCs. These radionuclides background have no data sets. If there is no associated BV or FV and the radionuclide is detected, it is retained as a COPC.

The FVs for the fallout radionuclides apply to the top 0.0–1.0 ft of soil and fill and to sediment regardless of depth. If a fallout radionuclide is detected in soil or fill samples collected below 1.0 ft or in tuff samples, the radionuclide is identified as a COPC. For soil and fill samples from 1.0 ft bgs or less, if the activity of a

fallout radionuclide is greater than the FV, comparisons of the top 0.0–1.0-ft sampling data are made with the fallout data set and the radionuclide is eliminated as a COPC if activities are similar to fallout activities. Sediment results are evaluated in the same manner, although all data are included, not only the data from 0.0–1.0 ft bgs.

The FV for tritium in surface soil (LANL 1998, 059730) is in units of pCi/mL. This FV requires using sample percent moisture to convert sample tritium data from pCi/g (as provided by analytical laboratories) to the corresponding values in units of pCi/mL. Because sample percent moisture historically has been determined using a variety of methods, often undocumented, the Laboratory has adopted the conservative approach of identifying tritium in soil as a COPC based on detection status.

### **5.1.2 Statistical Methods Overview**

A variety of statistical methods may be applied to each of the data sets. The use of any of these methods depends on how appropriate the method is for the available set.

#### **5.1.2.1 Distributional Comparisons**

Comparisons between site-specific data and Laboratory background data are performed using a variety of statistical methods. These methods begin with a simple comparison of site data with a UTL estimated from the background data (UTL or the 95% upper confidence bound on the 95th quantile). The UTLs are used to represent the upper end of the concentration distribution and are referred to as BVs. The UTL comparisons are then followed, when appropriate, by statistical tests that evaluate potential differences between the distributions. These tests are used for testing hypotheses about data from two potentially different distributions (e.g., a test of the hypothesis that site concentrations are elevated above background levels). Nonparametric tests most commonly performed include the Gehan test (modification of the Wilcoxon Rank Sum test) and the quantile test (Gehan 1965, 055611; Gilbert and Simpson 1990, 055612).

The Gehan test is recommended when between 10% and 50% of the data sets are nondetections. It handles data sets with nondetections reported at multiple DLs in a statistically robust manner (Gehan 1965, 055611; Millard and Deverel 1988, 054953). The Gehan test is not recommended if either of the two data sets has more than 50% nondetections. If there are no nondetected concentrations in the data, the Gehan test is equivalent to the Wilcoxon Rank Sum test. The Gehan test is the preferred test because of its applicability to a majority of environmental data sets and its recognition and recommendation in EPA sponsored workshops and publications.

The quantile test is better suited to assessing shifts in a subset of the data. The quantile test determines whether more of the observations in the top chosen quantile of the combined data set come from the site data set than would be expected by chance, given the relative sizes of the site and background data sets. If the relative proportion of the two populations being tested is different in the top chosen quantile of the data than in the remainder of the data, the distributions may be partially shifted because of a subset of site data. This test is capable of detecting a statistical difference when only a small number of concentrations are elevated (Gilbert and Simpson 1992, 054952). The quantile test is the most useful distribution shift test where samples from a release represent a small fraction of the overall data collected. The quantile test is applied at a prespecified quantile or threshold, usually the 80th percentile. The test cannot be performed if more than 80% (or, in general, more than the chosen percentile) of the combined data are nondetected values. It can be used when the frequency of nondetections is approximately the same as the quantile being tested. For example, in a case with 75% nondetections in the combined background and site data set, application of a quantile test comparing 80<sup>th</sup> percentiles is appropriate.

However, the test cannot be performed if nondetections occur in the top chosen quantile. The threshold percentage can be adjusted to accommodate the detection rate of an analyte or to analyze differences further into the distribution tails. The quantile test is more powerful than the Gehan test for detecting differences when only a small percentage of the site concentrations are elevated.

If the differences between two distributions appear to occur far into the tails, the slippage test might be performed. This test evaluates the potential for some of the site data to be greater than the maximum concentration in the background data set if, in fact, the site data and background data came from the same distribution. This test is based on the maximum concentration in the background data set and the number ("n") of site concentrations that exceed the maximum concentration in the background set (Gilbert and Simpson 1990, 055612, pp. 5–8). The result (p-value) of the slippage test is the probability that "n" site samples (or more) exceed the maximum background concentration by chance alone. The test accounts for the number of samples in each data set (the number of samples from the site and the number of samples from background) and determines the probability of "n" (or more) exceedances if the two data sets came from identical distributions. This test is similar to the BV comparison in that it evaluates the largest site measurements but is more useful than the BV comparison because it is based on a statistical hypothesis test, not simply on a statistic calculated from the background distribution.

For all statistical tests, a p-value greater than 0.05 was the criterion for accepting the null hypothesis that site sampling results are not different from background (Appendix F).

#### **5.1.2.2 Graphical Presentation**

Box plots are provided for a visual representation of the data and to help illustrate the presence of outliers or other anomalous data that might affect statistical results and interpretations. The plots allow a visual comparison among data distributions. The differences of interest may include an overall shift in concentration (shift of central location) or, when the centers are nearly equal, a difference between the upper tails of the two distributions (elevated concentrations in a small fraction of one distribution). The plots may be used in conjunction with the statistical tests (distributional comparisons) described above. Unless otherwise noted, the nondetected concentrations are included in the plots at their reported DLs.

The box plots presented in Appendix F of this report consist of a box, a line across the box, whiskers (lines extended beyond the box and terminated with a short perpendicular line), and points outside the whiskers. The box area of the plot is the region between the 25<sup>th</sup> percentile and the 75<sup>th</sup> percentile of the data, the interquartile range or middle half of the data. The horizontal line within the box represents the median (50<sup>th</sup> percentile) of the data. The whiskers extend to the most extreme point that is not considered an outlier, with a maximum whisker length of 1.5 times the interquartile range, outside of which data may be evaluated for their potential to be outliers. The concentrations are plotted as points overlying the box plot. When a data set contains both detected concentrations and nondetected concentrations reported as DLs, the detected concentrations are plotted as Xs, and the nondetected concentrations are plotted as Os.

### **5.2 Extent of Contamination**

Spatial concentration trends are initially used to determine whether the extent of contamination is defined. Evaluation of spatial concentration data considers the conceptual site model of the release and subsequent migration. Specifically, the conceptual site model should define where the highest concentrations would be expected if a release had occurred and how these concentrations should vary with distance and depth. If the results are different from the conceptual site model, it could indicate that no release has occurred or there are other sources of contamination.

In general, both laterally and vertically decreasing concentrations are used to define extent. If concentrations are increasing or not changing, other factors are considered to determine whether extent is defined or if additional extent sampling is warranted. These factors include

- the magnitude of concentrations and rate of increase compared with SSLs/SALs,
- the magnitude of concentrations of inorganic chemicals or radionuclides compared with the maximum background concentrations for the medium,
- concentrations of organic chemicals compared to estimated quantitation limits (EQLs), and
- results from nearby sampling locations.

The primary focus for defining the extent of contamination is characterizing contamination that potentially poses a potential unacceptable risk and may require additional corrective actions. As such, comparison with SSLs/SALs is used as an additional step following a determination of whether extent is defined by decreasing concentrations with depth and distance and whether concentrations are below EQLs or DLs. The initial SSL/SAL comparison is conducted using the residential SSL/SAL (regardless of whether the current and reasonably foreseeable future land use is residential) because this value is typically the most protective. If the current and reasonably foreseeable future land use is not residential, the relevant SSL/SAL may also be compared if the residential SSL/SAL is exceeded or otherwise similar to COPC concentrations. For the AOCs in the TA-57 Aggregate Area, the current and reasonably foreseeable future land use is industrial (section 4.1).

The SSL/SAL comparison is not necessary, if all COPC concentrations are decreasing with depth and distance. If, however, concentrations increase with depth and distance or do not display any obvious trends, the SSLs/SALs are used to determine whether additional sampling for extent is warranted. If the COPC concentrations are sufficiently below the SSL/SAL (e.g., the residential and/or industrial SSL/SAL is 10 times [an order of magnitude] or more than all concentrations), the COPC does not pose a potential unacceptable risk and no further sampling for extent is warranted. The validity of the assumption that the COPC does not pose a risk is confirmed using the results of the risk-screening assessment. The calculation of risk also assists in determining whether additional sampling is warranted to define the extent of contamination that needs additional corrective actions.

Several inorganic chemicals (calcium, magnesium, potassium, and sodium) may be COPCs but do not have SSLs. These constituents are essential nutrients and their maximum concentrations are compared with NMED's essential nutrient screening levels (NMED 2014, 600115). If the maximum concentration is less than the screening level, no additional sampling for extent is warranted.

## **6.0 TA-57 BACKGROUND AND FIELD-INVESTIGATION RESULTS**

Two AOCs located in TA-57 are addressed in this investigation report (Table 1.1-1). Each site is described separately in sections 6.2 and 6.3, including the site description and operational history, relationship to other SWMUs and AOCs, previous investigations, site contamination results based on decision-level data from the current and previous investigations, and summaries of human health and ecological risk screening assessments.



## **6.1 Background of TA-57**

### **6.1.1 Operational History**

TA-57 was established at the Fenton Hill site in 1974 to support the Laboratory's Hot Dry Rock (HDR) program. HDR was an experimental geothermal energy program designed to test the feasibility of extracting heat from deep geologic units near the Valles Caldera. The first location selected for HDR was in Barley Canyon north of the current TA-57 site. After one test well had been drilled, this location was abandoned because of poor winter access and topographic limitations. Operations were moved to the current TA-57 location, which offered a large flat area with easier access. Operations at TA-57 began in 1974.

The HDR energy recovery concept was based on drilling two deep (i.e., 10,000–15,000 ft) wells into the low-permeability, hot-crystalline rock beneath TA-57. Hydraulic fracturing was then used to create a permeable fractured zone between the two wells. During operations, pressurized water was injected into one well and extracted from the other after it flowed through the fractured zone and became heated. Heat exchangers on the surface were used to extract heat from the water, which was then reinjected.

The first geothermal well drilled at TA-57 was well GT-2, which was started in 1974 and completed in 1975. Upon completion of hydraulic fracturing of well GT-2, drilling began on well EE-1, which was to be the extraction well used with GT-2. After completion of fracturing and additional drilling, testing of the two-well system began in 1978. Work on a larger Phase II system began in 1979 with the drilling of well EE-2, the injection well for the Phase II system. Well EE-2 was completed in 1980, and drilling began on extraction well EE-3, which was completed in 1981. Testing of the Phase II system began in 1985 and continued until 1992, when operations were reduced substantially because of funding limitations.

When the extraction wells were drilled, drilling muds were discharged to mud pits and settling ponds near the drill sites. Drilling fluids, produced waters, and other wastes associated with the exploration, development, or production of geothermal energy are solid wastes that are specifically excluded from regulation as hazardous wastes under RCRA [40 Code of Federal Regulations 261.4(b)(5)]. These waste management sites were regulated by NMOCD and were closed in accordance with NMOCD requirements (NMOCD 2003, 101265).

After the HDR project ended, the 5-million-gal. pond originally constructed for the HDR program was converted to a gamma-ray observatory for a project known as Milagro. To construct the observatory, liquid was removed from the pond, the interior of the pond was cleaned, over 700 photomultiplier tubes were placed in the pond, and the pond was refilled with treated water and covered. This water was obtained from an on-site supply well and off-site sources and treated with ion-exchange, granular activated carbon, and ultraviolet light. The Milagro observatory began operating in 1996, and it was decommissioned in June 2008.

TA-57 is currently used to operate a fully automated observatory in support of the Thinking Telescopes project overseen by the Laboratory's Intelligence and Space Research Division. This project combines automated telescope observation, feature extraction from image data, change and anomaly detection, and automated response. An automated measurement program continuously scans the sky to detect optical transients.

### **6.1.2 Summary of Releases**

Releases at the TA-57 Aggregate Area sites may have occurred as a result of normal site operations or spills/leaks. Potential contaminant sources include a waste storage drum (AOC 57-006) and a leach field (AOC 57-007).

### **6.1.3 Current Site Usage and Status**

The fenced area at TA-57 is industrial. A portion of the area immediately adjacent to TA-57 is used by the U.S. Forest Service as a seasonal support area for firefighters.

## **6.2 AOC 57-006, Former Waste Storage Drum**

### **6.2.1 Site Description and Operational History**

AOC 57-006 is the former location of a plastic-lined 55-gal. drum that was buried in the ground at TA-57 beneath a trailer (structure 57-23) that served as an analytical chemistry laboratory (Figure 6.2-1). The chemistry trailer was used from about 1976 to 1989 to provide real-time analytical services for the geothermal project. A sink in the trailer was used to dispose of wastewater associated with chemical analyses. The sink drained to a leach field (AOC 57-007) near the trailer. Chemicals that could not be discharged to the leach field because of their toxicity were poured into a special drain connected to the polyethylene drum. When the drum was full, its contents were transported to the Laboratory for disposal. In 1994, the drum was removed as part of a voluntary corrective action (VCA). The chemistry trailer was removed from the site in March 1994.

The site of the former waste drum is currently vegetated with grasses. The ground surface where the trailer was located is level and then slopes to the southeast toward a drainage swale.

### **6.2.2 Relationship to Other SWMUs and AOCs**

AOC 57-006 is located southwest and upgradient of AOC 57-007.

### **6.2.3 Summary of Previous Investigations**

A VCA was conducted in 1994 to remove the waste collection drum (LANL 1995, 054336). The contents of the drum had previously been removed in January 1994 (LANL 1995, 054336, p. 1). Sampling of the contents indicated elevated levels of lead and mercury as well as various organic solvents, and the waste was classified as hazardous (LANL 1995, 054336, p. 1). During the VCA, the 55-gal. drum was removed. No evidence of leakage was observed during the removal. After the drum was removed, a sample was collected from the bottom of the excavation at a depth of 0.0–0.5 ft below the bottom of the excavation and submitted for laboratory analysis of TAL metals, total cyanide, total uranium, and VOCs. Data from the 1994 VCA are screening-level data and are summarized below. Section 2.1.3 of the historical investigation report (HIR) (LANL 2012, 214549) presents a more detailed discussion of the screening-level results.

Lead and mercury were each detected above BVs in one sample. Organic chemicals were not detected.

### **6.2.4 Site Contamination**

#### **6.2.4.1 Soil, Rock and Sediment Sampling**

Based on previous investigation results, further characterization using decision-level data was required to assess the potential contamination at AOC 57-006. As a result, the following activities were completed as part of the 2014 investigation:

- All investigation samples were field-screened for organic vapors and gross-alpha, -beta, and -gamma radiation. Field-screening results were recorded on the SCLs (Appendix E).

- Twelve samples were collected from four locations. Three samples were collected at the previously sampled location of the former waste storage drum (location 57-4022), and three samples each were collected at three step-out locations. At each location, samples were collected from 3.0–4.0 ft (approximately 0.0–1.0 ft below the bottom of the former drum location), 5.0–6.0 ft bgs, and 8.0–9.0 ft bgs. All samples were analyzed at off-site fixed laboratories for TAL metals, total cyanide, nitrate, perchlorate, VOCs, SVOCs, and isotopic uranium.

The 2014 sampling locations at AOC 57-006 are shown in Figure 6.2-1. Table 6.2-1 presents the samples collected and analysis requested for AOC 57-006. The geodetic coordinates of sampling locations are presented in Table 3.2-1.

#### **6.2.4.2 Soil, Rock, and Sediment Field-Screening Results**

During headspace screening for organic vapors at AOC 57-006, no organic vapors were detected. No radiological screening results exceeded twice the daily background levels. Field-screening results are presented in Table 3.2-2. There were no changes to sampling or other activities because of field-screening results.

#### **6.2.4.3 Soil, Rock, and Sediment Analytical Results**

Decision-level data at AOC 57-006 consist of 12 samples (7 fill and 5 tuff) collected from 4 locations.

##### **Inorganic Chemicals**

Twelve samples (seven fill and five tuff) were analyzed for TAL metals, total cyanide, nitrate, and perchlorate. Table 6.2-2 presents the inorganic chemicals above BVs and detected inorganic chemicals with no BVs. Figure 6.2-2 shows the spatial distribution of inorganic chemicals detected or detected above BVs.

Antimony was not detected above the soil and Qbt 2,3,4 BVs (0.83 mg/kg and 0.5 mg/kg) but had DLs (0.946 mg/kg to 1.12 mg/kg) above BVs in all 12 samples. The DLs were also above the maximum soil or Qbt 2,3,4 background concentrations (1 mg/kg and 0.4 mg/kg) in 10 samples. Antimony is retained as a COPC.

Barium was detected above the Qbt 2,3,4 BV (46 mg/kg) in four samples with a maximum concentration of 136 mg/kg. Barium is retained as a COPC.

Cadmium was not detected above the soil and Qbt 2,3,4 BVs (0.4 mg/kg and 1.63 mg/kg) but had DLs (0.477 mg/kg to 0.56 mg/kg) above the soil BV in 7 samples. The DLs were only 0.077 mg/kg to 0.16 mg/kg above the soil BV and were approximately 2 mg/kg to 2.1 mg/kg below the maximum soil background concentration (2.6 mg/kg). Cadmium was not detected in the 7 soil samples and was not detected above BVs in the 12 samples (detected in 1 tuff sample below the Qbt 2,3,4 BV). The single detected concentration of cadmium (0.14 mg/kg) was well below both BVs and indicates that cadmium, when present, is background. Cadmium is not a COPC.

Chromium was detected above the soil and Qbt 2,3,4 BVs (19.3 mg/kg and 7.14 mg/kg) in one fill sample and three tuff samples with a maximum concentration of 113 mg/kg. Chromium is retained as a COPC.

Copper was detected above the Qbt 2,3,4 BV (4.66 mg/kg) in two samples with a maximum concentration of 26 mg/kg. Copper is retained as a COPC.

Lead was detected above the Qbt 2,3,4 BV (11.2 mg/kg) in four samples with a maximum concentration of 14.5 mg/kg. The concentrations were only 0.6 mg/kg to 3.3 mg/kg above the Qbt 2,3,4 BV and were approximately 1 mg/kg to 3.7 mg/kg below the maximum Qbt 2,3,4 background concentration (15.5 mg/kg). Lead was detected below the soil and Qbt 2,3,4 BVs in the other eight samples and at similar concentrations in soil and tuff samples with concentrations ranging from 9.05 mg/kg to 14.5 mg/kg (a difference of 5.45 mg/kg). Lead is not a COPC.

Manganese was detected above the Qbt 2,3,4 BV (482 mg/kg) in 1 sample at a concentration of 536 mg/kg. The concentration was 54 mg/kg above the Qbt 2,3,4 BV and approximately 216 mg/kg below the maximum Qbt 2,3,4 background concentration (752 mg/kg). Manganese was detected below the soil and Qbt 2,3,4 BVs in the other 11 samples and at similar concentrations in soil and tuff samples with concentrations ranging from 326 mg/kg to 552 mg/kg (the maximum concentration was detected in a fill sample below the soil BV). Manganese is not a COPC.

Nitrate was detected in 12 samples with a maximum concentration of 8.03 mg/kg. Nitrate is naturally occurring, and the concentrations reflect naturally occurring levels of nitrate. Nitrate is not a COPC.

Selenium was detected above the Qbt 2,3,4 BV (0.3 mg/kg) in two samples with a maximum concentration of 0.358 mg/kg and had DLs (0.944 mg/kg to 1.06 mg/kg) above the BV in three samples. Selenium is retained as a COPC.

Zinc was detected above the soil and Qbt 2,3,4 BVs (48.8 mg/kg and 63.5 mg/kg) in five fill samples and two tuff samples with a maximum concentration of 75.1 mg/kg. Zinc is retained as a COPC.

### **Organic Chemicals**

Twelve samples (seven fill and five tuff) were analyzed for SVOCs and VOCs. Table 6.2-3 summarizes the analytical results for detected organic chemicals. Figure 6.2-3 shows the spatial distribution of detected organic chemicals.

The organic chemicals detected at AOC 57-006 include bis(2-ethylhexyl)phthalate, methylene chloride, and trichloroethene. All detected organic chemicals are retained as COPCs.

### **Radionuclides**

Twelve samples (seven fill and five tuff) were analyzed for isotopic uranium. Table 6.2-4 summarizes radionuclides detected above BVs. Figure 6.2-4 shows the spatial distribution of detected radionuclides.

Uranium-235/236 was detected above the Qbt 2,3,4 BV (0.09 mg/kg) in 1 sample at an activity of 0.0956 pCi/g. The activity was only 0.0056 pCi/g above the BV, and uranium-235/236 was not detected or was detected below the soil or Qbt 2,3,4 BVs in the other 11 samples (detected in 4 samples below the BVs). The Qbt 2,3,4 BV for uranium-235/236 is calculated using the total uranium measured in rock and the isotopic abundance and activity of uranium-234, uranium-235/236, and uranium-238. As presented in Table 5.3-4 of the Laboratory's background report (LANL 1998, 059730), the maximum activity of total uranium in Qbt 2,3,4 is about 23% greater (7.123 pCi/g versus 5.79 pCi/g) than the BV based on 26 background samples. A calculated maximum uranium-235/236 activity for Qbt 2,3,4 background is 0.11 pCi/g. This activity is 0.014 pCi/g above the maximum site activity and indicates the uranium-235/236 activities are naturally occurring. The other uranium isotopes (uranium-234 and uranium-238) are not different from background, also indicating naturally occurring activities of uranium-235/236. Uranium-235/236 is not a COPC.

#### 6.2.2.4 Nature and Extent of Contamination

The nature and extent of inorganic, organic, and radionuclide COPCs at AOC 57-006 are discussed below.

##### Inorganic Chemicals

Inorganic COPCs at AOC 57-006 are antimony, barium, chromium, copper, selenium, and zinc.

Antimony was not detected above the soil and Qbt 2,3,4 BVs but had DLs (0.946 mg/kg to 1.12 mg/kg) above BVs in all 12 samples. Because antimony was not detected in any sample and the residential SSL is approximately 28 times the maximum DL, further sampling for extent of antimony is not warranted.

Barium was detected above the Qbt 2,3,4 BV in four samples with a maximum concentration of 136 mg/kg. Concentrations decreased with depth at location 57-4023. The concentrations at locations 57-4022, 57-4024, and 57-4025 increased with depth, and concentrations increased laterally from location 57-4022. The residential and industrial SSLs were approximately 115 times and 1875 times the maximum concentration. Further sampling for extent of barium is not warranted.

Chromium was detected above the soil and Qbt 2,3,4 BVs in one fill sample and three tuff samples with a maximum concentration of 113 mg/kg. Concentrations decreased with depth at location 57-4024. The concentrations at locations 57-4022, 57-4023, and 57-4025 increased with depth and increased laterally from location 57-4022. As discussed in section 4.2, no source of hexavalent chromium was present at this site, and site conditions would not have produced hexavalent chromium. Therefore, the results were compared with trivalent chromium SSLs for extent purposes. The trivalent chromium residential and industrial SSLs were approximately 1035 times and 15,044 times the maximum concentration, respectively. Further sampling for extent of chromium is not warranted.

Copper was detected above the Qbt 2,3,4 BV in two samples with a maximum concentration of 26 mg/kg. Concentrations at location 57-4022 did not change substantially with depth (2.2 mg/kg) and increased with depth at location 57-4025. Concentrations increased laterally to the north from location 57-4022 to location 57-4025. The residential and industrial SSLs were approximately 120 times and 1996 times the maximum concentration, respectively. Further sampling for extent of copper is not warranted.

Selenium was detected above the Qbt 2,3,4 BV in two samples at concentrations of 0.347 mg/kg and 0.358 mg/kg and had DLs (0.944 mg/kg to 1.06 mg/kg) above the BV in three samples. The detected concentrations at locations 57-4022 and 57-4025 were in the deepest samples but only 0.047 mg/kg and 0.058 mg/kg above the BV. Selenium was not detected at locations 57-4023 and 57-4024. The residential SSL was approximately 1092 times the detected concentrations and approximately 368 times the maximum DL. Further sampling for extent of selenium is not warranted.

Zinc was detected above the soil and Qbt 2,3,4 BVs in five fill samples and two tuff samples with a maximum concentration of 75.1 mg/kg. Concentrations decreased with depth at locations 57-4024 and 57-4022. The concentrations at locations 57-4023 and 57-4025 increased slightly with depth (12.9 mg/kg and 24.7 mg/kg) and increased slightly laterally (12.3 mg/kg or less at depth) from location 57-4022. However, the concentrations were reported at similar ranges at each location across the site (44.5 mg/kg to 75.1 mg/kg) and were below the maximum soil background concentration (75.5 mg/kg) and below or slightly above (9.5 mg/kg or less) the maximum Qbt 2,3,4 background concentration (65.6 mg/kg). The residential and industrial SSLs were approximately 313 times and 5180 times the maximum concentration, respectively. Further sampling for extent of zinc is not warranted.

## Organic Chemicals

Organic COPCs at 57-006 include bis(2-ethylhexyl)phthalate, methylene chloride, and trichloroethene.

Bis(2-ethylhexyl)phthalate was detected in one sample at a concentration of 0.269 mg/kg. The concentration was below the EQL and decreased laterally from location 57-4022. The residential SSL was approximately 1412 times the concentration. Further sampling for extent of bis(2-ethylhexyl)phthalate is not warranted.

Methylene chloride was detected in two samples with a maximum concentration of 0.0028 mg/kg. Concentrations decreased with depth and were below the EQLs. Concentrations decreased or did not change substantially laterally (0.00032 mg/kg). The residential SSL was approximately 146,071 times the maximum concentration. The vertical extent of methylene chloride is defined, and further sampling for lateral extent is not warranted.

Trichloroethene was detected in two samples with a maximum concentration of 0.000726 mg/kg. The concentrations did not change substantially with depth and were below the EQLs. Concentrations increased laterally from location 57-4022. The residential SSL was approximately 9325 times the maximum concentration. The vertical extent of trichloroethene is defined, and further sampling for lateral extent is not warranted.

## Radionuclides

No radionuclide COPCs were identified at AOC 57-006.

### 6.2.5 Summary of Human Health Risk Screening

#### Industrial Scenario

Samples were not collected from the 0.0–1.0-ft depth interval; therefore, the industrial scenario was not evaluated for AOC 57-006.

#### Residential Scenario

The total excess cancer risk for the residential scenario is  $6 \times 10^{-6}$ , which is less than the NMED target risk level of  $1 \times 10^{-5}$ . The HI for the residential scenario is 0.05, which is less than the NMED target HI of 1.

Based on the risk-screening assessment results, no potential unacceptable risks or doses exist for the industrial and residential scenarios at AOC 57-006.

### 6.2.6 Summary of Ecological Risk Screening

Based on evaluations of the minimum ESLs, HI analyses, potential effects to populations, and LOAEL analyses, no potential ecological risks to the earthworm, plant, American robin, American kestrel, deer mouse, montane shrew, desert cottontail, and red fox exist at AOC 57-006.

### **6.3 AOC 57-007, Leach Field**

#### **6.3.1 Site Description and Operational History**

AOC 57-007 is a leach field at TA-57 that served a former trailer (structure 57-23) that was used as an analytical chemistry laboratory (Figure 6.2-1). The chemistry trailer was used from about 1976 to 1989 to provide real-time analytical services for the geothermal project. A sink in the trailer drained to the leach field and was used to dispose of wastewater associated with chemical analyses. Chemicals that could not be discharged to the leach field because of their toxicity were poured into a special drain connected to a polyethylene-lined 55-gal. drum (AOC 57-006). The chemistry trailer was removed from the site in March 1994.

The RCRA facility investigation (RFI) work plan for Operable Unit 1154 (LANL 1994, 034757) described the leach field's location as approximately 20 ft southeast of the trailer at 8.0–10.0 ft bgs. During the 1994 Phase I RFI at this site, the leach field was discovered to be northeast of the trailer and at a depth of 1.0–2.0 ft bgs. The site of the leach field is currently vegetated with grasses, shrubs, and small trees. The ground surface slopes to the southeast toward a drainage swale. An elevated electrical conduit rack runs across the site roughly parallel to the road.

#### **6.3.2 Relationship to Other SWMUs and AOCs**

AOC 57-007 is located northeast and downgradient of AOC 57-006.

#### **6.3.3 Summary of Previous Investigations**

During the 1994 Phase I RFI conducted at AOC 57-007, the drainline from the trailer to the leach field was found to be in place, uncovered, and used to locate the leach field (LANL 1996, 053801). One sample was collected where the drainline discharged to the leach field from a depth 0.0–1.0 ft below the bottom of the drainline. The sample was submitted for laboratory analysis of TAL metals, total cyanide, total uranium, and SVOCs. Data from the 1994 RFI are screening-level data and are summarized below. Section 2.2.3 of the HIR presents a more detailed discussion of the screening-level results (LANL 2012, 214549).

Mercury, uranium, and zinc were each detected above the soil BVs in the one sample. Organic chemicals were not detected.

#### **6.3.4 Site Contamination**

##### **6.3.4.1 Soil, Rock, and Sediment Sampling**

Based on previous investigation results, further characterization using decision-level data was required to assess the potential contamination at AOC 57-007. As a result, the following activities were completed as part of the 2014 investigation:

- All investigation samples were field-screened for organic vapors and gross-alpha, -beta, and -gamma radiation. Field screening results were recorded in the SCLs (Appendix E).

- Nine samples were collected where the drainline exited the former trailer (location 57-4011), beneath the midpoint of the drainline (location 57-4013), and near the previously sampled location where the drainline entered the leach field (location 57-4012) (see discussion of deviations in Appendix B). At each location, samples were collected from three depth intervals: the interval encompassing the former drainline; the interval 0.0–1.0 ft below the drainline/1 ft above tuff; and approximately 2.0–3.0 ft into tuff. These intervals deviate slightly from those proposed in investigation work plan because two of the intervals specified in the work plan were the same (see discussion of deviations in Appendix B). At location 57-4011, samples were collected from 0.0–1.0 ft, 1.0–2.0 ft, and 3.0–4.0 ft bgs. At location 57-4012, samples were collected from 0.0–1.0 ft, 1.25–2.25 ft, and 4.25–5.25 ft bgs. At location 57-4013, samples were collected from 0.0–1.0 ft, 1.0–2.0 ft, and 4.0–5.0 ft bgs. All samples were analyzed at off-site fixed laboratories for TAL metals, total cyanide, nitrate, perchlorate, VOCs, SVOCs, and isotopic uranium.
- Six samples were collected from two locations within the leach field. At location 57-4014 samples were collected from 1.0–2.0 ft, 2.0–3.0 ft, and 4.0–5.0 ft bgs. At location 57-4015 samples were collected from 1.5–2.5 ft, 2.5–3.5 ft, and 4.5–5.5 ft bgs. All samples were analyzed at off-site fixed laboratories for TAL metals, total cyanide, nitrate, perchlorate, VOCs, SVOCs, and isotopic uranium.
- Nine samples were collected from three step-out locations around the leach field. At location 57-4016, samples were collected from 2.5–3.5 ft, 3.0–4.0 ft, and 6.0–7.0 ft bgs. At location 57-4017, samples were collected from 1.0–2.0 ft, 2.5–3.5 ft, and 4.0–5.0 ft bgs. At location 57-4018, samples were collected from 2.5–3.5 ft, 4.4–5.4 ft, and 7.4–8.4 ft bgs. Samples were also collected from 0.0–1.0 ft bgs at each location (see deviations in Appendix B). All samples were analyzed at off-site fixed laboratories for TAL metals, total cyanide, nitrate, perchlorate, VOCs, SVOCs, and isotopic uranium.
- Nine samples were collected from three locations in the drainage downgradient of the leach field to define lateral extent of contamination. At location 57-4019, samples were collected from 0.0–1.0 ft, 1.5–2.5 ft, and 4.5–5.5 ft bgs. At location 57-4020, samples were collected from 0.0–1.0 ft, 2.5–3.5 ft, and 5.5–6.5 ft bgs. At location 57-4021, samples were collected from 0.0–1.0 ft, 4.5–5.5 ft, and 6.5–7.5 ft bgs. All samples were analyzed at off-site fixed laboratories for TAL metals, total cyanide, nitrate, perchlorate, VOCs, SVOCs, and isotopic uranium.
- Soil removal occurred at locations 57-4011 and 57-4020 to remove elevated arsenic concentrations in the 0.0–1.0-ft depth interval. Excavations were to 2.0 ft bgs at location 57-4011 and to 2.5 ft bgs at location 57-4020 (three samples were eliminated from the data set because of this activity). No additional samples were collected because sampling data from the bottom of the excavations were available.
- Four samples were collected from 2 locations (57-4026 and 57-4027) southwest of location 57-4011. At location 57-4026, samples were collected from 3.5–4.5 ft and 6.5–7.5 ft bgs. At location 57-4027, samples were collected from 2.0–3.0 ft and 5.0–6.0 ft bgs. Samples were analyzed at an off-site fixed laboratory for arsenic only.

The 2014 sampling locations at AOC 57-007 are shown in Figure 6.2-1. Table 6.3-1 presents the samples collected and analysis requested for AOC 57-007. The geodetic coordinates of sampling locations are presented in Table 3.2-1.



#### 6.3.4.2 Soil, Rock, and Sediment Field-Screening Results

During headspace screening for organic vapors at AOC 57-007, no organic vapors were detected. No radiological screening results exceeded twice the daily background levels. Field-screening results are presented in Table 3.2-2. There were no changes to sampling or other activities because of field-screening results.

#### 6.3.4.3 Soil, Rock, and Sediment Analytical Results

Decision-level data at AOC 57-007 consist of 37 samples (21 soil/fill and 16 tuff) collected from 13 locations.

#### Inorganic Chemicals

Thirty-three samples (19 soil/fill and 14 tuff) were analyzed for TAL metals, total cyanide, nitrate, and perchlorate. Four samples (2 soil and 2 tuff) were analyzed for arsenic only. Table 6.3-2 presents the inorganic chemicals above BVs and detected inorganic chemicals with no BVs. Figure 6.3-1 shows the spatial distribution of inorganic chemicals detected or detected above BVs.

Aluminum was detected above the soil and Qbt 2,3,4 BVs (29,200 mg/kg and 7340 mg/kg) in one soil and one tuff sample with a maximum concentration of 29,600 mg/kg. The Gehan and quantile tests indicated site concentrations of aluminum in soil are not statistically different from background (Figure F-1 and Table F-1). The quantile and slippage tests indicated site concentrations of aluminum in tuff are not statistically different from background (Figure F-1 and Table F-2). Aluminum is not a COPC.

Antimony was not detected above the soil and Qbt 2,3,4 BVs (0.83 mg/kg and 0.5 mg/kg) but had DLs (0.875 mg/kg to 1.15 mg/kg) above BVs in 14 soil samples and 12 tuff samples (78% of samples). The DLs were also above the maximum soil and Qbt 2,3,4 background concentrations (1 mg/kg and 0.4 mg/kg, respectively). Antimony is retained as a COPC.

Arsenic was detected above the Qbt 2,3,4 BV (2.79 mg/kg) in one sample at a concentration of 5.12 mg/kg. The Gehan and quantile tests indicated site concentrations of arsenic in tuff are statistically different from background (Table F-2 and Figure F-2). Arsenic is retained as a COPC.

Barium was detected above the soil and Qbt 2,3,4 BVs (295 mg/kg and 46 mg/kg) in one soil sample and eight tuff samples with a maximum concentration of 384 mg/kg. The Gehan and quantile tests indicated the site concentrations of barium in soil are not statistically different from background (Figure F-3 and Table F-1). The Gehan and quantile tests indicated site concentrations of barium in tuff are statistically different from background (Figure F-3 and Table F-2). Barium is retained as a COPC.

Beryllium was detected above the soil BV (1.83 mg/kg) in one soil sample at a concentration of 2.29 mg/kg. The Gehan and quantile tests indicated the site concentrations of beryllium in soil are not statistically different from background (Figure F-4 and Table F-1). Beryllium is not a COPC.

Cadmium was detected above the soil BV (0.4 mg/kg) in 1 sample at a concentration of 0.574 mg/kg and had DLs (0.479 mg/kg to 0.575 mg/mg) above the soil BV in 17 samples (the DLs for all samples, whether soil or tuff, were similar, ranging from 0.438 mg/kg to 0.575 mg/kg). The detected concentration above BV was only 0.174 mg/kg and the DLs were only 0.079 mg/kg to 0.175 mg/kg above the soil BV. The detected concentration and DLs were approximately 2 mg/kg to 2.1 mg/kg below the maximum soil background concentration (2.6 mg/kg). Cadmium was not detected in 27 samples, was detected below the soil BV in 1 sample, and was detected below the Qbt 2,3,4 BV (1.63 mg/kg) in 4 samples.

(concentrations were also below the soil BV). The detected concentrations of cadmium are well below both BVs and indicate that cadmium, when present, is background. Cadmium is not a COPC.

Chromium was detected above the Qbt 2,3,4 BV (7.14 mg/kg) in eight samples with a maximum concentration of 68.3 mg/kg. The Gehan and quantile tests indicated the site concentrations of chromium in tuff are statistically different from background (Table F-2 and Figure F-5). Chromium is retained as a COPC.

Copper was detected above the soil and Qbt 2,3,4 BVs (14.7 mg/kg and 4.66 mg/kg) in one soil sample and two tuff samples with a maximum concentration of 65.1 mg/kg. The Gehan and slippage tests indicated site concentrations of copper in soil are not statistically different from background (Figure F-6 and Table F-1). The Gehan and quantile tests indicated the site concentrations of copper in tuff are statistically different from background (Figures F-6 and Table F-2). Copper is retained as a COPC.

Cyanide was detected above the soil BV (0.5 mg/kg) in one soil sample at a concentration of 0.73 mg/kg. Cyanide is retained as a COPC.

Lead was detected above the soil and Qbt 2,3,4 BVs (22.3 mg/kg and 11.2 mg/kg) in one soil sample and seven tuff samples with a maximum concentration of 33.6 mg/kg. The Gehan and quantile tests indicated site concentrations of lead in soil are not statistically different from background (Figure F-7 and Table F-1). The Gehan and quantile tests indicated the site concentrations of lead in tuff are statistically different from background (Figure F-7 and Table F-2). Lead is retained as a COPC.

Mercury was detected above the soil and Qbt 2,3,4 BV (0.1 mg/kg) in two soil samples and two tuff samples with a maximum concentration of 20.6 mg/kg. Mercury is retained as a COPC.

Nitrate was detected in four soil samples and two tuff samples with a maximum concentration of 1.16 mg/kg. Nitrate is naturally occurring and the concentrations reflect naturally occurring levels of nitrate. Nitrate is not a COPC.

Perchlorate was detected in six soil samples and two tuff samples with a maximum concentration of 0.00159 mg/kg. Perchlorate is retained as a COPC.

Selenium was not detected above the Qbt 2,3,4 BV (0.3 mg/kg) but had DLs (0.917 mg/kg to 1.08 mg/kg) above the BV in 14 samples. Selenium is retained as a COPC.

Silver was detected above the soil BV (1 mg/kg) in two soil samples with a maximum concentration of 15.2 mg/kg. Silver is retained as a COPC.

Zinc was detected above the soil and Qbt 2,3,4 BVs (48.8 mg/kg and 63.5 mg/kg) in five soil samples and six tuff samples with a maximum concentration of 113 mg/kg. The Gehan and quantile tests indicated site concentrations of zinc in soil are statistically different from background (Figure F-8 and Table F-1). The Gehan and quantile tests indicated site concentrations of zinc in tuff are statistically different from background (Figure F-8 and Table F-2). Zinc is retained as a COPC.

## Organic Chemicals

Thirty-three samples (19 soil/fill and 14 tuff) were analyzed for SVOCs and VOCs. Table 6.3-3 summarizes the analytical results for detected organic chemicals. Figure 6.3-2 shows the spatial distribution of detected organic chemicals.

The organic chemicals detected at AOC 57-007 include benzoic acid; bis(2-ethylhexyl)phthalate; butylbenzylphthalate; 1,4-dichlorobenzene; fluoranthene; methylene chloride; phenanthrene; and trichloroethene. All detected organic chemicals are retained as COPCs.

## Radionuclides

Thirty-three samples (19 soil/fill and 14 tuff) were analyzed for isotopic uranium. Table 6.3-4 summarizes radionuclides detected or detected above BVs/FVs. Figure 6.3-3 shows the spatial distribution of detected radionuclides.

Uranium-235/236 was detected above the Qbt 2,3,4 BV (0.09 pCi/g) in 4 samples with a maximum activity of 0.115 pCi/g. The differences in activities between the site activities and the BV are 0.0056 pCi/g to 0.025 pCi/g, and the frequency of detected activities above BVs is only 4 of 33 samples. The Qbt 2,3,4 BV for uranium-235/236 is calculated using the total uranium measured in rock and the isotopic abundance and activity of uranium-234, uranium-235/236, and uranium-238. As presented in Table 5.3-4 of the Laboratory's background report (LANL 1998, 059730), the maximum activity of total uranium in Qbt 2,3,4 is about 23% greater than the BV (7.123 pCi/g versus 5.79 pCi/g) based on 26 background samples. A calculated maximum uranium-235/236 activity for Qbt 2,3,4 background is 0.11 pCi/g. This activity is similar to the maximum site activity and indicates the uranium-235/236 activities are naturally occurring. The other uranium isotopes (uranium-234 and uranium-238) are not different from background, also indicating naturally occurring activities of uranium-235/236. Uranium-235/236 is not a COPC.

### 6.3.4.4 Nature and Extent of Contamination

The nature and extent of inorganic, organic, and radionuclide COPCs at AOC 57-007 are discussed below.

## Inorganic Chemicals

Inorganic COPCs at AOC 57-007 are antimony, arsenic, barium, chromium, copper, cyanide, lead, mercury, perchlorate, selenium, silver, and zinc.

Antimony was not detected above the soil and Qbt 2,3,4 BVs but had DLs (0.875 mg/kg to 1.15 mg/kg) above BVs in 14 soil samples and 12 tuff samples. The residential SSL was approximately 27 times the maximum DL. Further sampling for extent of antimony is not warranted.

Arsenic was detected above the Qbt 2,3,4 BV in one sample at a concentration of 5.12 mg/kg. The concentration at location 57-4026 increased slightly with depth (approximately 3.3 mg/kg), but the concentration at depth (5.12 mg/kg) is similar to the maximum Qbt 2,3,4 background concentration (5 mg/kg). The industrial SSL was approximately 4.2 times the detected concentration. Further sampling for extent of arsenic is not warranted.

Barium was detected above the soil and Qbt 2,3,4 in one soil sample and eight tuff samples with a maximum concentration of 384 mg/kg. Concentrations decreased with depth at all locations and decreased downgradient. The lateral and vertical extent of barium are defined.

Chromium was detected above the Qbt 2,3,4 BV in eight samples with a maximum concentration of 68.3 mg/kg. Chromium concentrations decreased downgradient. Chromium concentrations decreased with depth at locations 57-4014 and 57-4015. Concentrations increased with depth at locations 57-4012, 57-4013, 57-4016, 57-4017, and 57-4018. As discussed in section 4.2, no source of hexavalent chromium is present at this site, and site conditions would not have produced hexavalent chromium. Therefore, the

results were compared with trivalent chromium SSLs for extent purposes. The trivalent chromium residential SSL was approximately 1713 times the maximum concentration. The lateral extent of chromium is defined, and further sampling for vertical extent is not warranted.

Copper was detected above the soil and Qbt 2,3,4 BVs in one soil sample and two tuff samples with a maximum concentration of 65.1 mg/kg. Concentrations decreased with depth at locations 57-4014, and 57-4015 and decreased downgradient. The lateral and vertical extent of copper are defined.

Cyanide was detected above the soil BV in one sample at a concentration of 0.73 mg/kg. Concentrations decreased with depth and decreased downgradient. The lateral and vertical extent of cyanide are defined.

Lead was detected above the soil and Qbt 2,3,4 BVs in one soil sample and seven tuff samples with a maximum concentration of 33.6 mg/kg. Lead concentrations decreased with depth at locations 57-4011 and 57-4020 (Appendix E, Excavated Samples Table) as well as at location 57-4015 and did not change substantially with depth (0.1 mg/kg to 3.6 mg/kg) at locations 57-4014, 57-4017, 57-4019, and 57-4021. The concentrations at depth at these four locations were less than or equivalent to the maximum Qbt 2,3,4 background concentration (15.5 mg/kg) and the residential and industrial SSLs were approximately 26 times and 52 times the maximum concentration at these locations. Concentrations decreased downgradient. The lateral extent of lead is defined, and further sampling for vertical extent is not warranted.

Mercury was detected above the soil and Qbt 2,3,4 BVs in two soil samples and two tuff samples with a maximum concentration of 20.6 mg/kg. Concentrations decreased with depth at locations 57-4014 and 57-4015 and decreased downgradient. The lateral and vertical extent of mercury are defined.

Perchlorate was detected in six soil samples and two tuff samples with a maximum concentration of 0.00159 mg/kg. Concentrations were below the estimated DLs and decreased with depth at locations 57-4011 (Appendix E, Excavated Samples Table), 57-4012, 57-4013, 57-4015, 57-4018, and 57-4020 and did not change substantially with depth (0.000954 mg/kg) at location 57-4016. Concentrations decreased downgradient. The lateral and vertical extent of perchlorate are defined.

Selenium was not detected above the Qbt 2,3,4 BV but had DLs (0.917 mg/kg to 1.08 mg/kg) above the BV in 14 samples. Because selenium was not detected in any samples and the residential SSL was approximately 362 times the maximum DL, further sampling for extent of selenium is not warranted.

Silver was detected above the soil BV in two samples with a maximum concentration of 15.2 mg/kg. Concentrations decreased with depth and decreased downgradient. The lateral and vertical extent of silver are defined.

Zinc was detected above the soil and Qbt 2,3,4 BVs in five soil samples and six tuff samples with a maximum concentration of 113 mg/kg. Concentrations decreased with depth at locations 57-4012, 57-4015, 57-4018, and 57-4021 and decreased downgradient. Concentrations increased slightly with depth (approximately 14 mg/kg to 24 mg/kg) at locations 57-4013, 57-4014, and 57-4017 with the deepest concentrations at locations 57-4013 and 57-4017 below or equivalent to the maximum Qbt 2,3,4 background concentration (65.6 mg/kg). The residential SSL was approximately 320 times the maximum concentration at these three locations. The lateral extent of zinc is defined, and further sampling for vertical extent is not warranted.

## Organic Chemicals

Organic COPCs at AOC 57-007 include benzoic acid; bis(2-ethylhexyl)phthalate; butylbenzylphthalate; 1,4-dichlorobenzene; fluoranthene; methylene chloride; phenanthrene; and trichloroethene.

Benzoic acid was detected in three samples with a maximum concentration of 2.83 mg/kg. Concentrations decreased with depth and decreased downgradient. The lateral and vertical extent of benzoic acid are defined.

Bis(2-ethylhexyl)phthalate and butylbenzylphthalate were detected in one sample at concentrations of 0.13 mg/kg and 0.339 mg/kg, respectively. Concentrations were below the EQLs, decreased with depth, and decreased downgradient. The lateral and vertical extent of bis(2-ethylhexyl)phthalate and butylbenzylphthalate are defined.

Dichlorobenzene[1,4-] and methylene chloride were detected in three and two samples, respectively, with maximum concentrations of 0.00043 mg/kg and 0.00299 mg/kg. Concentrations were below the EQLs, decreased with depth, and decreased downgradient. The lateral and vertical extent of 1,4-dichlorobenzene and methylene chloride are defined.

Fluoranthene and phenanthrene were detected in one or two samples with maximum concentrations of 0.0145 mg/kg and 0.0134 mg/kg, respectively. Concentrations were below the EQLs, decreased with depth at all locations, and decreased downgradient. The lateral and vertical extent of fluoranthene and phenanthrene are defined.

Trichloroethene was detected in two samples with a maximum concentration of 0.00294 mg/kg. Concentrations decreased with depth or did not change substantially downgradient (0.00186 mg/kg). The residential SSL was approximately 2303 times the maximum concentration. The vertical extent of trichloroethene is defined, and further sampling for lateral extent is not warranted.

## Radionuclides

No radionuclide COPCs were identified at AOC 57-007.

### 6.3.5 Summary of Human Health Risk Screening

#### Industrial Scenario

Carcinogenic COPCs were not identified in the 0.0–1.0-ft depth interval. The HI for the industrial scenario is 0.001, which is less than the NMED target HI of 1.

#### Residential Scenario

The total excess cancer risk for the residential scenario is  $7 \times 10^{-6}$ , which is less than the NMED target risk level of  $1 \times 10^{-5}$ . The HI for the residential scenario is 0.3, which is less than the NMED target HI of 1.

Based on the risk-screening assessment results, no potential unacceptable risks or doses exist for the industrial and residential scenarios at AOC 57-007.

### **6.3.6 Summary of Ecological Risk Screening**

Based on evaluations of the minimum ESLs, HI analyses, potential effects to populations, LOAEL analyses, and chemicals of potential ecological concern (COPECs) without ESLs, no potential ecological risks to the earthworm, plant, American robin, American kestrel, deer mouse, montane shrew, desert cottontail, and red fox exist at AOC 57-007.

## **7.0 CONCLUSIONS**

### **7.1 Nature and Extent of Contamination**

Based on the evaluation of the data, the nature and extent of contamination have been defined and/or no further sampling for extent is warranted for the sites investigated.

#### **7.1.1 TA-57 Aggregate Area**

The nature and extent of contamination have been defined, and/or no further sampling for extent is warranted for the following sites in TA-57:

- AOC 57-006, Former Waste Storage Drum
- AOC 57-007, Leach Field

### **7.2 Summary of Risk-Screening Assessments**

AOCs 57-006 and 57-007 were evaluated for potential risk by human health and ecological risk-screening assessments.

#### **7.2.1 Human Health Risk-Screening Assessments**

The human health risk-screening assessments are presented in Appendix G, section G-4.0.

The industrial scenario was not evaluated AOC 57-006 because samples were not collected from the 0.0–1.0-ft depth interval. The human health risk-screening assessments found no unacceptable risks under the industrial scenario at AOC 57-007 and found no unacceptable risks under the residential scenario at both AOCs. The total excess cancer risks were less than the NMED target risk level of  $1 \times 10^{-5}$  and the HIs were less than the NMED target HI of 1.

#### **7.2.2 Ecological Risk-Screening Assessment**

The ecological risk-screening assessments are presented in Appendix G, section G-5.0.

Ecological risks were evaluated for both sites based on comparisons to minimum ESLs, HI analyses, potential effects to populations, and LOAEL analyses. These lines of evidence and the analysis of COPECs with no ESLs support the conclusion that no potential ecological risk exists at these sites.

## 8.0 RECOMMENDATIONS

The determination of site status is based on the results of the risk-screening assessments and the nature and extent evaluation. Depending upon the decision scenario used, the sites are recommended as corrective actions complete either with or without controls or for additional action. The residential scenario is the only scenario under which corrective action complete without controls is applicable; that is, no additional corrective actions or conditions are necessary. The other decision scenarios (industrial, construction worker, and recreational) result in corrective action complete with controls; that is, some type of institutional controls must be in place to ensure land use remains consistent with site cleanup levels. The current and reasonably foreseeable future land use for the TA-57 Aggregate Area is industrial.

### 8.1 Additional Field Characterization Activities

Additional sampling to define the nature and extent of contamination is not warranted for AOCs 57-006 and 57-007.

### 8.2 Recommendations for Corrective Actions Complete

AOCs 57-006 and 57-007 do not pose a potential unacceptable risk or dose under the industrial and residential scenarios and have no potential ecological risks to any receptor, and the nature and extent of contamination are defined and/or no further sampling for extent is warranted. At these sites, the Laboratory recommends no further investigation or remediation activities, and both sites are appropriate for corrective actions complete without controls.

## 9.0 REFERENCES AND MAP DATA SOURCES

### 9.1 References

*The following list includes all documents cited in this report. Parenthetical information following each reference provides the author(s), publication date, and ER ID or ESH ID. This information is also included in text citations. ER IDs were assigned by the Environmental Programs Directorate's Records Processing Facility (IDs through 599999), and ESH IDs are assigned by the Environment, Safety, and Health (ESH) Directorate (IDs 600000 and above). IDs are used to locate documents in the Laboratory's Electronic Document Management System and, where applicable, in the master reference set.*

*Copies of the master reference set are maintained at the NMED Hazardous Waste Bureau and the ESH Directorate. The set was developed to ensure that the administrative authority has all material needed to review this document, and it is updated with every document submitted to the administrative authority. Documents previously submitted to the administrative authority are not included.*

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## 9.2 Map Data Sources

Data sources used in original figures created for this report are described below and identified by legend title.

Legend Item	Data Source
LANL Technical Areas	Technical Area Boundaries; Los Alamos National Laboratory, Site Planning & Project Initiation Group, Infrastructure Planning Office; September 2007; as published 04 December 2008.
Paved roads	Paved Road Arcs; Los Alamos National Laboratory, KSL Site Support Services, Planning, Locating and Mapping Section; 06 January 2004; as published 28 May 2009.
Dirt roads	Dirt Road Arcs; Los Alamos National Laboratory, KSL Site Support Services, Planning, Locating and Mapping Section; 06 January 2004; as published 28 May 2009.
Drainages	WQH Drainage Arcs; Los Alamos National Laboratory, ENV Water Quality and Hydrology Group; 1:24,000 Scale Data; 03 June 2003.
LANL AOC boundaries	Areas of Concern; Los Alamos National Laboratory, Waste and Environmental Services Division, Environmental Data and Analysis Group, EP2009-0137; 1:2,500 Scale Data; 25 January 2010.
LANL structures	Structures; Los Alamos National Laboratory, KSL Site Support Services, Planning, Locating and Mapping Section; 06 January 2004; as published 28 May 2009.
LANL fence lines	Security and Industrial Fences and Gates; Los Alamos National Laboratory, KSL Site Support Services, Planning, Locating and Mapping Section; 06 January 2004; as published 28 May 2009.
LANL communications lines	Communication Lines; Los Alamos National Laboratory, KSL Site Support Services, Planning, Locating and Mapping Section; 08 August 2002; as published 28 May 2009.
LANL electric lines	Primary Electric Grid; Los Alamos National Laboratory, KSL Site Support Services, Planning, Locating and Mapping Section; 06 January 2004; as published 28 May 2009.
LANL gas lines	Primary Gas Distribution Lines; Los Alamos National Laboratory, KSL Site Support Services, Planning, Locating and Mapping Section; 06 January 2004; as published 28 May 2009.
LANL sewer lines	Sewer Line System; Los Alamos National Laboratory, KSL Site Support Services, Planning, Locating and Mapping Section; 06 January 2004; as published 28 May 2009.
LANL water lines	Water Lines; Los Alamos National Laboratory, KSL Site Support Services, Planning, Locating and Mapping Section; 06 January 2004; as published 28 May 2009.
Contours	Hypsography, 2, 10, 20, and 100 Foot Contour Interval; Los Alamos National Laboratory, ENV Environmental Remediation and Surveillance Program; 1991.