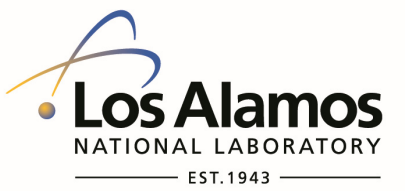
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Investigation Report for Area of Concern 01-007(k) in the Upper Los Alamos Canyon Aggregate Area, Revision 1



Prepared by the Environmental Programs Directorate

Los Alamos National Laboratory, operated by Los Alamos National Security, LLC, for the U.S. Department of Energy under Contract No. DE-AC52-06NA25396, has prepared this document pursuant to the Compliance Order on Consent, signed March 1, 2005. The Compliance Order on Consent contains requirements for the investigation and cleanup, including corrective action, of contamination at Los Alamos National Laboratory. The U.S. government has rights to use, reproduce, and distribute this document. The public may copy and use this document without charge, provided that this notice and any statement of authorship are reproduced on all copies.

EP2014-0471

Investigation Report for Area of Concern 01-007(k) in the Upper Los Alamos Canyon Aggregate Area, Revision 1

November 2014

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EXECUTIVE SUMMARY

This investigation report presents the investigation activities at one area of concern (AOC) located within the Upper Los Alamos Canyon Aggregate Area at Los Alamos National Laboratory (LANL or the Laboratory). The AOC [01-007(k)] is located in former Technical Area 01.

The objectives of this investigation are to define the nature and extent of contamination and, if defined, to determine whether the site poses a potential unacceptable risk or dose to human health or the environment. This report presents the results of site characterization activities conducted during a 2008 investigation, as directed by the approved investigation work plan for the Upper Los Alamos Canyon Aggregate Area. Sampling was conducted in 2013 at additional locations following removal of structures to complete the extent of contamination determination at the AOC with the intent of changing its status from corrective action complete with controls to corrective action complete without controls.

The investigation activities included collecting soil and tuff samples from the surface to a maximum depth of 6 ft below ground surface. Data from samples collected during the investigations meet current Laboratory data-quality requirements.

The sampling data presented in this report indicate the extent of contamination is defined at AOC 01-007(k). The human health risk-screening assessment results indicate no potential unacceptable risks or doses exist from chemicals of potential concern under the industrial, construction worker, and residential scenarios. The total excess cancer risks are below the New Mexico Environment Department (NMED) target risk level of 1×10^{-5}, the hazard indexes (HIs) are below the NMED target HI of 1, and the total doses are below the U.S. Department of Energy (DOE) target dose limit of 25 mrem/yr as authorized by DOE Order 458.1.

An ecological risk-screening assessment was conducted for AOC 01-007(k), and the results indicate no potential risks exist to any ecological receptors at the site.

No further investigation or remediation activities are necessary at AOC 01-007(k). Based on the risk-screening assessment results, the Laboratory recommends corrective actions complete without controls for AOC 01-007(k).

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Plate

Plate 1 Former TA-01 site map

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^2 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.

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 one site [AOC 01-007(k)] in former Technical Area 01 (TA-01) within the Upper Los Alamos Canyon Aggregate Area (Plate 1). The site is potentially contaminated with hazardous chemicals 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 at the Laboratory are subject to a Compliance Order on Consent (the Consent Order). This investigation report describes work activities that were completed in accordance with the Consent Order.

1.1 General Site Information

Figure 1.1-1 shows the location of Upper Los Alamos Canyon Aggregate Area and surrounding TAs. The Upper Los Alamos Canyon Aggregate Area consists of sites in seven TAs (TA-00, former TA-01, TA-03, former TA-32, TA-41, TA-43, and TA-61). The AOC described in this report is within former TA-01, which was the Laboratory's first TA. Beginning in 1943, it housed the Laboratory administration, theoretical divisions, plutonium chemistry, and physics research. Between 1943 and 1945, much of the theoretical, experimental, and production work in developing the atomic bomb took place at former TA-01. From 1946 to 1965, these activities were moved elsewhere in the Laboratory, and the site underwent decontamination and decommissioning (D&D) in 1966. The site of former TA-01 lies within the current town site of Los Alamos, on the south side of Trinity Drive surrounding Ashley Pond (Plate 1). The properties are owned privately, by Los Alamos County, and by DOE.

AOC 01-007(k) is located on, and surrounded by, private properties that are both developed and undeveloped. The majority of AOC 01-007(k) is situated on a parcel of private property that is currently vacant.

1.2 Purpose of Investigation

AOC 01-007(k) was investigated in 2008 as part of the Upper Los Alamos Canyon Aggregate Area Phase I investigation (LANL 2010, 108528). The NMED-approved investigation report concluded that the nature and extent of contamination are defined at AOC 01-007(k) and the site poses no potential unacceptable human-health risk under the residential scenario and there is no potential unacceptable ecological risk (LANL 2010, 108528; NMED 2010, 109195). Based on the results of the 2008 investigation, the Laboratory requested a certificate of completion for corrective action complete without controls for AOC 01-007(k) (LANL 2010, 109765). In response to this request, NMED issued a certificate of completion for corrective action complete with controls (NMED 2010, 110667). At the time of the 2008 investigation, a large portion of the AOC 01-007(k) footprint could not be characterized because it was occupied by the former Los Alamos Inn building. Therefore, the control for the site specified by NMED was to utilize the building as a means of preventing exposure to receptors from potential subsurface contamination under the structure. This control was considered to be effective as long as the existing structure remained intact. Further, the certificate of completion required that the Laboratory investigate potential contamination beneath the structure when it was demolished and removed. The Los Alamos Inn building has since been demolished, and additional sampling was performed in 2013 within and around the footprint of the former Los Alamos Inn to complete the investigation of AOC 01-007(k). This report presents the results of 2008 and 2013 investigation activities conducted at AOC 01-007(k).

1.3 Overview of Investigation Report

Section 1 presents general site information, the purpose of the investigations, and an overview of the site investigation. 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 sampling. Section 4 describes the regulatory criteria used to evaluate potential risk/dose to ecological and human receptors. Section 5 describes the data review methods. Section 6 presents an overview of the operational history of the site, historical releases, summary of previous investigations, results of the field activities performed during the investigations, site contamination, evaluation of the nature and extent of contamination, and summary of the results of the human health and ecological risk-screening assessments. Section 7 presents the conclusions of the nature and extent of contamination investigation and risk-screening assessments. Section 8 discusses recommendations based on applicable data and the risk-screening assessments. Section 9 includes a list of references cited and the map data sources used in all the figures and plates.

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 (Appendix D); analytical suites and results and analytical reports (Appendix E); box plots and statistical comparisons (Appendix F); and risk-screening assessments (Appendix G).

2.0 SITE CONDITIONS

2.1 Surface Conditions

2.1.1 Soil

Soil on the Pajarito Plateau was initially mapped and described by Nyhan et al. (1978, 005702). The soil on the slopes between the mesa tops and canyon floors has been mapped as mostly steep rock outcrops consisting of approximately 90% bedrock outcrop and patches of shallow, weakly developed colluvial soil.

South-facing canyon walls are generally steep and usually have shallow soil in limited, isolated patches between rock outcrops. In contrast, the north-facing canyon walls generally have more extensive areas of shallow dark-colored soil under thicker forest vegetation. The canyon floors generally contain poorly developed, deep, well-drained soil on floodplain terraces or small alluvial fans (Nyhan et al. 1978, 005702).

The soil on the mesa top in the Upper Los Alamos Canyon Aggregate Area generally belongs to either the Carjo or Pogna soil series (Nyhan et al. 1978, 005702). Carjo soil consists of moderately deep, well-drained, and moderately developed soils with an A-B-C horizon sequence. Soil textures can range from clay loams to fine, sandy loams. The Pogna soil consists of shallow, well-drained, and weakly developed soil with an A–C horizon sequence. The soil texture of Pogna soil is usually fine sandy loam. The parent material of the soil may range from Bandelier Tuff to sequences of alluvium/colluvium interstratified with moderately developed to well-developed buried soil.

A majority of the natural mesa-top surface soil has been altered by anthropogenic activities. Excavation and fill, paved roads, parking lots, parks, landscaped yards, and buildings have changed the natural soil landscape considerably.

2.1.2 Surface Water

The Rio Grande is the primary river in north-central New Mexico. All surface-water drainage and groundwater discharge from the plateau ultimately arrive at the Rio Grande. Most surface water in the Los Alamos area occurs as ephemeral, intermittent, or interrupted streams in canyons cut into the Pajarito Plateau. Springs on the flanks of the Jemez Mountains, west of the Laboratory's western boundary, supply flow to the upper reaches of Cañon de Valle and to Guaje, Los Alamos, Pajarito, and Water Canyons (Purtymun 1975, 011787; Stoker 1993, 056021). These springs discharge water perched in the Bandelier Tuff and Tschicoma Formation at rates from 2 to 135 gal./min (Abeele et al. 1981, 006273). The volume of flow from the springs maintains natural perennial reaches of varying lengths in each of the canyons.

Perennial flow occurs in the upper reaches of Los Alamos Canyon (west of the Los Alamos Reservoir). Typically, the overflow of water from the reservoir during spring snowmelt results in nearly continuous surface-water flow between the western Laboratory boundary and TA-02 for several weeks to several months each year (LANL 1995, 050290). Surface water in Los Alamos Canyon rarely flows across the entire length of the Laboratory. Most often, surface waters are depleted by infiltration into canyon alluvium, creating saturated zones of seasonally variable extent (LANL 1995, 050290).

The mesa-top portion of former TA-01 is now a commercially developed area. No natural surface water is present at this site. Ashley Pond is a closed water body maintained as a Los Alamos County beautification project. During summer thunderstorms and spring snowmelt, runoff flows from the mesa top down the hillsides and into the ephemeral stream in Los Alamos Canyon. Surface runoff from the former TA-01 mesa top enters Los Alamos Canyon by way of several primary drainages. Laboratory studies have indicated that relatively little surface water has infiltrated the underlying tuff at former TA-01 because of low infiltration and high evaporation rates (LANL 1992, 043454, pp. 3-6, 3-7).

2.1.3 Land Use

Currently, former TA-01 is a residential, commercial, and industrial-use area made up of private, Los Alamos County, and DOE lands. It includes both mesa-top and canyon-wall areas. The mesa-top portion of former TA-01 is situated outside the Laboratory's boundary, includes a portion of the Los Alamos townsite, and is located on the north and south sides of Trinity Drive. The mesa-top area of former TA-01 is owned by

Los Alamos County and private parties. The wall and floor of Los Alamos Canyon in former TA-01 lie within the Laboratory's boundary and are owned by DOE. Part of AOC 01-007(k) is situated on a parcel of private property that is currently vacant and surrounded by private properties that are both developed and undeveloped.

2.2 Subsurface Conditions

2.2.1 Stratigraphic Units

The stratigraphy of the Upper Los Alamos Canyon Aggregate Area is summarized in this section. Additional information on the geologic setting of the area and on the Pajarito Plateau can be found in the Laboratory's hydrogeological synthesis report (Collins et al. 2005, 092028).

The bedrock at or near the surface of the mesa top is the Bandelier Tuff. There are approximately 1250 ft of volcanic and sedimentary materials between any potential contaminant-bearing units at the mesa surface and the regional aquifer. The descriptions begin with the oldest (deepest) and proceed to the youngest (topmost).

The Bandelier Tuff consists of the Otowi and Tshirege Members, which are stratigraphically separated in many places by the tephras and volcaniclastic sediment of the Cerro Toledo interval. The Bandelier Tuff was emplaced during cataclysmic eruptions of the Valles Caldera between 1.61 and 1.22 million yr ago. The tuff is composed of pumice, minor rock fragments, and crystals supported in an ashy matrix. It is a prominent cliff-forming unit because of its generally strong consolidation (Broxton and Reneau 1995, 049726).

2.2.1.1 Otowi Member

Griggs and Hem (1964, 092516); Smith and Bailey (1966, 021584); Bailey et al. (1969, 021498); and Smith et al. (1970, 009752) describe the Otowi Member. It consists of moderately consolidated (indurated), porous, and nonwelded vitric tuff (ignimbrite) that forms gentle colluvium-covered slopes along the base of canyon walls. The Otowi ignimbrites contain light gray to orange pumice that is supported in a white to tan ash matrix (Broxton et al. 1995, 050121; Broxton et al. 1995, 050119; Goff 1995, 049682). The ash matrix consists of glass shards, broken pumice, and crystal fragments, and fragments of perlite.

2.2.1.2 Guaje Pumice Bed

The Guaje Pumice Bed occurs at the base of the Otowi Member, making a significant and extensive marker horizon. The Guaje Pumice Bed (Bailey et al. 1969, 021498; Self et al. 1986, 021579) contains well-sorted pumice fragments whose mean size varies between 0.8 and 1.6 in. Its thickness averages approximately 28 ft below most of the plateau, with local areas of thickening and thinning. Its distinctive white color and texture make it easily identifiable in borehole cuttings and core, and it is an important marker bed for the base of the Bandelier Tuff.

2.2.1.3 Tephras and Volcaniclastic Sediment of the Cerro Toledo Interval.

The Cerro Toledo interval is an informal name given to a sequence of volcaniclastic sediment and tephra of mixed provenance that separates the Otowi and Tshirege Members of the Bandelier Tuff (Broxton et al. 1995, 050121; Broxton and Reneau 1995, 049726; Goff 1995, 049682). Although it is located between the two members of the Bandelier Tuff, it is not considered part of that formation (Bailey et al. 1969,

021498). Outcrops of the Cerro Toledo interval generally occur wherever the top of the Otowi Member appears in Mortandad Canyon and in canyons to the north. The unit contains primary volcanic deposits described by Smith et al. (1970, 009752) as well as reworked volcaniclastic sediment. The occurrence of the Cerro Toledo interval is widespread; however, its thickness is variable, ranging between several feet and more than 100 ft.

The predominant rock types in the Cerro Toledo interval are rhyolitic tuffaceous sediment and tephra (Heiken et al. 1986, 048638; Stix et al. 1988, 049680; Broxton et al. 1995, 050121; Goff 1995, 049682). The tuffaceous sediment is the reworked equivalents of Cerro Toledo rhyolite tephra. Oxidation and clay-rich horizons indicate at least two periods of soil development occurred within the Cerro Toledo deposits. Because the soil is rich in clay, it may act as a barrier to the movement of vadose zone moisture. Some of the deposits contain both crystal-poor and crystal-rich varieties of pumice. The pumice deposits tend to form porous and permeable horizons within the Cerro Toledo interval and locally may provide important pathways for moisture transport in the vadose zone. A subordinate lithology within the Cerro Toledo interval includes clast-supported gravel, cobble, and boulder deposits derived from the Tschicoma Formation (Broxton et al. 1995, 050121; Goff 1995, 049682; Broxton and Reneau 1996, 055429).

2.2.1.4 Tshirege Member

The Tshirege Member of the Bandelier Tuff (Qbt) and is the upper member and the most widely exposed bedrock unit of the Pajarito Plateau (Griggs and Hem 1964, 092516; Smith and Bailey 1966, 021584; Bailey et al. 1969, 021498; Smith et al. 1970, 009752). Emplacement of this unit occurred during eruptions of the Valles Caldera approximately 1.2 million yr ago (Izett and Obradovich 1994, 048817; Spell et al. 1996, 055542). The Tshirege Member is a multiple-flow, ash-and-pumice sheet that forms the prominent cliffs in most of the canyons on the Pajarito Plateau. It is a cooling unit whose physical properties vary vertically and laterally. The consolidation in this member is largely from compaction and welding at high temperatures after the tuff was emplaced. Its light brown, orange-brown, purplish, and white cliffs have numerous, mostly vertical fractures that may extend from several feet up to several tens of feet. The Tshirege Member includes thin but distinctive layers of bedded, sand-sized particles called surge deposits that demark separate flow units within the tuff. The Tshirege Member is generally over 200 ft thick.

The Tshirege Member differs from the Otowi Member most notably in its generally greater degree of welding and compaction. Time breaks between the successive emplacement of flow units caused the tuff to cool as several distinct cooling units. For this reason, the Tshirege Member consists of at least four cooling subunits that display variable physical properties vertically and horizontally (Smith and Bailey 1966, 021584; Crowe et al. 1978, 005720; Broxton et al. 1995, 050121). The welding and crystallization variability in the Tshirege Member produce recognizable vertical variations in its properties, such as density, porosity, hardness, composition, color, and surface-weathering patterns. The subunits are mappable based on a combination of hydrologic properties and lithologic characteristics.

Broxton et al. (1995, 050121) provide extensive descriptions of the Tshirege Member cooling units. The following paragraphs describe, in ascending order, subunits of the Tshirege Member.

The Tsankawi Pumice Bed forms the base of the Tshirege Member. Where exposed, it is commonly 20 to 30 in. thick. This pumice-fall deposit contains moderately well-sorted pumice lapilli (diameters reaching about 2.5 in.) in a crystal-rich matrix. Several thin ash beds are interbedded with the pumice-fall deposits.

Subunit Qbt 1g is the lowermost tuff subunit of the Tshirege Member. It consists of porous, nonwelded, and poorly sorted ash-flow tuff. This unit is poorly indurated but nonetheless forms steep cliffs because of a resistant bench near the top of the unit; the bench forms a harder, protective cap over the softer underlying tuff. A thin (4 to 10 in.) pumice-poor surge deposit commonly occurs at the base of this unit.

Subunit Qbt 1v forms alternating cliff like and sloping outcrops composed of porous, nonwelded, crystallized tuff. The base of this unit is a thin, horizontal zone of preferential weathering that marks the abrupt transition from glassy tuff below (in Unit Qbt 1g) to the crystallized tuff above. This feature forms a widespread marker horizon (locally termed the vapor-phase notch) throughout the Pajarito Plateau that is readily visible in canyon walls in parts of Mortandad Canyon. The lower part of Qbt 1v is orange-brown, resistant to weathering, and has distinctive columnar (vertical) joints; hence, the term “colonnade tuff” is appropriate for its description. A distinctive white band of alternating cliff- and slope-forming tuffs overlies the colonnade tuff. The tuff of Qbt 1v is commonly nonwelded (pumices and shards retain their initial equant shapes) and have an open, porous structure.

Unit Qbt 2 forms a distinctive, medium-brown, vertical cliff that stands out in marked contrast to the slope-forming, lighter-colored tuff above and below. It displays the greatest degree of welding in the Tshirege Member. A series of surge beds commonly mark its base. It typically has low porosity and permeability relative to the other units of the Tshirege Member.

Unit Qbt 3 is a nonwelded to partially welded, vapor-phase-altered tuff that forms the upper cliffs in Mortandad Canyon. Its base consists of a purple-gray, unconsolidated, porous, and crystal-rich nonwelded tuff that forms a broad, gently sloping bench developed on top of Qbt 2. Abundant fractures extend through the upper units of the Bandelier Tuff, including the ignimbrite of unit Qbt 3 of the Tshirege. The origin of the fractures has not been fully determined, but the most probable cause is brittle failure of the tuff caused by cooling contraction soon after initial emplacement (Vaniman 1991, 009995.1; Wohletz 1995, 054404).

2.2.2 Hydrogeology

The hydrogeology of the Pajarito Plateau is generally separable in terms of mesas and canyons forming the plateau. Mesas are generally devoid of water, both on the surface and within the rock forming the mesa. Canyons range from wet to relatively dry; the wettest canyons contain continuous streams and perennial groundwater in the canyon-bottom alluvium. Dry canyons have only occasional streamflow and may lack alluvial groundwater. Intermediate-perched groundwater has been found at certain locations on the plateau at depths ranging between 100 and 400 ft. The regional aquifer is found at depths of about 600 to 1200 ft (Collins et al. 2005, 092028).

Watershed-specific hydrogeologic conceptual site models for the Laboratory show that, under natural conditions, relatively small volumes of water move beneath mesa tops because of low rainfall, high evaporation, and efficient water use by vegetation. Atmospheric evaporation may extend into mesas, further inhibiting downward flow.

2.2.2.1 Groundwater

In the Los Alamos area, groundwater occurs as (1) water in shallow alluvium in some of the larger canyons; (2) intermediate-perched groundwater (a perched groundwater body lies above a less permeable layer and is separated from the underlying aquifer by an unsaturated zone); and (3) the regional aquifer (Collins et al. 2005, 092028). Numerous wells have been installed at the Laboratory and in the surrounding area to investigate the presence of groundwater in these zones and to monitor groundwater quality.

The Laboratory formulated a comprehensive groundwater protection plan for an enhanced set of characterization and monitoring activities. The Laboratory's Interim Facility-Wide Groundwater Monitoring Plan (the Interim Plan) (LANL 2013, 241962) details the implementation of extensive groundwater characterization across the Pajarito Plateau within an area potentially affected by past and present Laboratory operations.

Alluvial Groundwater

Intermittent and ephemeral streamflow in the canyons of the Pajarito Plateau have deposited alluvium that can be as thick as 100 ft. The alluvium in canyons of the Jemez Mountains is generally composed of sand, gravel, pebbles, cobbles, and boulders derived from the Tschicoma Formation and Bandelier Tuff. The alluvium in canyons of the Pajarito Plateau is finer-grained, consisting of clay, silt, sand, and gravel derived from the Bandelier Tuff (Purtymun 1995, 045344).

In contrast to the underlying volcanic tuff and sediment, alluvium is relatively permeable. Ephemeral runoff in some canyons infiltrates the alluvium until downward movement is impeded by the less permeable tuff and sediment, which results in the buildup of a shallow alluvial groundwater body. Depletion by evapotranspiration and movement into the underlying rock limit the horizontal and vertical extent of the alluvial water (Purtymun et al. 1977, 011846). The limited saturated thickness and extent of the alluvial groundwater preclude its use as a viable source of water for municipal and industrial needs. Lateral flow of the alluvial perched groundwater is in an easterly, downcanyon direction (Purtymun et al. 1977, 011846).

Two saturated zones are known to exist in the alluvium of Los Alamos Canyon. The first is in the upper part of Los Alamos Canyon and extends eastward from the Los Alamos Reservoir to the vicinity of observation well LAO-4.5, west of NM 4. The second is in the lower part of Los Alamos Canyon and extends from Basalt Spring to the Rio Grande. In middle and upper Los Alamos Canyon, the saturated thickness in the alluvium varies seasonally from a few feet in the winter months to 25 ft in the spring and summer months when recharge is the greatest (LANL 1994, 052951.71).

Intermediate-Perched Water

Two intermediate-perched zones between the alluvial water and the regional aquifer, one beneath the other, have been encountered in Los Alamos Canyon between TA-02 and the confluence with DP Canyon. The upper intermediate-perched zone occurs within the Guaje Pumice Bed. This zone was encountered in boreholes LADP-3 (at 325 ft) and LAOI(A)-1.1 (at 295 ft) (Broxton et al. 1995, 050119; Longmire et al. 1996, 054168). The saturated thickness of this zone decreases from west to east, ranging between 22 ft at LAOI(A)-1.1 and 5 ft at LADP-3. A deeper intermediate-perched zone was encountered in LAOI(A)-1.1 in the Puye Formation at approximately 317 ft. However, no deeper intermediate-perched zone was found at LADP-3 in the approximately 19 ft of the Puye Formation that was penetrated. Although no perched aquifers are known to exist in the immediate vicinity of former TA-01, a perched aquifer has been located at an intermediate depth (325 ft below Los Alamos Canyon) in drill hole LADP-3 at TA-21, approximately 2 mi (3 k) east of the site (Broxton et al. 1995, 050119; Longmire et al. 1996, 054168).

Regional Aquifer

The regional aquifer of the Los Alamos area is the only aquifer capable of large-scale municipal water supply (Purtymun 1984, 006513). The surface of the regional aquifer rises westward from the Rio Grande within the Santa Fe Group into the lower part of the Puye Formation beneath the central and western part

of the Pajarito Plateau. The depths to groundwater below the mesa tops range between about 1200 ft along the western margin of the plateau and about 600 ft at the eastern margin. The location of wells and the generalized water-level contours on top of the regional aquifer are described in the Interim Plan (LANL 2013, 241962). The regional aquifer is typically separated from the alluvial groundwater and intermediate-perched zone groundwater by 350 to 620 ft of tuff, basalt, and sediment (LANL 1993, 023249).

Groundwater in the regional aquifer flows east-southeast, toward the Rio Grande. The velocity of groundwater flow ranges from about 20 to 250 ft/yr (LANL 1998, 058841, pp. 2-7). Details of depths to the regional aquifer, flow directions and rates, and well locations are presented in various Laboratory documents (Purtymun 1995, 045344; LANL 1997, 055622; LANL 2000, 066802).

The regional aquifer beneath East Mesa is at an elevation of approximately 6000 ft in the sediment of the Puye and Totavi formations. At mesa-top sites of the Upper Los Alamos Canyon Aggregate Area, the surface is separated from the regional aquifer by an unsaturated zone that is 1000 to 1300 ft thick.

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 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.

Although water moves slowly through the unsaturated tuff matrix, it can move rapidly through fractures if saturated conditions exist (Hollis et al. 1997, 063131). Fractures may provide conduits for fluid flow but probably only in discrete, disconnected intervals of the subsurface. Because they are open to the passage of both air and water, fractures can have both wetting and drying effects, depending on the relative abundance of water in the fractures and the tuff matrix.

The Bandelier Tuff is very 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 of transpiration by vegetation, which flourishes during 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 native tuff 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

The Upper Los Alamos Canyon Aggregate Area investigation work plan was submitted to NMED in April 2006 (LANL 2006, 091916), and the Laboratory received a notice of disapproval (NOD) in August 2006 (NMED 2006, 093541). A response to the NOD was submitted to NMED (LANL 2006, 094200), and the investigation work plan was subsequently approved in November 2006 (NMED 2006, 095460). Site investigations began in 2008–2009 and additional samples were collected at several sites, including AOC 01-007(k), in 2013.

The samples were analyzed for the following: target analyte list (TAL) metals, cyanide (total), nitrate, perchlorate, polychlorinated biphenyls (PCBs), semivolatile organic compounds (SVOCs), volatile organic compounds (VOCs), americium-241, gamma-emitting radionuclides, isotopic plutonium, isotopic uranium, strontium-90, and tritium.

The following sections describe the scope of activities conducted during the 2008–2009 investigation of the Upper Los Alamos Aggregate Area. Appendix B describes the methods and procedures used in completing the scope.

3.1 Geodetic Survey

Geodetic surveys were conducted to locate surface and subsurface sampling locations. Initial geodetic surveys were performed to establish and mark the planned sampling locations in the field. Geodetic surveys were conducted at the completion of the sampling campaign to establish the spatial coordinates for all sampling locations. Geodetic surveys were conducted in accordance with 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 3.1-1. All geodetic coordinates are expressed as State Plane Coordinate System 1983, New Mexico Central, U.S.

3.2 Field Screening

Environmental samples were analyzed for organic vapors with a MiniRAE 2000 photoionization detector (PID) equipped with an 11.7 electronvolt (eV) or 10.6 eV lamp. Calibration was performed in accordance with the manufacturer's specifications and SOP-06.33, Headspace Vapor Screening with a Photoionization Detector, and recorded in the field logbook. After it was collected, the sample was placed in a sealed plastic bag for approximately 5 min to allow soil and vapor concentrations to equilibrate. Screening measurements were recorded in the field 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 screening results are presented in Table 3.2-2.

All samples collected were field-screened for radioactivity before they were submitted to the Sample Management Office (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. All field results for radioactivity were recorded in disintegrations per minute (dpm) on the field SCL/COCs. The SCLs and COC forms are provided on CD in Appendix E. The radiological screening results are presented in Table 3.2-2.

3.3 Collection of Soil, Fill, and Tuff Samples

Samples were collected in 2008–2009 according to the work plan (LANL 2006, 091916) and subsequent revisions (LANL 2006, 094200) and NMED's approval with modifications (NMED 2006, 095460). Additional samples were collected in 2013.

Surface and shallow subsurface 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. Samples for VOC analysis were collected first and immediately transferred to containers to minimize loss.

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. Standard quality assurance/quality control 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 on CD in Appendix E).

3.4 Equipment Decontamination

All field equipment that had the potential to contact sample material (e.g., hand augers, sampling scoops, bowls, core-barrel sections) was decontaminated between sample collections and between sampling locations to prevent cross-contamination of samples and sampling equipment. Decontamination was performed in accordance with EP-ERSS-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.

3.5 Storage and Disposal of Investigation-Derived Waste

The IDW generated as a result of field-investigation activities included drill cuttings, excavated material (soil, asphalt, and concrete pavement removed to access the material below, cast-iron pipe), used personal protective equipment, and miscellaneous materials used during dry decontamination of sampling equipment (e.g., paper towels and nitrile gloves). The IDW was characterized as specified in the approved waste characterization strategy form (WCSF). All waste was placed in approved containers, and was managed in accordance with EP-DIR-SOP-10021, “Characterization and Management of Environmental Program Waste.” The management of IDW is described in Appendix C. All available waste documentation, including WCSFs, WCSF amendments, and waste profile forms, are provided in Appendix C.

3.6 Deviations

There were no deviations from the approved work plan. Deviations associated with the 2013 sampling are presented in Appendix B.

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 site using NMED and Laboratory guidance (LANL 2012, 228852; NMED 2012, 219971). 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 AOC 01-007(k) is currently commercial/industrial. A construction worker scenario is evaluated because underground utilities are present near or within the boundary of the AOC, and maintenance or repair of these underground utilities is a reasonable possibility in the foreseeable future. Also it is anticipated that a building will be constructed on the site in the reasonably foreseeable future. The residential scenario is also evaluated as a reasonably foreseeable future land use 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 chemicals of potential concern (COPCs) detected in solid media at the site. The human health risk-screening assessments (Appendix G) were performed on inorganic and organic COPCs using NMED soil screening levels (SSLs) for the industrial, construction worker, and residential scenarios (NMED 2012, 219971). 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) (adjusted to a risk level of 10^{-5} for carcinogens). Radionuclides were assessed using the Laboratory screening action levels (SALs) for the same scenarios (LANL 2012, 228852).

Total chromium does not have an NMED or EPA SSL. Because the toxicity of chromium strongly depends on its oxidation state, NMED and EPA have SSLs for trivalent chromium and hexavalent chromium rather than total chromium. For screening purposes, the SSLs for trivalent chromium are used for comparison with total chromium results unless there is a known or suspected source of hexavalent chromium at the SWMU or AOC, and hexavalent chromium was not analyzed for in the samples. This approach is consistent with guidance from the Texas Commission on Environmental Quality (Stone 2002, 243627), which indicates comparison of total chromium results with trivalent chromium screening levels is appropriate for low-level releases to soil from sources not typically associated with hexavalent chromium. Similarly, EPA recommends collecting valence-specific data for chromium when chromium is likely to be an important contaminant at a site and when hexavalent chromium may exist (http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm). Otherwise, total chromium data are used.

AOC 01-007(k) is not a known or suspected source of hexavalent chromium, and samples from this site were analyzed for total chromium only. Total chromium results are screened using the SSLs for trivalent chromium.

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 3.1 (LANL 2012, 226667). The ESLs are based on similar species and are derived from experimentally determined no observed adverse effect levels, lowest observed adverse effect levels, 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 3.1 (LANL 2012, 226667).

4.4 Cleanup Standards

As specified in the Consent Order, SSLs for inorganic and organic chemicals (NMED 2012, 219971) 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 2012, 228852). Screening assessments compare COPC concentrations for each site with industrial, residential, and construction worker 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 contaminants for the AOC. The nature of a contaminant refers to the specific contaminants present, the affected media, and associated concentrations. The nature of contamination is defined through identification of COPCs, which is discussed in section 5.1. The identification of a chemical or radionuclide as a COPC does not mean the constituent(s) is related to the site and a result of site operations. A COPC is identified because it is present at a site based on the criteria discussed below but might be present as a result of operations at adjacent and/or upgradient sites, and/or infrastructure typical of industrial and metropolitan development. If such origins are evident, the constituents may be excluded from the data analyses and risk assessments. 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 SWMUs or AOCs. 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 exist, 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-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 unless available information indicates it is not present as a result of a release from the SWMU or AOC).

Organic chemicals may also be present as a result of anthropogenic activities unrelated to the SWMU or AOC or, to a lesser extent, from natural sources. Because no background data are available 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., the organic chemical is detected). 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 SWMU

or AOC or is present from non-site-related sources. Organic chemicals that are clearly present from sources other than releases from a SWMU or AOC (e.g., polycyclic aromatic hydrocarbons [PAHs]) may be eliminated as COPCs and not evaluated further.

5.1.1 Inorganic Chemical and Radionuclide Background Comparisons

The COPCs are identified for inorganic chemicals and radionuclides following SOP-5245, Background Value Comparisons—Inorganic Chemicals, and SOP-5246, Background Value Comparisons—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 95^{th} 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 (10 or more sampling results), statistical tests are used to compare the site sample 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 and the maximum background concentration for the appropriate media. If at least one sampling result is above the BV and the maximum background concentration, the inorganic chemical is identified as a COPC. The same evaluation is performed using DLs when an inorganic chemical is not detected but has a DL above the BV. Other lines of evidence are also used to support whether the inorganic chemical is not a COPC, when available. 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 have no background 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 below ground surface (bgs) or less, if the activity of a fallout radionuclide is greater than the FV, comparisons of the top 0.0–1.0 ft sample data are made with the fallout data set and the radionuclide is eliminated as a COPC if activities are similar to fallout activities is based on statistical comparisons or comparisons to the maximum fallout concentration. 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.

Sample media encountered during the investigations include soil (all soil horizons, designated by the media code ALLH or SOIL); fill material (media code FILL); and Bandelier Tuff (media codes Qbt2, Qbt3, and Qbt4). Because no separate BVs are available for fill material, fill samples are evaluated by comparison with soil BVs (LANL 1998, 059730). In this report, the discussions of site contamination in soil include fill samples with soil samples in sample counts and comparisons to background. Fill samples are not discussed separately from soil. The units of the upper Bandelier Tuff (Qbt2, Qbt3, and Qbt4) are likewise evaluated together with respect to background (LANL 1998, 059730).

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 data. The results of the statistical tests are presented in Appendix G tables.

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 an 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 80th 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 look for 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.

Occasionally, 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" (or more) site samples exceed the maximum background concentration by chance alone. The test accounts for the number of samples in each data set (number of samples from the site and 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 less than 0.05 was the criterion for accepting the null hypothesis that site sampling results are not different from background.

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 DL.

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 25th percentile and the 75th percentile of the data, the interquartile range or middle half of the data. The horizontal line within the box represents the median (50th 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 with 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, comparison with the relevant SSL/SAL may also be conducted if the residential SSL/SAL is exceeded or otherwise similar to COPC concentrations. For AOC 01-007(k), the current and reasonably foreseeable future land use is commercial/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 needing 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 recommended daily allowances. If the maximum concentration is less than the recommended daily allowance, no additional sampling for extent is warranted.

6.0 TA-01 BACKGROUND AND FIELD-INVESTIGATION RESULTS

6.1 Background of Former TA-01

Former TA-01 is a residential, commercial, and industrial-use area made up of private, Los Alamos County, and DOE lands. It includes both mesa-top and canyon-slope areas.

Starting in 1976, land located in former TA-01 was transferred from DOE to Los Alamos County and private parties. Except for the sites located on the slope of Los Alamos Canyon that are still on DOE land, the majority of these sites are located within the Los Alamos townsite on private land or County property.

These sites have been backfilled, regraded, and recontoured and have undergone significant construction since the property transfer. No evidence of previous TA-01 Laboratory structures exists in the area.

The former TA-01 sites are located on or next to County, commercial, and private as well as DOE property. Many sites are paved with either concrete or asphalt, are under buildings, or are in lawns next to private residences. Some sites are located on both the mesa-top and south-facing slope in Los Alamos Canyon, while others are entirely on south-facing slope or entirely on the mesa top.

Much of the natural mesa-top soil in former TA-01 has been replaced by fill material during various remediation, construction, and landscaping activities (LANL 2006, 091915; LANL 2006, 091916). The canyon slope consists mainly of bare tuff with only small, isolated pockets of soil and sediment. Media encountered during surface and near-surface sampling at former TA-01 included soil, fill, sediment, and tuff (Qbt 3 and Qbt 1g).

Vegetation at mesa-top sites consists of nonnative grasses, trees, and shrubs planted by property owners. Vegetation on the canyon slope and in the canyon bottom consists of widely scattered native trees and shrubs, including ponderosa pine, piñon pine, juniper, and an understory of native grasses.

6.1.1 Operational History

The approximately 50-acre mesa-top area of former TA-01 was the location of the initial Los Alamos Scientific Laboratory from 1943 to 1965. During this time, research work on nuclear weapons was carried out. Most of these locations are currently beneath paved roads, parking lots, commercial buildings, or townhouses, which comprise a major portion of the present-day Los Alamos townsite. Operations at former TA-01 were gradually relocated to new TAs from 1945 to 1965. Phased D&D activities began at former TA-01 in 1953 and continued through 1976 (Ahlquist et al. 1977, 005710, p. 2).

AOC 01-007(k) is an area of suspected subsurface soil contamination. Subsurface contamination may be present in soil beneath and next to former TA-01 buildings. The suspected soil contamination could have resulted from original Laboratory operations.

6.1.2 Summary of Releases

Potential contaminants at former TA-01 may have been released into the environment from septic systems, the industrial waste line, drainlines, and storm water drainages that occurred as a result of normal site operations (e.g., discharges from outfalls) and accidental spills or releases. No documentation exists to estimate the volumes or rates of the flow of the effluent from septic system outlet pipes, industrial waste line, drainlines, or storm water drainages to outfalls.

6.1.3 Current Site Usage

Former TA-01 is almost completely developed. Roads and large paved parking areas surround the buildings. Unpaved areas are usually landscaped.

Currently, the footprint of former buildings U and W [AOC 01-007(k)] encompasses the building footprint of the former Los Alamos Inn (now a vacant lot), is under portions of existing buildings, and is partially covered by asphalt paved parking areas (Figures 6.1-1 and 6.1-2).

6.2 AOC 01-007(k), Soil Contamination

6.2.1 Site Description and Operational History

AOC 01-007(k) is a suspected soil-contamination area located beneath former buildings U and W (LANL 1992, 043454, p. 1-13) (Figure 6.2-1). Constructed in 1943, former buildings U and W contained physics laboratories used to conduct experiments involving uranium-235, uranium-238, radium-226, carbon-14, polonium-210, and tritium. In 1959, buildings U and W were removed from service and subsequently destroyed.

6.2.2 Relationship to Other SWMUs and AOCs

AOC 01-007(k) is the footprint of former buildings U and W in the Los Alamos townsite along Diamond Drive. No other SWMUs or AOCs are associated with this site.

6.2.3 Summary of Previous Investigations

Sampling was conducted at AOC 01-007(k) in 2008 as part of the initial Upper Los Alamos Canyon Aggregate Area investigations. The results of the 2008 investigations were included in the Investigation Report for Upper Los Alamos Canyon Aggregate Area, Revision 1. NMED subsequently issued a certificate of completion with controls on September 10, 2010, for AOC 01-007(k). Site characterization was considered incomplete pending the removal of structures located on the site. The presence of existing structures was considered adequate controls for the site at that time. Subsequently, the structures were demolished and additional samples were collected in 2013 to complete the characterization of the site with the intent of changing its status from corrective action complete with controls to corrective action complete without controls.

The data presented and analyzed in this report includes all previously collected data as well as data collected in 2013 data.

6.2.4 Site Contamination

6.2.4.1 Soil, Rock, and Sediment Sampling

The sampling locations at AOC 01-007(k) are shown in Figure 6.2-1. Table 6.2-1 provides the sampling locations, depths, and the analyses requested. Coordinates of sampling locations are presented in Table 3.1-1. Sampling at AOC 01-007(k) consisted of the following activities in 2008 and 2013:

- Six samples were collected from 3 locations and 2 depth intervals.
- Forty-two samples were collected from 14 locations and 3 depth intervals.

Samples were analyzed at off-site fixed laboratories for TAL metals, nitrate, perchlorate, total cyanide, PCBs, SVOCs, VOCs, americium-241, gamma-emitting radionuclides, isotopic plutonium, isotopic uranium, strontium-90, and tritium.

6.2.4.2 Soil, Rock, and Sediment Field-Screening Results

No elevated organic vapors were detected during PID screening. No radiological screening results exceeded twice the daily site background levels. No changes to sampling or other activities occurred because of field-screening results. The field-screening results are presented in Table 3.2-2.

6.2.4.3 Soil, Rock, and Sediment Sampling Analytical Results

Decision-level data collected at AOC 01-007(k) consist of 48 samples (11 soil and 37 tuff) collected from 17 locations.

Inorganic Chemicals

Forty-eight samples were analyzed for TAL metals, nitrate, perchlorate, and total cyanide. Table 6.2-2 presents the inorganic chemicals above BVs and detected inorganic chemicals that have no BVs. Figure 6.2-2 shows the spatial distribution of inorganic chemicals detected or detected above BVs.

Aluminum was detected above the Qbt 2,3,4 BV (7340 mg/kg) in five samples with a maximum concentration of 12,100 mg/kg. The Gehan and quantile tests indicated site concentrations of aluminum in tuff are not statistically different from background (Figure F-1 and Table F-1). 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 (0.57 mg/kg to 1.23 mg/kg) above the BVs in 43 samples (90% of samples); 5 samples collected in 2008 had DLs below the BVs. The 43 DLs were also above the maximum soil and Qbt 2,3,4 background concentrations (1 mg/kg and 0.4 mg/kg). Based on these lines of evidence, 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 2.9 mg/kg. The Gehan test indicated arsenic in tuff is statistically different from background, but the quantile and slippage tests indicated site concentrations of arsenic in tuff are not statistically different from background (Figure F-2 and Table F-1). Arsenic is not a COPC.

Barium was detected above the Qbt 2,3,4 BV (46 mg/kg) in six samples with a maximum concentration of 87.4 mg/kg. The Gehan and quantile tests indicated site concentrations of barium in tuff are not statistically different from background (Figure F-3 and Table F-1). Barium is not a COPC.

Beryllium was detected above the soil and Qbt 2,3,4 BVs (1.83 mg/kg and 1.21 mg/kg) in one soil sample and one tuff sample with a maximum concentration of 1.84 mg/kg. The Gehan test indicated beryllium in soil is statistically different from background, but the quantile and slippage tests indicated site concentrations of beryllium in soil are not statistically different from background (Figure F-4 and Table F-2). The Gehan and quantile tests indicated site concentrations of beryllium in tuff are not statistically different from background (Figure F-5 and Table F-1). Beryllium is not a COPC.

Cadmium was not detected above the soil BV (0.4 mg/kg) but had DLs (0.503 mg/kg to 0.615 mg/kg) above the BV in 11 soil samples. The DLs were only 0.103 mg/kg to 0.215 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 11 soil samples and was not detected above BVs in the 48 samples (detected in 5 samples below the Qbt 2,3,4 BV). The detected concentrations of cadmium (0.014 mg/kg to 0.107 mg/kg) are well below all BVs and indicate that cadmium, when present, is below BVs. If an assumption is made that all the DLs above the soil BV are detects, the quantile and slippage tests indicate the data sets are not statistically different (p-values = 0.135 and 1, respectively). Based on these lines of evidence, cadmium is not a COPC.

Calcium was detected above the soil and Qbt 2,3,4 BVs (6120 mg/kg and 2200 mg/kg) in two soil samples and nine tuff samples with a maximum concentration of 9960 mg/kg. The Gehan test indicated calcium in soil is statistically different from background, but the quantile and slippage tests indicated site concentrations of calcium in soil are not statistically different from background (Figure F-6 and Table F-2).

The Gehan and quantile tests indicated site concentrations of calcium in tuff are statistically different from background (Figure F-7 and Table F-1). Calcium is retained as a COPC.

Chromium was detected above the Qbt 2,3,4 BV (7.14 mg/kg) in seven samples with a maximum concentration of 21.3 mg/kg. The Gehan and quantile tests indicated site concentrations of chromium in tuff are statistically different from background (Figure F-8 and Table F-1). Chromium is retained as a COPC.

Cobalt was detected above the Qbt 2,3,4 BV (3.14 mg/kg) in two samples with a maximum concentration of 4.04 mg/kg. The Gehan and quantile tests indicated site concentrations of cobalt in tuff are not statistically different from background (Figure F-9 and Table F-1). Cobalt is not a COPC.

Copper was detected above the Qbt 2,3,4 BV (4.66 mg/kg) in four samples with a maximum concentration of 159 mg/kg. The Gehan and slippage tests indicated site concentrations of copper in tuff are statistically different from background (Figure F-10 and Table F-1). Copper is retained as a COPC.

Cyanide was not detected above the Qbt 2,3,4 BV (0.5 mg/kg) but had DLs (0.58 mg/kg to 0.62 mg/kg) above the BV in 4 tuff samples. The DLs were only 0.08 mg/kg to 0.12 mg/kg above the Qbt 2,3,4 BV. The other 44 samples had DLs (0.11 mg/kg to 0.3 mg/kg) below the soil and Qbt 2,3,4 BVs. Cyanide was not detected in any of the 48 samples. The data indicate cyanide is not present at the site above BVs. Based on these lines of evidence, cyanide is not a COPC.

Lead was detected above the soil and Qbt 2,3,4 BVs (22.3 mg/kg and 11.2 mg/kg) in four soil samples and seven tuff samples with a maximum concentration of 46.4 mg/kg. The Gehan and quantile tests indicated site concentrations of lead in soil are statistically different from background (Figure F-11 and Table F-2). The Gehan and quantile tests indicated site concentrations of lead in tuff are statistically different from background (Figure F-12 and Table F-1). Lead is retained as a COPC.

Magnesium was detected above the Qbt 2,3,4 BV (1690 mg/kg) in four samples with a maximum concentration of 2420 mg/kg. The Gehan test indicated magnesium in tuff is statistically different from background, but the quantile and slippage tests indicated site concentrations of magnesium in tuff are not statistically different from background (Figure F-13 and Table F-1). Magnesium is not a COPC.

Mercury was detected above the soil and Qbt 2,3,4 BVs (0.1 mg/kg) in one soil sample and one tuff sample with a maximum concentration of 0.716 mg/kg. Mercury is retained as a COPC.

Nickel was detected above the Qbt 2,3,4 BV (6.58 mg/kg) in nine samples with a maximum concentration of 10.3 mg/kg. The quantile and slippage tests indicated site concentrations of nickel in tuff are statistically different from background (Figure F-14 and Table F-1). Nickel is retained as a COPC.

Nitrate was detected in 18 samples with a maximum concentration of 3.1 mg/kg. Although nitrate is naturally occurring and the concentrations likely reflect naturally occurring levels, nitrate is retained as a COPC.

Perchlorate was detected in 12 samples with a maximum concentration of 0.00499 mg/kg. Perchlorate is retained as a COPC.

Selenium was detected above the Qbt 2,3,4 BV (0.3 mg/kg) in 3 samples with a maximum concentration of 0.557 mg/kg and had DLs (0.57 mg/kg to 1.17 mg/kg) above the BV in 34 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 two soil samples and one tuff sample with a maximum concentration of 393 mg/kg. The Gehan and quantile tests indicated site

concentrations of zinc in soil are statistically different from background (Figure F-15 and Table F-2). The Gehan and quantile tests indicated site concentrations of zinc in tuff are not statistically different from background (Figure F-16 and Table F-1). Zinc is retained as a COPC.

Organic Chemicals

Forty-eight samples were analyzed for SVOCs, VOCs, and PCBs. Table 6.2-3 summarizes the analytical results for detected organic chemicals. Figure 6.2-3 shows the spatial distribution of detected organic chemicals.

PAHs

PAHs are a class of SVOCs frequently detected as a result of environmental sampling but generally were not released from the SWMUs or AOCs being investigated. PAHs unrelated to site activities are thus often detected in samples analyzed for the presence of site related SVOCs.

PAHs are known to be widely distributed in the environment from a number of sources, both natural, such as forest fires, and anthropogenic, such as combustion of fossil fuels, oil drips off motor vehicles, vehicle tires, coal tar pitch, and weathering or eroding of asphalt pavement (Kose et al. 2008, 219977; Teaf 2008, 219976). PAHs from these sources generally occur as complex mixtures, not as single compounds. Individual PAH compounds can be manufactured for research purposes and some PAHs (e.g., anthracene, fluorene, naphthalene, and pyrene) are used in dye production, in the manufacture of synthetic fibers, and in plastics and pesticides.

The principal sources of PAHs in soil along parking lots, roads and highways are vehicular exhaust and emissions, the wearing of tires, and asphalt. PAH-containing materials, such as asphalt and rubber particles, do not easily dissolve in water, thus preventing migration, except as suspended particles in storm water. PAH concentrations in excess of soil cleanup levels may result from common anthropogenic sources such as runoff from asphalt paved areas (e.g., roads and parking areas).

Site Activities

AOC 01-007(k) was identified as an AOC because of possible soil contamination resulting from radiological experiments conducted in former buildings U and W. Constructed in 1943, former buildings U and W contained physics laboratories that were used to conduct experiments involving uranium-235, uranium-238, radium-226, carbon-14, polonium-210, and tritium. PAHs were not used in these experiments. In 1959, buildings U and W were removed from service and subsequently destroyed.

Currently, a portion of AOC 01-007(k) includes the building footprint of the former Los Alamos Inn, which is bare soil with some debris and rubble on the surface including small and large chunks of old asphalt (Figures 6.1-1 and 6.1-2). The former structure was removed by a private property owner and the site filled and graded with material from an unknown location. The remaining area within and surrounding the AOC is private property and includes paved asphalt parking areas currently being utilized by the surrounding businesses and office buildings (also previously utilized by Los Alamos Inn guests) (Figures 6.1-1 and 6.1-2). Based on the fact that PAHs were not used in experiments in the former buildings and the long-term presence of an asphalt paved parking lot (approximately 55 yr), the PAHs detected in samples used to characterize this site [benzo(a)anthracene; benzo(b)fluoranthene; chrysene; fluoranthene; and pyrene] are from the paved asphalt parking areas and/or from the bare soil containing chunks of old asphalt, are not related to historical Laboratory site operations, and are not COPCs.

Organic COPCs

Other organic chemicals detected at AOC 01-007(k) include acetone, Aroclor-1248, Aroclor-1254, Aroclor-1260, benzoic acid, bis(2-ethylhexyl)phthalate, butylbenzylphthalate, di-n-butyl phthalate, diethylphthalate, and methylene chloride. The detected organic chemicals listed are retained as COPCs.

Radionuclides

Forty-eight samples were analyzed for americium-241, gamma-emitting radionuclides, isotopic plutonium, isotopic uranium, strontium-90, and tritium. Table 6.2-4 summarizes the analytical results for radionuclides. Figure 6.2-4 shows the spatial distribution of detected radionuclides.

Plutonium-239/240 was detected in two samples with a maximum activity of 0.038 pCi/g. Plutonium-239/240 is retained as a COPC.

Tritium was detected in 18 samples with a maximum activity of 0.634 pCi/g. Tritium is retained as a COPC.

Uranium-235/236 was detected above the Qbt 2,3,4 BV (0.09 pCi/g) in three samples with a maximum activity of 0.197 pCi/g. Uranium-235/236 is retained as a COPC.

6.2.4.4 Nature and Extent of Contamination

The nature and extent of inorganic, organic, and radionuclide COPCs at AOC 01-007(k) are discussed below.

Inorganic Chemicals

Inorganic COPCs at AOC 01-007(k) include antimony, calcium, chromium, copper, lead, mercury, nickel, nitrate, perchlorate, selenium, and zinc.

Antimony was not detected above the soil and Qbt 2,3,4 BVs but had DLs (0.57 mg/kg to 1.23 mg/kg) above the BVs in 43 samples. Because antimony was not detected in any samples and the residential SSL was approximately 24 times the maximum DL, further sampling for extent of antimony is not warranted.

Calcium was detected above the soil and Qbt 2,3,4 BVs in 11 samples with a maximum concentration of 9960 mg/kg. Concentrations decreased with depth or were below the BVs at all locations, except at location 00-603881. At location 01-105, concentrations decreased with depth (the concentrations in the shallower depths [3490 mg/kg and 3000 mg/kg] were below the soil BV [Appendix E, Inorganic Results Table]). The concentrations above the BVs were below the recommended daily allowances for an adult and child (Appendix G). Further sampling for extent of calcium is not warranted.

Chromium was detected above the Qbt 2,3,4 BV in seven samples with a maximum concentration of 21.3 mg/kg. Concentrations decreased with depth, were below the maximum Qbt 2,3,4 background concentration (13 mg/kg), or were below the BVs at all locations, except at locations 00-603879 and 00-603881. The concentrations at location 00-603881 did not change substantially with depth (0.3 mg/kg) and were within 0.9 mg/kg to 1.2 mg/kg of the maximum Qbt 2,3,4 background concentration. As discussed in section 4.2, because there was no known use of hexavalent chromium at this site, the results were compared with SSLs for trivalent chromium. The trivalent chromium residential SSL was approximately 5490 times the maximum concentration. Further sampling for extent of chromium is not warranted.

Copper was detected above the Qbt 2,3,4 BV in four samples with a maximum concentration of 159 mg/kg. Concentrations decreased with depth or were below the BVs at all locations. The change in concentration with depth at most locations was <6 mg/kg. The residential SSL was approximately 20 times the maximum concentration. Further sampling for extent of copper is not warranted.

Lead was detected above the soil and Qbt 2,3,4 BVs in four soil samples and seven tuff samples with a maximum concentration of 46.4 mg/kg. Concentrations decreased with depth, were below the maximum Qbt 2,3,4 background concentration (15.5 mg/kg), or were below the BVs at all locations, except at location 01-109. Concentrations at location 01-109 increased with depth by only 7.9 mg/kg, and the residential SSL was approximately 13 times and the industrial SSL was approximately 26 times the maximum concentration at this location. Concentrations decreased laterally. The lateral extent of lead is defined, and further sampling for vertical extent is not warranted.

Mercury was detected above the Qbt 2,3,4 BV in two samples with a maximum concentration of 0.716 mg/kg. Concentrations decreased with depth at location 01-107 and increased slightly with depth (0.067 mg/kg) at location 01-110. The maximum concentration at location 01-110 was only 0.028 mg/kg above the BV (0.1 mg/kg). The residential SSL was approximately 184 times the maximum concentration at this location. Further sampling for extent of mercury is not warranted.

Nickel was detected above the Qbt 2,3,4 BV in nine samples with a maximum concentration of 10.3 mg/kg. Concentrations decreased with depth at four locations (the concentrations in the shallower depths [11.2 mg/kg and 10.8 mg/kg] at location 01-105 were below the soil BV [Appendix E, Inorganic Results Table]). The concentrations at locations 00-603879, 00-603880, and 00-603881 did not change substantially with (3.9 mg/kg or less) and were less than 3.3 mg/kg above the maximum Qbt 2,3,4 background concentration. The residential SSL was approximately 151 times the maximum concentration. Further sampling for extent of nickel is not warranted.

Nitrate was detected in 18 samples with a maximum concentration of 3.1 mg/kg. Concentrations did not change substantially with depth or laterally (3.1 mg/kg or less) at any location. The residential SSL was approximately 40,000 times the maximum concentration. Further sampling for extent of nitrate is not warranted.

Perchlorate was detected in 12 samples with a maximum concentration of 0.00499 mg/kg. Concentrations did not change substantially with depth (0.0019 mg/kg or less) at any location. The residential SSL was approximately 11,000 times the maximum concentration. Further sampling for extent of perchlorate is not warranted.

Selenium was detected above the Qbt 2,3,4 BV in 3 samples with a maximum concentration of 0.557 mg/kg and had DLs (0.57 mg/kg to 1.17 mg/kg) above the Qbt 2,3,4 BV in 34 samples. Selenium was not detected at depth at location 01-114 and was detected slightly above the Qbt 2,3,4 BV (0.3 mg/kg) at locations 00-603879 and 00-603881 (0.06 mg/kg and 0.02 mg/kg). The residential SSL was approximately 700 times the maximum detected concentration and approximately 335 times the maximum DL. Concentrations decreased laterally. The lateral extent of selenium is defined, and further sampling for vertical extent is not warranted.

Zinc was detected above the soil and Qbt 2,3,4 BVs in two soil samples and one tuff sample with a maximum concentration of 393 mg/kg. Concentrations decreased with depth at all locations and decreased laterally. The lateral and vertical extent of zinc are defined.

Organic Chemicals

Organic COPCs at AOC 01-007(k) include acetone, Aroclor-1248, Aroclor-1254, Aroclor-1260, benzoic acid, bis(2-ethylhexyl)phthalate, butylbenzylphthalate, diethylphthalate, di-n-butyl phthalate, and methylene chloride.

Other organic chemicals detected but not related to site operations include several PAH compounds. Benzo(a)anthracene, benzo(b)fluoranthene, chrysene, fluoranthene, and pyrene were detected in one or two samples. Concentrations were below the EQLs and decreased with depth. The lateral and vertical extent of these organic chemicals are defined.

Acetone was detected in five samples with a maximum concentration of 0.00883 mg/kg. The concentrations decreased with depth at location 01-114, were below the EQL at location 00-603879, and did not change substantially with depth (0.00288 mg/kg) at location 01-110. Concentrations decreased laterally, and the residential SSL was approximately 7,542,000 times the maximum concentration. Further sampling for extent of acetone is not warranted.

Aroclor-1248 was detected in three samples with a maximum concentration of 0.0415 mg/kg. Concentrations decreased with depth at location 01-108. The residential SSL was approximately 54 times the maximum concentration. The vertical extent of Aroclor-1248 is defined, and further sampling for lateral extent is not warranted.

Aroclor-1254 was detected in five samples with a maximum concentration of 0.0339 mg/kg. Concentrations decreased with depth at locations 01-107 and 01-108. The residential SSL was approximately 33 times the maximum concentration. The vertical extent of Aroclor-1254 is defined, and further sampling for lateral extent is not warranted.

Aroclor-1260 was detected in two samples with a maximum concentration of 0.0132 mg/kg. Concentrations decreased with depth at locations 01-107 and 01-108. The residential SSL was approximately 170 times the maximum concentration. The vertical extent of Aroclor-1260 is defined, and further sampling for lateral extent is not warranted.

Benzoic acid was detected in one sample at a concentration of 0.47 mg/kg. The concentration was below the EQL. The residential SSL was approximately 510,000 times the concentration. Further sampling for extent of benzoic acid is not warranted.

Bis(2-ethylhexyl)phthalate was detected in two samples with a maximum concentration of 0.386 mg/kg. The concentrations were below the EQLs. The residential SSL was approximately 900 times the maximum concentration. Further sampling for extent of bis(2-ethylhexyl)phthalate is not warranted.

Butylbenzylphthalate was detected in two samples with a maximum concentration of 0.746 mg/kg. The concentrations decreased with depth at locations 01-107 and 01-108. The residential SSL was approximately 3480 times the maximum concentration. The vertical extent of butylbenzylphthalate is defined, and further sampling for lateral extent is not warranted.

Diethylphthalate was detected in one sample at a concentration of 0.139 mg/kg. The concentration was below the EQL. The residential SSL was approximately 35,200 times the concentration. Further sampling for extent of diethylphthalate is not warranted.

Di-n-butyl phthalate was detected in five samples with a maximum concentration of 0.487 mg/kg. Concentrations decreased with depth at locations 01-105 and 01-115. Concentrations at locations 01-104

and 01-114 were below the EQLs. The residential SSL was approximately 12,550 times the maximum concentration at location 01-106. Further sampling for extent of di-n-butyl phthalate is not warranted.

Methylene chloride was detected in six samples with a maximum concentration of 0.026 mg/kg. The concentrations were below the EQLs and did not change substantially with depth (0.006 mg/kg or less). The residential SSL was approximately 15,700 times the maximum concentration. Further sampling for extent of methylene chloride is not warranted.

Radionuclides

Radionuclide COPCs at AOC 01-007(k) include plutonium-239/240, tritium, and uranium-235/236.

Plutonium-239/240 was detected in two samples with a maximum activity of 0.038 pCi/g. The activity decreased with depth at both locations and did not change substantially laterally (0.05 pCi/g). The residential SAL was approximately 2100 times the maximum activity. The vertical extent of plutonium-239/240 is defined, and further sampling for lateral extent is not warranted.

Tritium was detected in eight soil/fill samples and nine tuff samples with a maximum activity of 0.634 pCi/g. The activity decreased with depth or did not change substantially with depth (0.006 pCi/g to 0.05 pCi/g). The residential SAL is approximately 1340 times the maximum activity. Further sampling for extent of tritium is not warranted.

Uranium-235/236 was detected above the Qbt 2,3,4 BV in three samples with a maximum activity of 0.197 pCi/g. The activity at location 01-105 is only slightly above the BV (0.0039 pCi/g). Activities decreased laterally. The residential SAL is approximately 200 times the maximum activity. The lateral extent of uranium-235/236 is defined, and further sampling for vertical extent is not warranted.

6.2.5 Summary of Human Health Risk Screening

Industrial Scenario

The total excess cancer risk for the industrial scenario is 1×10^{-7}, which is below the NMED target risk level of 1×10^{-5} (NMED 2012, 219971). The industrial HI is 0.02, which is below the NMED target HI of 1 (NMED 2012, 219971). The total dose is 0.002 mrem/yr, which is less than the DOE target dose of 25 mrem/yr.

Construction Worker Scenario

The total excess cancer risk for the construction worker scenario is 7×10^{-9}, which is below the NMED target risk level of 1×10^{-5} (NMED 2012, 219971). The construction worker HI is approximately 0.04, which is below the NMED target HI of 1 (NMED 2012, 219971). The total dose is 0.01 mrem/yr, which is less than the DOE target dose of 25 mrem/yr.

Residential Scenario

The total excess cancer risk for the residential scenario is approximately 3×10^{-7}, which is below the NMED target risk level of 1×10^{-5} (NMED 2012, 219971). The residential HI is 0.1, which is below the NMED target HI of 1 (NMED 2012, 219971). The total dose is 0.02 mrem/yr, which is less than the DOE target dose of 25 mrem/yr.

Based on the risk-screening assessment results, no potential unacceptable risks or doses exist for the industrial, construction worker, and residential scenarios at AOC 01-007(k).

6.2.6 Summary of Ecological Risk Screening

Based on evaluations of the minimum ESLs, HI analyses, potential effects to populations (individuals for T&E species), LOAEL analyses, and the relationship of detected concentrations and DLs to background concentrations, no potential ecological risks to the earthworm, plant, American robin, American kestrel, deer mouse, montane shrew, desert cottontail, red fox, and Mexican spotted owl exist at AOC 01-007(k).

7.0 CONCLUSIONS

7.1 Nature and Extent of Contamination

The nature and extent of contamination have been defined, and/or no further sampling for extent is warranted at AOC 01-007(k).

7.2 Summary of Risk-Screening Assessments

AOC 01-007(k) was evaluated for potential risk by human health and ecological risk-screening assessments. The human health risk-screening assessments were performed for the site under the industrial, construction worker, and residential scenarios.

7.2.1 Human Health Risk-Screening Assessment

The human health risk-screening assessments are presented in Appendix G, section G-4.2. The human health risk-screening assessments found no potential unacceptable risks or doses under the industrial, construction worker, and residential scenarios at AOC 01-007(k). The total excess cancer risks were less than the NMED target risk level of 1×10^{-5} and the HIs were less than the NMED target HI of 1 (NMED 2012, 219971) for all three scenarios. The total doses were below the target dose limit of 25 mrem/yr as authorized by DOE Order 458.1 for all three scenarios.

The Laboratory's as low as reasonably achievable (ALARA) program description states that quantitative ALARA evaluations are not necessary for Laboratory activities that have a potential for annual public exposure less than a 3-mrem total effective dose equivalent individual dose ("Los Alamos National Laboratory Environmental ALARA Program," PD410, p. 7, effective November 8, 2008). The calculated radiation dose for the residential scenario was 0.02 mrem/yr. Therefore, radiation exposures to the public at AOC 01-007(k) are ALARA.

7.2.2 Ecological Risk-Screening Assessment

The ecological risk-screening assessment is presented in Appendix G, section G-5.3. No unacceptable ecological risks exist at AOC 01-007(k).

No potential ecological risks were found for any receptor following evaluations based on minimum ESL, HI analyses, potential effects to populations (individuals for threatened and endangered species), LOAEL analyses, and the relationship of detected concentrations and DLs to background concentrations.

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 site is commercial/industrial.

8.1 Additional Field Characterization Activities

No additional sampling is needed to define the extent of contamination at AOC 01-007(k).

8.2 Recommendations for Corrective Actions Complete

AOC 01-007(k) does not pose a potential unacceptable risk or dose under the industrial, construction worker, and residential scenarios, has no potential ecological risks for any receptor, and the nature and extent of contamination is defined and/or no further sampling for extent is warranted. Therefore, the Laboratory recommends no further investigation or remediation activities are warranted, and the site is appropriate for corrective actions complete without controls.

9.0 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. This information is also included in text citations. ER IDs are assigned by the Environmental Programs Directorate's Records Processing Facility (RPF) and are used to locate the document at the RPF and, where applicable, in the master reference set.

Copies of the master reference set are maintained at the NMED Hazardous Waste Bureau and the 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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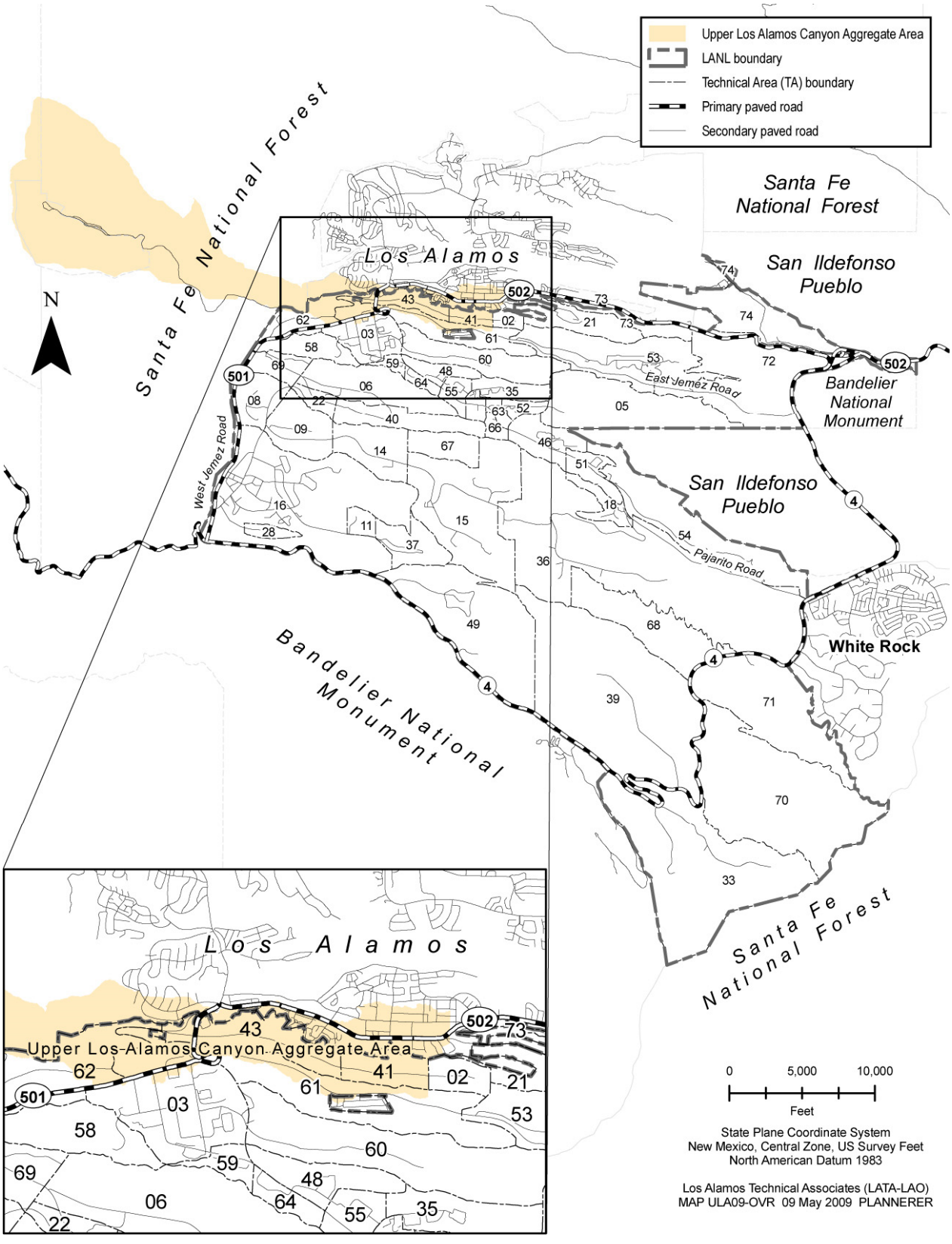


Figure 1.1-1 Location of Upper Los Alamos Canyon Aggregate Area with respect to Laboratory TAs

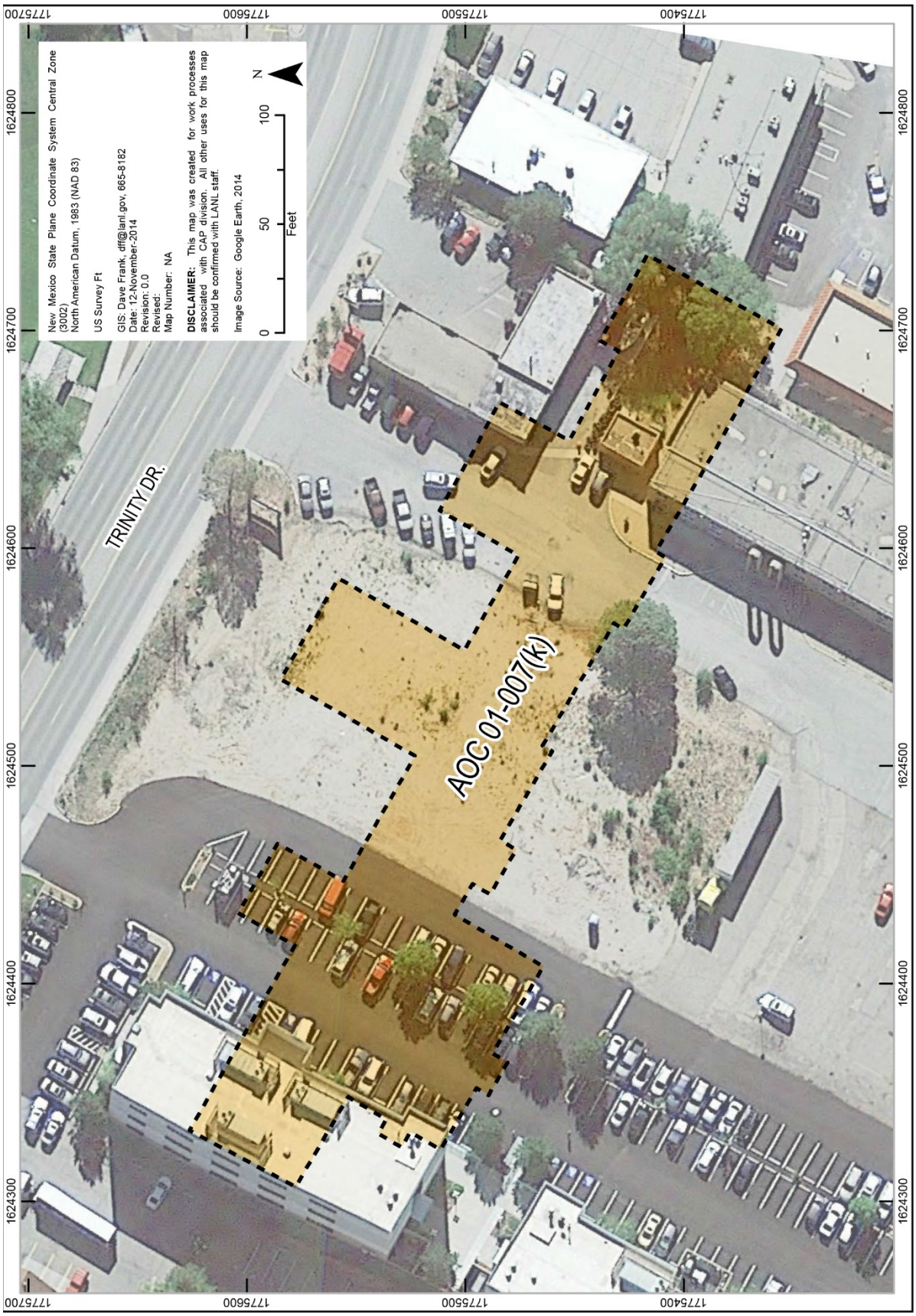


Figure 6.1-1 Aerial view of current site condition with AOC 01-007(k) (former buildings U and W footprint) superimposed



Figure 6.1-2 View of current site condition from ground level looking south/southwest

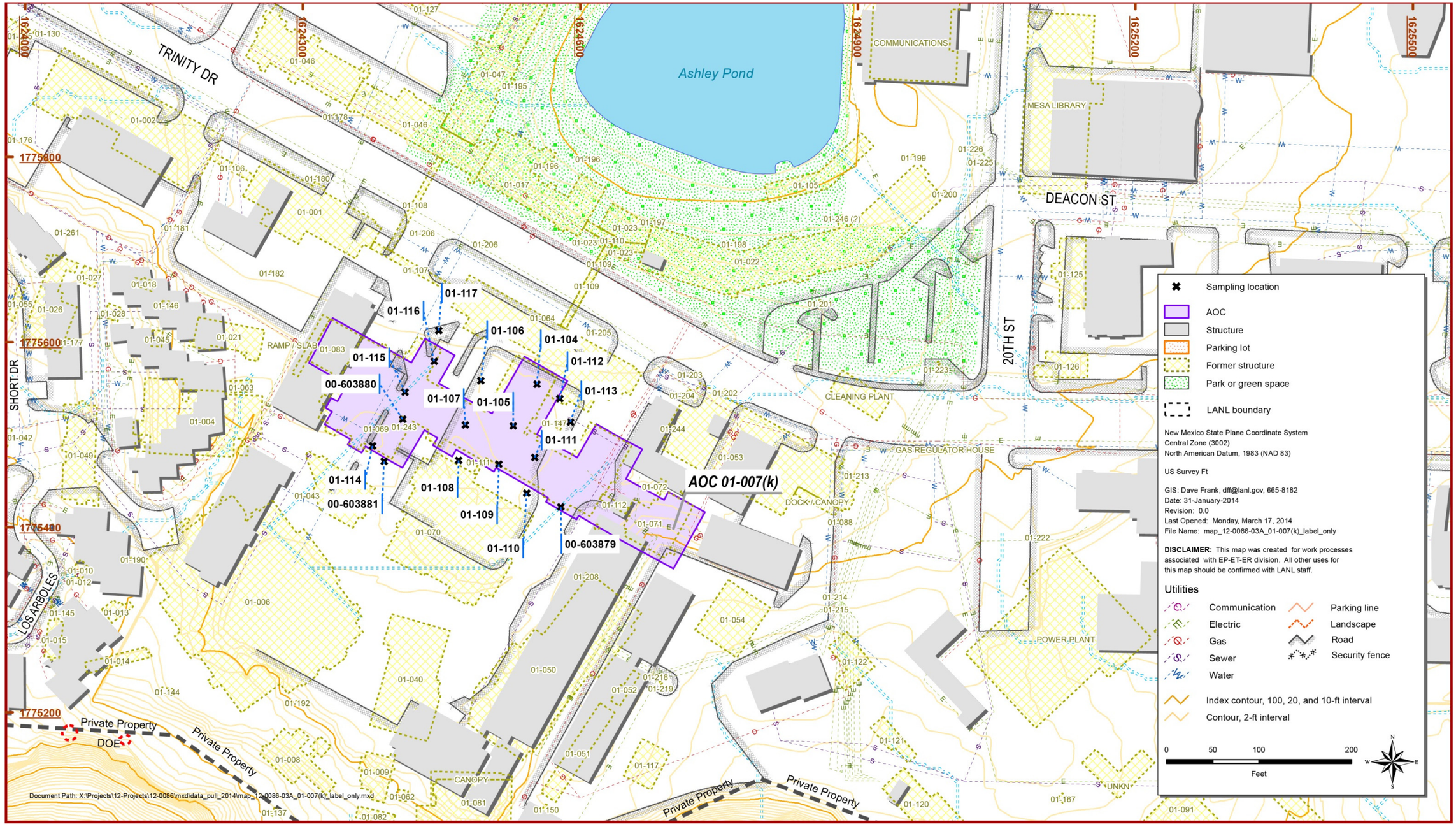


Figure 6.2-1 Site map of AOC 01-007(k)

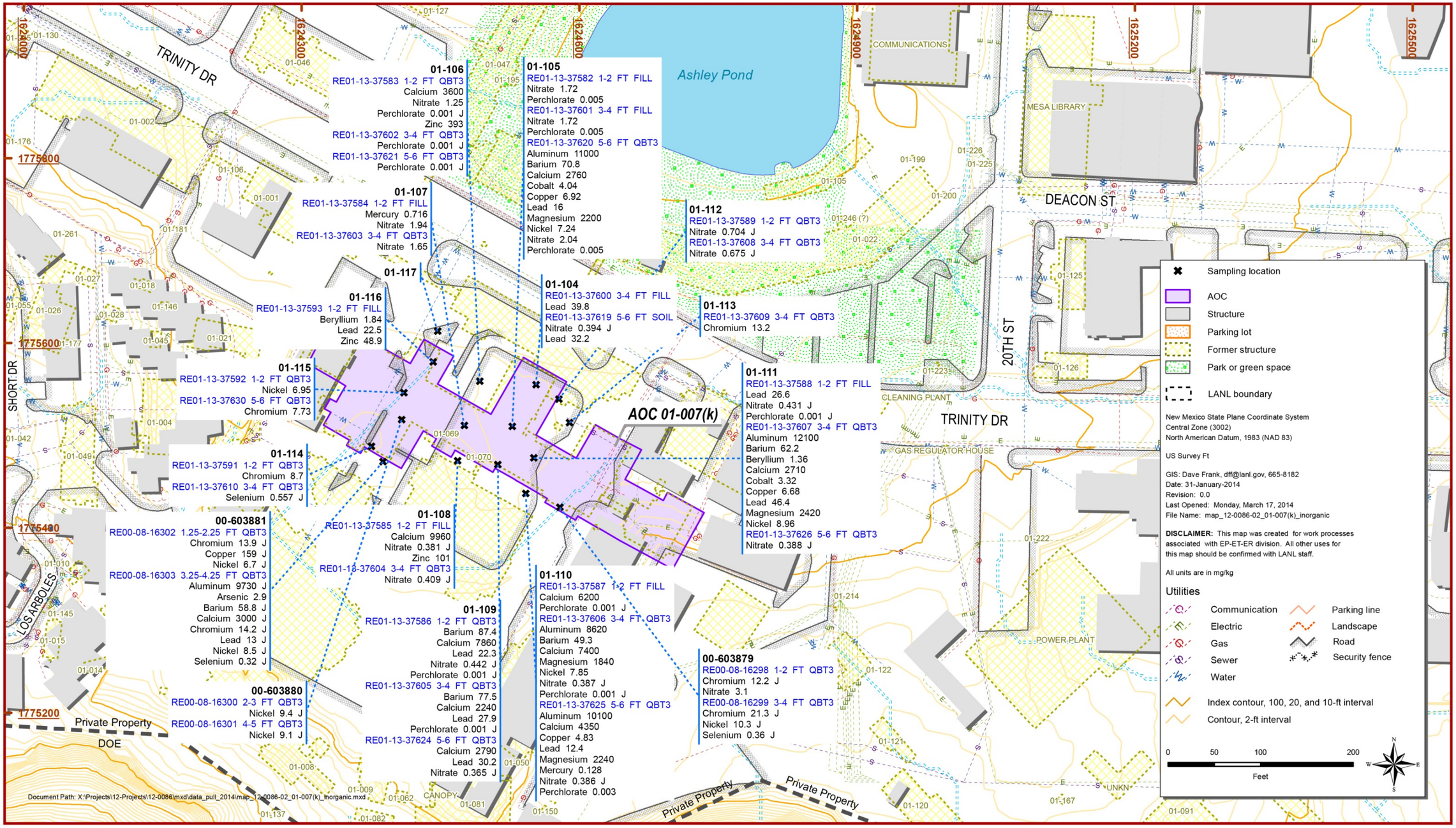


Figure 6.2-2 Inorganic chemical concentrations detected or detected above BVs at AOC 01-007(k)

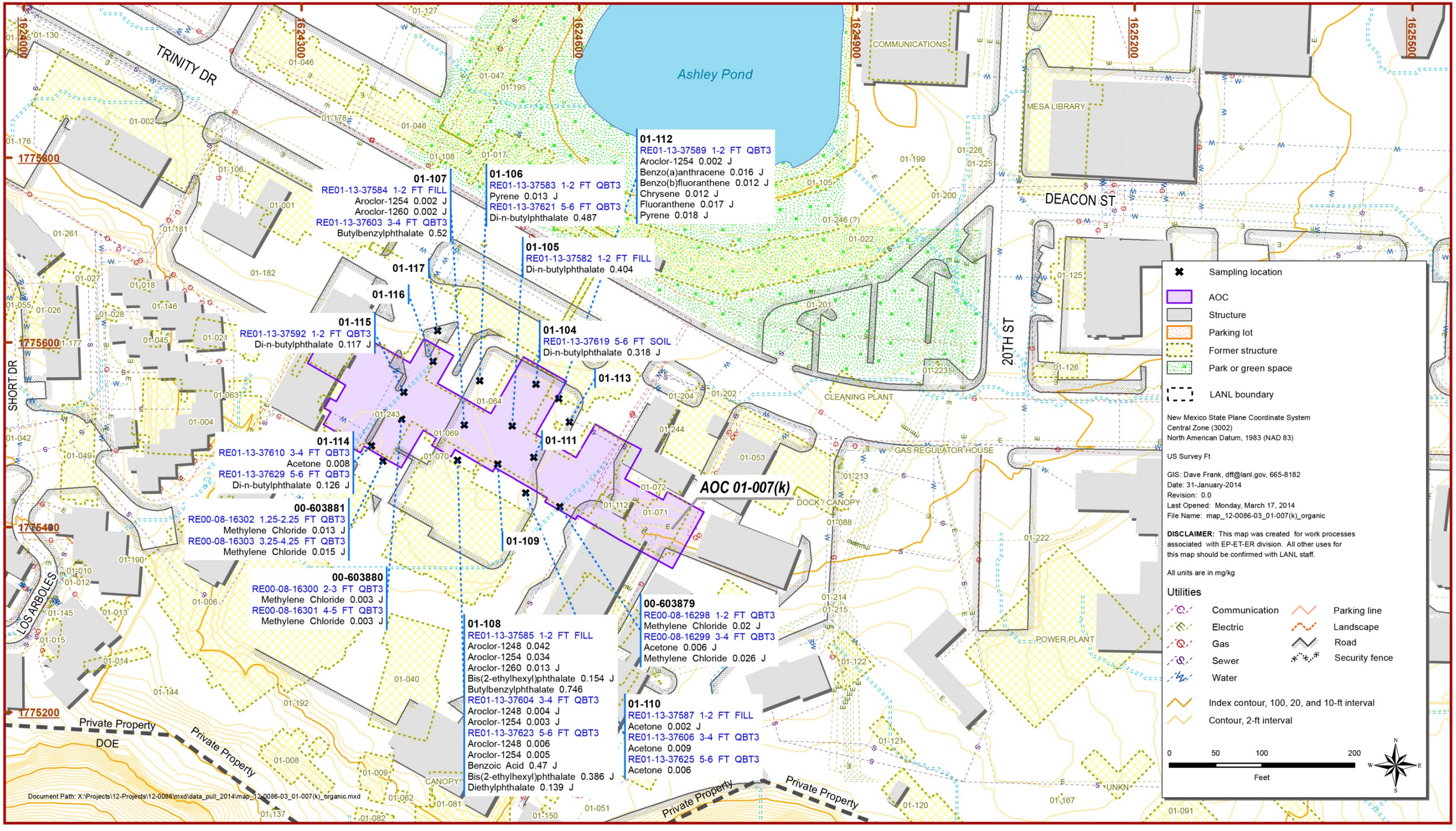


Figure 6.2-3 Organic chemical concentrations detected at AOC 01-007(k)

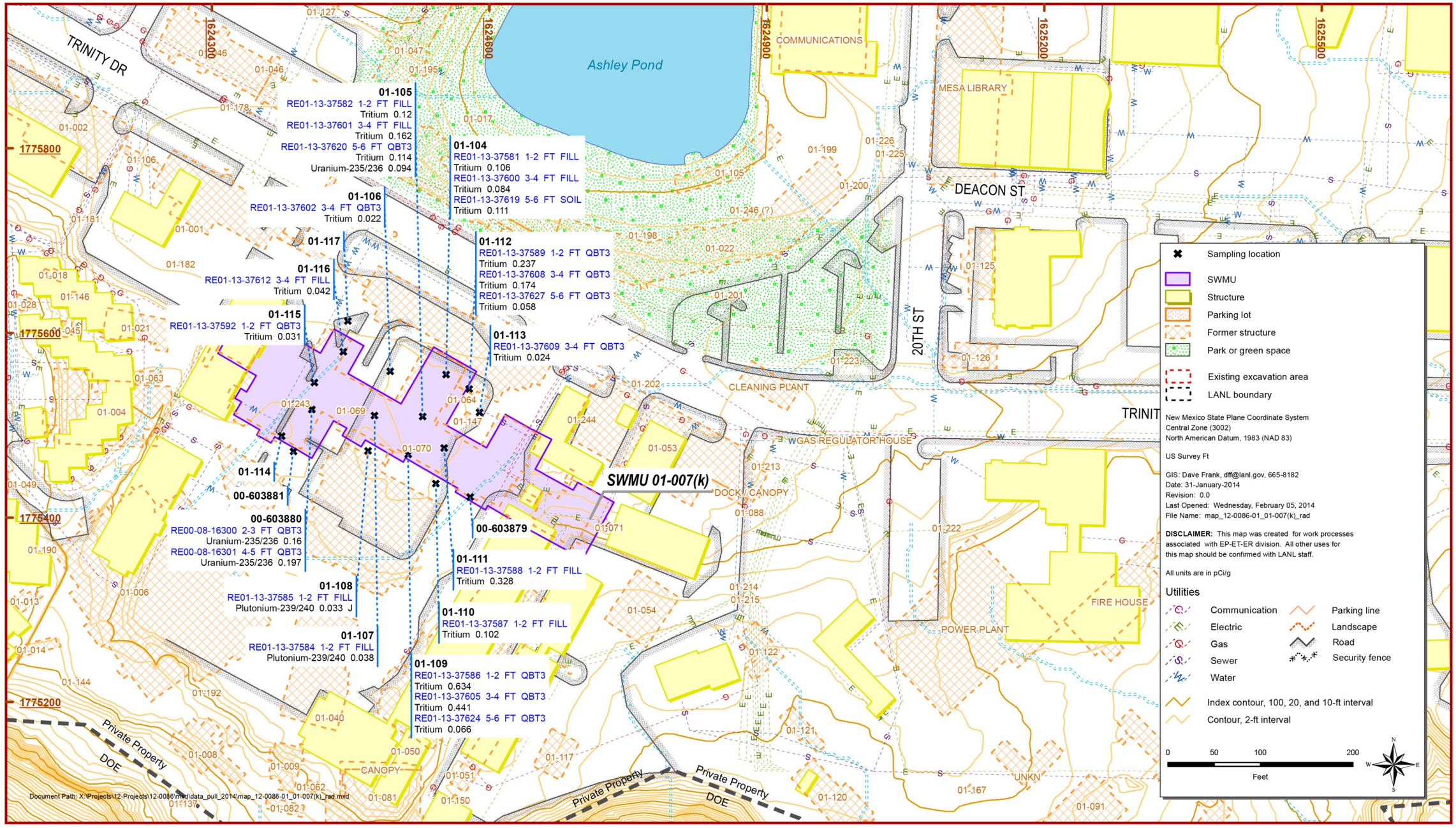


Figure 6.2-4 Radionuclide concentrations detected or detected above BVs/FVs at AOC 01-007(k)

Table 3.1-1
Surveyed Coordinates for Locations Sampled at AOC 01-007(k)

Site	Location ID	Easting (ft)	Northing (ft)
01-007(k)	00-603879	1624579.01	1775422.1
01-007(k)	00-603880	1624407.93	1775516.72
01-007(k)	00-603881	1624387.91	1775471.44
01-007(k)	01-117	1624446.81	1775612.726
01-007(k)	01-116	1624441.935	1775579.381
01-007(k)	01-115	1624410.489	1775546.088
01-007(k)	01-114	1624375.249	1775487.93
01-007(k)	01-106	1624492.456	1775558.287
01-007(k)	01-108	1624468.584	1775472.263
01-007(k)	01-109	1624511.995	1775468.28
01-007(k)	01-105	1624527.612	1775509.329
01-007(k)	01-104	1624553.133	1775554.641
01-007(k)	01-112	1624577.884	1775539.074
01-007(k)	01-113	1624589.137	1775513.655
01-007(k)	01-110	1624541.987	1775436.75
01-007(k)	01-107	1624475.7	1775510.424
01-007(k)	01-111	1624550.77	1775475.31

Table 3.2-2
Field-Screening Results for Samples Collected at AOC 01-007(k)

Site	Location ID	Depth (ft)	Sample ID	PID (ppm)	Alpha (dpm)	Beta/Gamma (dpm)
01-007(k)	00-603879	1–2	RE00-08-16298	0	41	2580
01-007(k)	00-603879	3–4	RE00-08-16299	0	65	2660
01-007(k)	00-603880	2–3	RE00-08-16300	0	30.1	1923
01-007(k)	00-603880	4–5	RE00-08-16301	0	42.2	1895
01-007(k)	00-603881	1.25–2.25	RE00-08-16302	0	17	2620
01-007(k)	00-603881	3.25–4.25	RE00-08-16303	0	17	2620
01-007(k)	01-117	1–2	RE01-13-37594	0	17	622
01-007(k)	01-117	3–4	RE01-13-37613	0	17	622
01-007(k)	01-117	5–6	RE01-13-37632	0	17	622
01-007(k)	01-116	1–2	RE01-13-37593	0	32	980
01-007(k)	01-116	3–4	RE01-13-37612	0	32	980
01-007(k)	01-116	5–6	RE01-13-37631	0	32	980
01-007(k)	01-115	1–2	RE01-13-37592	0	27	1098
01-007(k)	01-115	3–4	RE01-13-37611	0	0	1043
01-007(k)	01-115	5–6	RE01-13-37630	0	0	1043

Table 3.2-2 (continued)

Site	Location ID	Depth (ft)	Sample ID	PID (ppm)	Alpha (dpm)	Beta/Gamma (dpm)
01-007(k)	01-114	1–2	RE01-13-37591	0	27	1098
01-007(k)	01-114	3–4	RE01-13-37610	0	27	1098
01-007(k)	01-114	5–6	RE01-13-37629	0	27	1098
01-007(k)	01-106	1–2	RE01-13-37583	0	2	911
01-007(k)	01-106	3–4	RE01-13-37602	0	2	911
01-007(k)	01-106	5–6	RE01-13-37621	0	2	911
01-007(k)	01-108	1–2	RE01-13-37585	0	40	561
01-007(k)	01-108	3–4	RE01-13-37604	0	40	561
01-007(k)	01-108	5–6	RE01-13-37623	0	40	561
01-007(k)	01-109	1–2	RE01-13-37586	0	18	427
01-007(k)	01-109	3–4	RE01-13-37605	0	18	427
01-007(k)	01-109	5–6	RE01-13-37624	0	18	427
01-007(k)	01-104	1–2	RE01-13-37582	0	2	820
01-007(k)	01-105	3–4	RE01-13-37601	0	2	820
01-007(k)	01-105	5–6	RE01-13-37620	0	2	820
01-007(k)	01-104	1–2	RE01-13-37581	0	0	613
01-007(k)	01-104	3–4	RE01-13-37600	0	0	613
01-007(k)	01-104	5–6	RE01-13-37619	0	0	613
01-007(k)	01-112	1–2	RE01-13-37589	0	8	1068
01-007(k)	01-112	3–4	RE01-13-37608	0	8	1068
01-007(k)	01-112	5–6	RE01-13-37627	0	8	1068
01-007(k)	01-113	1–2	RE01-13-37590	0	14	2410
01-007(k)	01-113	3–4	RE01-13-37609	0	14	2410
01-007(k)	01-113	5–6	RE01-13-37628	0	14	2410
01-007(k)	01-110	1–2	RE01-13-37587	0	18	646
01-007(k)	01-110	3–4	RE01-13-37606	0	18	646
01-007(k)	01-110	5–6	RE01-13-37625	0	18	646
01-007(k)	01-107	1–2	RE01-13-37584	0	0	615
01-007(k)	01-107	3–4	RE01-13-37603	0	0	615
01-007(k)	01-107	5–6	RE01-13-37622	0	0	615
01-007(k)	01-111	1–2	RE01-13-37588	0	0	788
01-007(k)	01-111	3–4	RE01-13-37607	0	0	788
01-007(k)	01-111	5–6	RE01-13-37626	0	0	788

Table 6.2-1
Samples Collected and Analyses Requested at AOC 01-007(k)

Sample ID	Location ID	Depth (ft)	Media	Nitrate	Gamma Spectroscopy	Strontium-90	Tritium	Isotopic Plutonium	Isotopic Uranium	Metals	Perchlorate	PCBs	VOC	SVOC	Total Cyanide	pH
RE00-08-16298	00-603879	1–2	QBT3	09-543*	09-543	09-543	09-543	09-543	09-543	09-543	09-543	09-543	09-543	09-543	09-543	09-543
RE00-08-16299	00-603879	3–4	QBT3	09-543	09-543	09-543	09-543	09-543	09-543	09-543	09-543	09-543	09-543	09-543	09-543	09-543
RE00-08-16300	00-603880	2–3	QBT3	09-466	09-466	09-466	09-466	09-466	09-466	09-466	09-466	09-466	09-466	09-466	09-466	09-466
RE00-08-16301	00-603880	4–5	QBT3	09-466	09-466	09-466	09-466	09-466	09-466	09-466	09-466	09-466	09-466	09-466	09-466	09-466
RE00-08-16302	00-603881	1.25–2.25	QBT3	09-531	09-531	09-531	09-531	09-531	09-531	09-531	09-531	09-531	09-531	09-531	09-531	09-531
RE00-08-16303	00-603881	3.25–4.25	QBT3	09-531	09-531	09-531	09-531	09-531	09-531	09-531	09-531	09-531	09-531	09-531	09-531	09-531
RE01-13-37581	01-104	1–2	FILL	2013-2071	2013-2071	2013-2071	2013-2071	2013-2071	2013-2071	2013-2071	2013-2071	2013-2071	2013-2071	2013-2071	2013-2071	2013-2071
RE01-13-37600	01-104	3–4	FILL	2013-2071	2013-2071	2013-2071	2013-2071	2013-2071	2013-2071	2013-2071	2013-2071	2013-2071	2013-2071	2013-2071	2013-2071	2013-2071
RE01-13-37619	01-104	5–6	ALLH	2013-2071	2013-2071	2013-2071	2013-2071	2013-2071	2013-2071	2013-2071	2013-2071	2013-2071	2013-2071	2013-2071	2013-2071	2013-2071
RE01-13-37582	01-105	1–2	FILL	2013-2071	2013-2071	2013-2071	2013-2071	2013-2071	2013-2071	2013-2071	2013-2071	2013-2071	2013-2071	2013-2071	2013-2071	2013-2071
RE01-13-37601	01-105	3–4	FILL	2013-2071	2013-2071	2013-2071	2013-2071	2013-2071	2013-2071	2013-2071	2013-2071	2013-2071	2013-2071	2013-2071	2013-2071	2013-2071
RE01-13-37620	01-105	5–6	QBT3	2013-2071	2013-2071	2013-2071	2013-2071	2013-2071	2013-2071	2013-2071	2013-2071	2013-2071	2013-2071	2013-2071	2013-2071	2013-2071
RE01-13-37583	01-106	1–2	QBT3	2013-2071	2013-2071	2013-2071	2013-2071	2013-2071	2013-2071	2013-2071	2013-2071	2013-2071	2013-2071	2013-2071	2013-2071	2013-2071
RE01-13-37602	01-106	3–4	QBT3	2013-2071	2013-2071	2013-2071	2013-2071	2013-2071	2013-2071	2013-2071	2013-2071	2013-2071	2013-2071	2013-2071	2013-2071	2013-2071
RE01-13-37621	01-106	5–6	QBT3	2013-2071	2013-2071	2013-2071	2013-2071	2013-2071	2013-2071	2013-2071	2013-2071	2013-2071	2013-2071	2013-2071	2013-2071	2013-2071
RE01-13-37584	01-107	1–2	FILL	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067
RE01-13-37603	01-107	3–4	QBT3	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067
RE01-13-37622	01-107	5–6	QBT3	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067
RE01-13-37585	01-108	1–2	FILL	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067
RE01-13-37604	01-108	3–4	QBT3	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067
RE01-13-37623	01-108	5–6	QBT3	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067
RE01-13-37586	01-109	1–2	QBT3	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067
RE01-13-37605	01-109	3–4	QBT3	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067
RE01-13-37624	01-109	5–6	QBT3	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067
RE01-13-37587	01-110	1–2	FILL	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067
RE01-13-37606	01-110	3–4	QBT3	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067
RE01-13-37625	01-110	5–6	QBT3	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067	2013-2067
RE01-13-37588	01-111	1–2	FILL	2013-2056	2013-2056	2013-2056	2013-2056	2013-2056	2013-2056	2013-2056	2013-2056	2013-2056	2013-2056	2013-2056	2013-2056	2013-2056
RE01-13-37607	01-111	3–4	QBT3	2013-2056	2013-2056	2013-2056	2013-2056	2013-2056	2013-2056	2013-2056	2013-2056	2013-2056	2013-2056	2013-2056	2013-2056	2013-2056
RE01-13-37626	01-111	5–6	QBT3	2013-2056	2013-2056	2013-2056	2013-2056	2013-2056	2013-2056	2013-2056	2013-2056	2013-2056	2013-2056	2013-2056	2013-2056	2013-2056
RE01-13-37589	01-112	1–2	QBT3	2013-2056	2013-2056	2013-2056	2013-2056	2013-2056	2013-2056	2013-2056	2013-2056	2013-2056	2013-2056	2013-2056	2013-2056	2013-2056

Table 6.2-1 (continued)

Sample ID	Location ID	Depth (ft)	Media	Nitrate	Gamma Spectroscopy	Strontium-90	Tritium	Isotopic Plutonium	Isotopic Uranium	Metals	Perchlorate	PCBs	VOC	SVOC	Total Cyanide	pH
RE01-13-37608	01-112	3–4	QBT3	2013-2056	2013-2056	2013-2056	2013-2056	2013-2056	2013-2056	2013-2056	2013-2056	2013-2056	2013-2056	2013-2056	2013-2056	2013-2056
RE01-13-37627	01-112	5–6	QBT3	2013-2056	2013-2056	2013-2056	2013-2056	2013-2056	2013-2056	2013-2056	2013-2056	2013-2056	2013-2056	2013-2056	2013-2056	2013-2056
RE01-13-37590	01-113	1–2	QBT3	2013-2142	2013-2142	2013-2142	2013-2142	2013-2142	2013-2142	2013-2142	2013-2142	2013-2142	2013-2142	2013-2142	2013-2142	2013-2142
RE01-13-37609	01-113	3–4	QBT3	2013-2142	2013-2142	2013-2142	2013-2142	2013-2142	2013-2142	2013-2142	2013-2142	2013-2142	2013-2142	2013-2142	2013-2142	2013-2142
RE01-13-37628	01-113	5–6	QBT3	2013-2142	2013-2142	2013-2142	2013-2142	2013-2142	2013-2142	2013-2142	2013-2142	2013-2142	2013-2142	2013-2142	2013-2142	2013-2142
RE01-13-37591	01-114	1–2	QBT3	2013-2142	2013-2142	2013-2142	2013-2142	2013-2142	2013-2142	2013-2142	2013-2142	2013-2142	2013-2142	2013-2142	2013-2142	2013-2142
RE01-13-37610	01-114	3–4	QBT3	2013-2142	2013-2142	2013-2142	2013-2142	2013-2142	2013-2142	2013-2142	2013-2142	2013-2142	2013-2142	2013-2142	2013-2142	2013-2142
RE01-13-37629	01-114	5–6	QBT3	2013-2142	2013-2142	2013-2142	2013-2142	2013-2142	2013-2142	2013-2142	2013-2142	2013-2142	2013-2142	2013-2142	2013-2142	2013-2142
RE01-13-37592	01-115	1–2	QBT3	2013-2142	2013-2142	2013-2142	2013-2142	2013-2142	2013-2142	2013-2142	2013-2142	2013-2142	2013-2142	2013-2142	2013-2142	2013-2142
RE01-13-37611	01-115	3–4	QBT3	2013-2142	2013-2142	2013-2142	2013-2142	2013-2142	2013-2142	2013-2142	2013-2142	2013-2142	2013-2142	2013-2142	2013-2142	2013-2142
RE01-13-37630	01-115	5–6	QBT3	2013-2142	2013-2142	2013-2142	2013-2142	2013-2142	2013-2142	2013-2142	2013-2142	2013-2142	2013-2142	2013-2142	2013-2142	2013-2142
RE01-13-37593	01-116	1–2	FILL	2013-2144	2013-2144	2013-2144	2013-2144	2013-2144	2013-2144	2013-2144	2013-2144	2013-2144	2013-2144	2013-2144	2013-2144	2013-2144
RE01-13-37612	01-116	3–4	FILL	2013-2144	2013-2144	2013-2144	2013-2144	2013-2144	2013-2144	2013-2144	2013-2144	2013-2144	2013-2144	2013-2144	2013-2144	2013-2144
RE01-13-37631	01-116	5–6	QBT3	2013-2144	2013-2144	2013-2144	2013-2144	2013-2144	2013-2144	2013-2144	2013-2144	2013-2144	2013-2144	2013-2144	2013-2144	2013-2144
RE01-13-37594	01-117	1–2	QBT3	2013-2144	2013-2144	2013-2144	2013-2144	2013-2144	2013-2144	2013-2144	2013-2144	2013-2144	2013-2144	2013-2144	2013-2144	2013-2144
RE01-13-37613	01-117	3–4	QBT3	2013-2144	2013-2144	2013-2144	2013-2144	2013-2144	2013-2144	2013-2144	2013-2144	2013-2144	2013-2144	2013-2144	2013-2144	2013-2144
RE01-13-37632	01-117	5–6	QBT3	2013-2144	2013-2144	2013-2144	2013-2144	2013-2144	2013-2144	2013-2144	2013-2144	2013-2144	2013-2144	2013-2144	2013-2144	2013-2144

* Request numbers.

Table 6.2-2
Inorganic Chemicals above Background at AOC 01-007(k)

Sample ID	Location ID	Depth (ft)	Media	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Cyanide (Total)	Lead	Magnesium	Mercury	Nickel	Nitrate	Perchlorate	Selenium	Zinc
Soil BV[a]				**29200**	**0.83**	**8.17**	**295**	**1.83**	**0.4**	**6120**	**19.3**	**8.64**	**14.7**	**0.5**	**22.3**	**4610**	**0.1**	**15.4**	**na[b]**	**na**	**1.52**	**48.8**
Qbt2, 3, 4 BV[a]				**7340**	**0.5**	**2.79**	**46**	**1.21**	**1.63**	**2200**	**7.14**	**3.14**	**4.66**	**0.5**	**11.2**	**1690**	**0.1**	**6.58**	**na**	**na**	**0.3**	**63.5**
Industrial SSL[c]				**1130000**	**454**	**17.7**	**223000**	**2260**	**897**	**na**	**1700000[d]**	**300[e]**	**45400**	**681**	**800**	**na**	**341**	**22500**	**1820000**	**795**	**5680**	**341000**
Construction Worker SSL[c]				**40700**	**124**	**53**	**4350**	**144**	**277**	**na**	**465000[d]**	**34.8[f]**	**12400**	**186**	**800**	**na**	**92.9**	**6190**	**496000**	**217**	**1550**	**92900**
Residential SSL[c]				**78000**	**31.3**	**3.9**	**15600**	**156**	**70.3**	**na**	**117000[d]**	**23[e]**	**3130**	**46.9**	**400**	**na**	**23.5**	**1560**	**125000**	**54.8**	**391**	**23500**
RE00-08-16298	00-603879	1-2	QBT3	—[g]	—	—	—	—	—	—	12.2 (J)	—	—	0.59 (U)	—	—	—	—	3.1	—	0.59 (U)	—
RE00-08-16299	00-603879	3-4	QBT3	—	—	—	—	—	—	—	21.3 (J)	—	—	—	—	—	—	10.3 (J)	—	—	0.36 (J)	—
RE00-08-16300	00-603880	2-3	QBT3	—	—	—	—	—	—	—	—	—	—	0.58 (UJ)	—	—	—	9.4 (J)	—	—	0.58 (U)	—
RE00-08-16301	00-603880	4-5	QBT3	—	0.57 (U)	—	—	—	—	—	—	—	—	—	—	—	—	9.1 (J)	—	—	0.57 (U)	—
RE00-08-16302	00-603881	1.25-2.25	QBT3	—	—	—	—	—	—	—	13.9 (J)	—	159 (J)	0.61 (U)	—	—	—	6.7 (J)	—	—	0.61 (UJ)	—
RE00-08-16303	00-603881	3.25-4.25	QBT3	9730 (J)	—	2.9	58.8 (J)	—	—	3000 (J)	14.2 (J)	—	—	0.62 (U)	13 (J)	—	—	8.5 (J)	—	—	0.32 (J)	—
RE01-13-37581	01-104	1-2	FILL	—	1.16 (U)	—	—	—	0.579 (U)	—	—	—	—	—	—	—	—	—	—	—	—	—
RE01-13-37600	01-104	3-4	FILL	—	1.07 (U)	—	—	—	0.536 (U)	—	—	—	—	—	39.8	—	—	—	—	—	—	—
RE01-13-37619	01-104	5-6	SOIL	—	1.13 (U)	—	—	—	0.564 (U)	—	—	—	—	—	32.2	—	—	—	0.394 (J)	—	—	—
RE01-13-37582	01-105	1-2	FILL	—	1.05 (U)	—	—	—	0.523 (U)	—	—	—	—	—	—	—	—	—	1.72	0.00499	—	—
RE01-13-37601	01-105	3-4	FILL	—	1.16 (U)	—	—	—	0.582 (U)	—	—	—	—	—	—	—	—	—	1.72	0.00483	—	—
RE01-13-37620	01-105	5-6	QBT3	11000	1.16 (U)	—	70.8	—	—	2760	—	4.04	6.92	—	16	2200	—	7.24	2.04	0.00456	1.15 (U)	—
RE01-13-37583	01-106	1-2	QBT3	—	1.12 (U)	—	—	—	—	3600	—	—	—	—	—	—	—	—	1.25	0.0012 (J)	1.09 (U)	393
RE01-13-37602	01-106	3-4	QBT3	—	0.959 (U)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.000902 (J)	1.09 (U)	—
RE01-13-37621	01-106	5-6	QBT3	—	0.989 (U)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.000683 (J)	1.04 (U)	—
RE01-13-37584	01-107	1-2	FILL	—	1.05 (U)	—	—	—	0.523 (U)	—	—	—	—	—	—	—	0.716	—	1.94	—	—	—
RE01-13-37603	01-107	3-4	QBT3	—	1.06 (U)	—	—	—	—	—	—	—	—	—	—	—	—	—	1.65	—	1.09 (U)	—
RE01-13-37622	01-107	5-6	QBT3	—	1.09 (U)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1.04 (U)	—
RE01-13-37585	01-108	1-2	FILL	—	1.09 (U)	—	—	—	0.545 (U)	9960	—	—	—	—	—	—	—	—	0.381 (J)	—	—	101
RE01-13-37604	01-108	3-4	QBT3	—	1.16 (U)	—	—	—	—	—	—	—	—	—	—	—	—	—	0.409 (J)	—	1.08 (U)	—
RE01-13-37623	01-108	5-6	QBT3	—	1.07 (U)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1.12 (U)	—
RE01-13-37586	01-109	1-2	QBT3	—	1.13 (U)	—	87.4	—	—	7860	—	—	—	—	22.3	—	—	—	0.442 (J)	0.00129 (J)	1.06 (U)	—

Table 6.2-2 (continued)

Sample ID	Location ID	Depth (ft)	Media	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Cyanide (Total)	Lead	Magnesium	Mercury	Nickel	Nitrate	Perchlorate	Selenium	Zinc
Soil BV[a]				**29200**	**0.83**	**8.17**	**295**	**1.83**	**0.4**	**6120**	**19.3**	**8.64**	**14.7**	**0.5**	**22.3**	**4610**	**0.1**	**15.4**	**na[b]**	**na**	**1.52**	**48.8**
Qbt2, 3, 4 BV[a]				**7340**	**0.5**	**2.79**	**46**	**1.21**	**1.63**	**2200**	**7.14**	**3.14**	**4.66**	**0.5**	**11.2**	**1690**	**0.1**	**6.58**	**na**	**na**	**0.3**	**63.5**
Industrial SSL[c]				**1130000**	**454**	**17.7**	**223000**	**2260**	**897**	**na**	**1700000[d]**	**300[e]**	**45400**	**681**	**800**	**na**	**341**	**22500**	**1820000**	**795**	**5680**	**341000**
Construction Worker SSL[c]				**40700**	**124**	**53**	**4350**	**144**	**277**	**na**	**465000[d]**	**34.8[f]**	**12400**	**186**	**800**	**na**	**92.9**	**6190**	**496000**	**217**	**1550**	**92900**
Residential SSL[c]				**78000**	**31.3**	**3.9**	**15600**	**156**	**70.3**	**na**	**117000[d]**	**23[e]**	**3130**	**46.9**	**400**	**na**	**23.5**	**1560**	**125000**	**54.8**	**391**	**23500**
RE01-13-37605	01-109	3-4	QBT3	—	1.03 (U)	—	77.5	—	—	2240	—	—	—	—	27.9	—	—	—	—	0.000621 (J)	1.15 (U)	—
RE01-13-37624	01-109	5-6	QBT3	—	1.09 (U)	—	—	—	—	2790	—	—	—	—	30.2	—	—	—	0.365 (J)	—	1.01 (U)	—
RE01-13-37587	01-110	1-2	FILL	—	1.01 (U)	—	—	—	0.503 (U)	6200	—	—	—	—	—	—	—	—	—	0.00144 (J)	—	—
RE01-13-37606	01-110	3-4	QBT3	8620	0.973 (U)	—	49.3	—	—	7400	—	—	—	—	—	1840	—	7.85	0.387 (J)	0.00114 (J)	1.15 (U)	—
RE01-13-37625	01-110	5-6	QBT3	10100	1.03 (U)	—	—	—	—	4350	—	—	4.83	—	12.4	2240	0.128	-	0.386 (J)	0.00336	1 (U)	—
RE01-13-37588	01-111	1-2	FILL	—	1.14 (U)	—	—	—	0.568 (U)	—	—	—	—	—	26.6	—	—	—	0.431 (J)	0.00092 (J)	—	—
RE01-13-37607	01-111	3-4	QBT3	12100	1.15 (U)	—	62.2	1.36	—	2710	—	3.32	6.68	—	46.4	2420	—	8.96	—	—	1.17 (U)	—
RE01-13-37626	01-111	5-6	QBT3	—	0.999 (U)	—	—	—	—	—	—	—	—	—	—	—	—	—	0.388 (J)	—	1.08 (U)	—
RE01-13-37589	01-112	1-2	QBT3	—	0.946 (U)	—	—	—	—	—	—	—	—	—	—	—	—	—	0.704 (J)	—	0.956 (U)	—
RE01-13-37608	01-112	3-4	QBT3	—	1.08 (U)	—	—	—	—	—	—	—	—	—	—	—	—	—	0.675 (J)	—	1.02 (U)	—
RE01-13-37627	01-112	5-6	QBT3	—	0.938 (U)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1.06 (U)	—
RE01-13-37590	01-113	1-2	QBT3	—	1.11 (U)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1.13 (U)	—
RE01-13-37609	01-113	3-4	QBT3	—	1.04 (U)	—	—	—	—	—	13.2	—	—	—	—	—	—	—	—	—	1.05 (U)	—
RE01-13-37628	01-113	5-6	QBT3	—	1.01 (U)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1.02 (U)	—
RE01-13-37591	01-114	1-2	QBT3	—	1.12 (U)	—	—	—	—	—	8.7	—	—	—	—	—	—	—	—	—	1.08 (U)	—
RE01-13-37610	01-114	3-4	QBT3	—	1.07 (U)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.557 (J)	—
RE01-13-37629	01-114	5-6	QBT3	—	1.12 (U)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.973 (U)	—
RE01-13-37592	01-115	1-2	QBT3	—	1.15 (U)	—	—	—	—	—	—	—	—	—	—	—	—	6.95	—	—	1.15 (U)	—
RE01-13-37611	01-115	3-4	QBT3	—	1.08 (U)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1.14 (U)	—
RE01-13-37630	01-115	5-6	QBT3	—	1.1 (U)	—	—	—	—	—	7.73	—	—	—	—	—	—	—	—	—	1.11 (U)	—
RE01-13-37593	01-116	1-2	FILL	—	1.23 (U)	—	—	1.84	0.615 (U)	—	—	—	—	—	22.5	—	—	—	—	—	—	48.9
RE01-13-37612	01-116	3-4	FILL	—	1.2 (U)	—	—	—	0.598 (U)	—	—	—	—	—	—	—	—	—	—	—	—	—

Table 6.2-2 (continued)

Sample ID	Location ID	Depth (ft)	Media	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Cyanide (Total)	Lead	Magnesium	Mercury	Nickel	Nitrate	Perchlorate	Selenium	Zinc
Soil BV[a]				**29200**	**0.83**	**8.17**	**295**	**1.83**	**0.4**	**6120**	**19.3**	**8.64**	**14.7**	**0.5**	**22.3**	**4610**	**0.1**	**15.4**	**na[b]**	**na**	**1.52**	**48.8**
Qbt2, 3, 4 BV[a]				**7340**	**0.5**	**2.79**	**46**	**1.21**	**1.63**	**2200**	**7.14**	**3.14**	**4.66**	**0.5**	**11.2**	**1690**	**0.1**	**6.58**	**na**	**na**	**0.3**	**63.5**
Industrial SSL[c]				**1130000**	**454**	**17.7**	**223000**	**2260**	**897**	**na**	**1700000[d]**	**300[e]**	**45400**	**681**	**800**	**na**	**341**	**22500**	**1820000**	**795**	**5680**	**341000**
Construction Worker SSL[c]				**40700**	**124**	**53**	**4350**	**144**	**277**	**na**	**465000[d]**	**34.8[f]**	**12400**	**186**	**800**	**na**	**92.9**	**6190**	**496000**	**217**	**1550**	**92900**
Residential SSL[c]				**78000**	**31.3**	**3.9**	**15600**	**156**	**70.3**	**na**	**117000[d]**	**23[e]**	**3130**	**46.9**	**400**	**na**	**23.5**	**1560**	**125000**	**54.8**	**391**	**23500**
RE01-13-37631	01-116	5-6	QBT3	—	1.03 (U)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1.06 (U)	—
RE01-13-37594	01-117	1-2	QBT3	—	1.07 (U)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1.05 (U)	—
RE01-13-37613	01-117	3-4	QBT3	—	1.09 (U)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1.17 (U)	—
RE01-13-37632	01-117	5-6	QBT3	—	1.13 (U)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1.1 (U)	—

Notes: Results are in mg/kg. Data qualifiers are defined in Appendix A.

[a] BVs from LANL (1998, 059730).

[b] na = Not available.

[c] SSLs from NMED (2012, 219971).

[d] SSL for trivalent chromium.

[e] EPA regional screening level (http://www.epa.gov/region06/6pd/rcra_c/pd-n/screen.htm).

[f] Construction worker SSL calculated using toxicity value from EPA regional screening tables (http://www.epa.gov/region06/6pd/rcra_c/pd-n/screen.htm) and equation and parameters from NMED (2012, 219971).

[g] — = Not detected or not detected above BV.

Table 6.2-3
Organic Chemicals Detected at AOC 01-007(k)

Sample ID	Location ID	Depth (ft)	Media	Acetone	Aroclor-1248	Aroclor-1254	Aroclor-1260	Benzo(a)anthracene	Benzo(b)fluoranthene	Benzoic Acid	Bis(2-ethylhexyl)phthalate	Butylbenzylphthalate	Chrysene	Di-n-butylphthalate	Diethylphthalate	Fluoranthene	Methylene Chloride	Pyrene
Industrial SSL[a]				**868000**	**8.26**	**8.26**	**8.26**	**23.4**	**23.4**	**2500000[b]**	**1370**	**9100[b]**	**2340**	**68400**	**547000**	**24400**	**4700**	**18300**
Construction Worker SSL[a]				**221000**	**75.8**	**4.36**	**75.8**	**213**	**213**	**953000[c]**	**4760**	**47600[c]**	**20600**	**23800**	**191000**	**8910**	**1120**	**6680**
Residential SSL[a]				**66600**	**2.22**	**1.12**	**2.22**	**1.48**	**1.48**	**240000[b]**	**347**	**2600[b]**	**148**	**6100**	**48900**	**2290**	**409**	**1720**
RE00-08-16298	00-603879	1–2	QBT3	—[d]	—	—	—	—	—	—	—	—	—	—	—	—	0.02 (J)	—
RE00-08-16299	00-603879	3–4	QBT3	0.0064 (J)	—	—	—	—	—	—	—	—	—	—	—	—	0.026 (J)	—
RE00-08-16300	00-603880	2–3	QBT3	—	—	—	—	—	—	—	—	—	—	—	—	—	0.0032 (J)	—
RE00-08-16301	00-603880	4–5	QBT3	—	—	—	—	—	—	—	—	—	—	—	—	—	0.0025 (J)	—
RE00-08-16302	00-603881	1.25–2.25	QBT3	—	—	—	—	—	—	—	—	—	—	—	—	—	0.013 (J)	—
RE00-08-16303	00-603881	3.25–4.25	QBT3	—	—	—	—	—	—	—	—	—	—	—	—	—	0.015 (J)	—
RE01-13-37619	01-104	5–6	SOIL	—	—	—	—	—	—	—	—	—	—	0.318 (J)	—	—	—	—
RE01-13-37582	01-105	1–2	FILL	—	—	—	—	—	—	—	—	—	—	0.404	—	—	—	—
RE01-13-37583	01-106	1–2	QBT3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.0126 (J)
RE01-13-37621	01-106	5–6	QBT3	—	—	—	—	—	—	—	—	—	—	0.487	—	—	—	—
RE01-13-37584	01-107	1–2	FILL	—	—	0.00219 (J)	0.00188 (J)	—	—	—	—	—	—	—	—	—	—	—
RE01-13-37603	01-107	3–4	QBT3	—	—	—	—	—	—	—	—	0.52	—	—	—	—	—	—
RE01-13-37585	01-108	1–2	FILL	—	0.0415	0.0339	0.0132 (J)	—	—	—	0.154 (J)	0.746	—	—	—	—	—	—
RE01-13-37604	01-108	3–4	QBT3	—	0.00384 (J)	0.00288 (J)	—	—	—	—	—	—	—	—	—	—	—	—
RE01-13-37623	01-108	5–6	QBT3	—	0.00589	0.00489	—	—	—	0.47 (J)	0.386 (J)	—	—	—	0.139 (J)	—	—	—
RE01-13-37587	01-110	1-2	FILL	0.00229 (J)	—	—	—	—	—	—	—	—	—	—	—	—	—	—
RE01-13-37606	01-110	3-4	QBT3	0.00883	—	—	—	—	—	—	—	—	—	—	—	—	—	—
RE01-13-37625	01-110	5-6	QBT3	0.00595	—	—	—	—	—	—	—	—	—	—	—	—	—	—
RE01-13-37589	01-112	1-2	QBT3	—	—	0.0017 (J)	—	0.0163 (J)	0.0115 (J)	—	—	—	0.0122 (J)	—	—	0.0166 (J)	—	0.0177 (J)
RE01-13-37610	01-114	3-4	QBT3	0.00755	—	—	—	—	—	—	—	—	—	—	—	—	—	—
RE01-13-37629	01-114	5-6	QBT3	—	—	—	—	—	—	—	—	—	—	0.126 (J)	—	—	—	—
RE01-13-37592	01-115	1-2	QBT3	—	—	—	—	—	—	—	—	—	—	0.117 (J)	—	—	—	—

Notes: Results are in mg/kg. Data qualifiers are defined in Appendix A.

[a] SSLs from NMED (2012, 219971) unless otherwise indicated.

[b] EPA regional screening level (http://www.epa.gov/region06/6pd/rcra_c/pd-n/screen.htm).

[c] Construction worker SSL calculated using toxicity value from EPA regional screening tables (http://www.epa.gov/region06/6pd/rcra_c/pd-n/screen.htm) and equation and parameters from NMED (2012, 219971).

[d] — = Not detected.

Table 6.2-4
Radionuclides Detected or Detected above BVs/FVs at AOC 01-007(k)

Sample ID	Location ID	Depth (ft)	Media	Plutonium-239/240	Tritium	Uranium-235/236
Soil BV[a]				**0.054**[b]	**na**[c]	**0.2**
Qbt2, 3, 4 BV[a]				**na**	**na**	**0.09**
Industrial SSL[d]				**1200**	**200000**	**150**
Construction Worker SSL[d]				**120**	**62000**	**100**
Residential SSL[d]				**79**	**850**	**39**
RE00-08-16300	00-603880	2–3	QBT3	—[e]	—	0.16
RE00-08-16301	00-603880	4–5	QBT3	—	—	0.197
RE01-13-37581	01-104	1–2	FILL	—	0.105761	—
RE01-13-37600	01-104	3–4	FILL	—	0.0837926	—
RE01-13-37619	01-104	5–6	SOIL	—	0.111338	—
RE01-13-37582	01-105	1-2	FILL	—	0.119657	—
RE01-13-37601	01-105	3–4	FILL	—	0.162	—
RE01-13-37620	01-105	5–6	QBT3	—	0.114393	0.0939
RE01-13-37602	01-106	3–4	QBT3	—	0.0219799	—
RE01-13-37584	01-107	1–2	FILL	0.038	—	—
RE01-13-37585	01-108	1–2	FILL	0.0332	—	—
RE01-13-37586	01-109	1–2	QBT3	—	0.633597	—
RE01-13-37605	01-109	3–4	QBT3	—	0.441163	—
RE01-13-37624	01-109	5–6	QBT3	—	0.0656868	—
RE01-13-37587	01-110	1–2	FILL	—	0.102112	—
RE01-13-37588	01-111	1–2	FILL	—	0.327746	—
RE01-13-37589	01-112	1–2	QBT3	—	0.236667	—
RE01-13-37608	01-112	3–4	QBT3	—	0.173749	—
RE01-13-37627	01-112	5–6	QBT3	—	0.0581963	—
RE01-13-37609	01-113	3–4	QBT3	—	0.0244087	—
RE01-13-37592	01-115	1–2	QBT3	—	0.0311148	—
RE01-13-37612	01-116	3–4	FILL	—	0.0421968	—

Note: Results are in pCi/g.

[a] BVs/FVs are from LANL (1998, 059730).

[b] FV applies to soil and tuff samples collected from 0–1 ft only.

[c] na = Not available.

[d] SALs for radionuclides from LANL (2012, 228852).

[e] — = Not detected or not detected above BV/FV.

Appendix A

Acronyms and Abbreviations,
Metric Conversion Table, and Data Qualifier Definitions

A-1.0 ACRONYMS AND ABBREVIATIONS

%R	percent recovery
AOC	area of concern
AK	acceptable knowledge
ALARA	as low as reasonably achievable
ATSDR	Agency for Toxic Substances and Disease Registry
AUF	area use factors
bgs	below ground surface
BV	background value
CCV	continuing calibration verification
COC	chain of custody
Consent Order	Compliance Order on Consent
COPEC	chemical of potential ecological concern
COPC	chemical of potential concern
CSM	conceptual site model
CVAA	cold vapor atomic absorption
D&D	decontamination and decommissioning
DAF	dilution attenuation factor
DGPS	differential global-positioning system
DL	detection limit
DOE	Department of Energy (U.S.)
dpm	disintegrations per minute
Eh	oxidation-reduction potential
EPA	Environmental Protection Agency (U.S.)
EPC	exposure point concentration
EQL	estimated quantitation limit
ESL	ecological screening level
eV	electronvolt
FV	fallout value
GS/MS	gas chromatography–mass spectrometry
HI	hazard index
HQ	hazard quotient
HR	home range

ICS	interference check sample
ICV	initial calibration verification
I.D.	inside diameter
ID	identification
IDW	investigation-derived waste
IS	internal standard
K_d	soil-water partition coefficient
K_{oc}	organic-carbon partition coefficient
K_{ow}	octanol-water partition coefficient
LAL	lower acceptance limit
LANL	Los Alamos National Laboratory
LANS	Los Alamos National Security, LLC
LCS	laboratory control sample
LOAEL	lowest observed adverse effect level
MDC	minimum detectable concentration
MDL	method detection limit
MS	matrix spike
MSD	matrix spike duplicate
MSW	municipal solid waste
NMED	New Mexico Environment Department
NOAEL	no-observed-adverse-effect level
NOD	notice of disapproval
PAH	polycyclic aromatic hydrocarbon
PAUF	population area use factor
PCB	polychlorinated biphenyls
PID	photoionization detector
PRG	preliminary remediation goal
QA	quality assurance
QC	quality control
RCT	radiological control technician
RDA	recommended daily allowance
RfD	reference dose
RPD	relative percent difference
RPF	Records Processing Facility

SAL	screening action level
SCL	sample collection log
SF	slope factor
SMO	Sample Management Office
SOP	standard operating procedure
SOW	statement of work
SSL	soil screening level
SVOC	semivolatile organic compound
SWMU	solid waste management unit
T&E	threatened and endangered
TA	technical area
TAL	target analyte list
TRV	toxicity reference value
UAL	upper acceptance level
UCL	upper confidence limit
UTL	upper tolerance limit
VOC	volatile organic compound
WCSF	waste characterization strategy form

A-2.0 METRIC CONVERSION TABLE

Multiply SI (Metric) Unit	by	To Obtain U.S. Customary Unit
kilometers (km)	0.622	miles (mi)
kilometers (km)	3281	feet (ft)
meters (m)	3.281	feet (ft)
meters (m)	39.37	inches (in.)
centimeters (cm)	0.03281	feet (ft)
centimeters (cm)	0.394	inches (in.)
millimeters (mm)	0.0394	inches (in.)
micrometers or microns (µm)	0.0000394	inches (in.)
square kilometers (km^2)	0.3861	square miles (mi^2)
hectares (ha)	2.5	acres
square meters (m^2)	10.764	square feet (ft^2)
cubic meters (m^3)	35.31	cubic feet (ft^3)
kilograms (kg)	2.2046	pounds (lb)
grams (g)	0.0353	ounces (oz)
grams per cubic centimeter (g/cm^3)	62.422	pounds per cubic foot (lb/ft^3)
milligrams per kilogram (mg/kg)	1	parts per million (ppm)
micrograms per gram (µg/g)	1	parts per million (ppm)
liters (L)	0.26	gallons (gal.)
milligrams per liter (mg/L)	1	parts per million (ppm)
degrees Celsius (°C)	9/5 + 32	degrees Fahrenheit (°F)

A-3.0 DATA QUALIFIER DEFINITIONS

Data Qualifier	Definition
U	The analyte was analyzed for but not detected.
J	The analyte was positively identified, and the associated numerical value is estimated to be more uncertain than would normally be expected for that analysis.
J+	The analyte was positively identified, and the result is likely to be biased high.
J-	The analyte was positively identified, and the result is likely to be biased low.
UJ	The analyte was not positively identified in the sample, and the associated value is an estimate of the sample-specific detection or quantitation limit.
R	The data are rejected as a result of major problems with quality assurance/quality control (QA/QC) parameters.

Appendix B

Field Methods

B-1.0 INTRODUCTION

This appendix summarizes field methods implemented during the investigation Area of Concern (AOC) 01-007(k) at Los Alamos National Laboratory (LANL or the Laboratory). Table B-1.0-1 provides a summary of field investigation methods, and the following sections provide more detailed descriptions of these methods. All activities were conducted in accordance with approved subcontractor procedures technically equivalent to Laboratory standard operating procedures (SOPs) listed in Table B-1.0-2 and available at http://www.lanl.gov/community-environment/environmental-stewardship/plans-procedures.php.

B-2.0 EXPLORATORY DRILLING CHARACTERIZATION

No drilling was conducted during the investigation.

B-3.0 FIELD-SCREENING METHODS

This section summarizes the field-screening methods used during the investigation activities. Field screening for organic vapors was performed as necessary for health and safety purposes. Field screening for radioactivity was performed on every sample submitted to the Sample Management Office (SMO). Field screening for all investigation activities are described in section 3.2 of the investigation report and results are presented in Table 3.2-2.

B-3.1 Field Screening for Organic Vapors

Field screening for organic vapors was conducted for all samples. Screening was conducted using a MiniRae 2000 photoionization detector (PID) equipped with an 11.7-electronvolt lamp. Screening was performed in accordance with the manufacturer's specifications and SOP-06.33, Headspace Vapor Screening with a Photoionization Dectector. Screening was performed on each sample collected, and screening measurements were recorded on the field sample collection logs (SCLs) and chain-of-custody (COC) forms, provided on CD in Appendix E. The field-screening results are presented in Table 3.2-2.

B-3.2 Field Screening for Radioactivity

All samples collected were field screened for radioactivity before they were submitted to the SMO, targeting alpha and beta/gamma emitters. A Laboratory radiological control technician (RCT) 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 Eberline E-600 with attachment SHP-380AB consists of a dual phosphor plate covered by two Mylar windows housed in a light-excluding metal body. The phosphor plate is a plastic scintillator used to detect beta and gamma emissions and is thinly coated with zinc sulfide for detection of alpha emissions. The operational range varies from trace emissions to 1 million disintegrations per minute. Screening measurements were recorded on the SCLs and COC forms and are provided on CD in Appendix E. The screening results are presented in Table 3.2-2.

B-4.0 FIELD INSTRUMENT CALIBRATION

Instrument calibration and/or function check was completed daily. Several environmental factors affected the instruments' integrity, including air temperature, atmospheric pressure, wind speed, and humidity. Calibration of the PID was conducted by the site-safety officer. Calibration of the Eberline E-600 was

conducted by the RCT. All calibrations were performed according to the manufacturer's specifications and requirements.

B-4.1 MiniRAE 2000 Instrument Calibration

The MiniRAE 2000 PID was calibrated both to ambient air and a standard reference gas (100 ppm isobutylene). The ambient-air calibration determined the zero point of the instrument sensor calibration curve in ambient air. Calibration with the standard reference gas determined a second point of the sensor calibration curve. Each calibration was within 3% of 100 ppm isobutylene, qualifying the instrument for use.

The following calibration information was recorded daily on operational calibration logs:

- instrument identification (ID) number
- final span settings
- date and time
- concentration and type of calibration gas used (isobutylene at 100 ppm)
- name of the personnel performing the calibration

All daily calibration procedures for the MiniRAE 2000 PID met the manufacturer's specifications for standard reference gas calibration.

B-4.2 Eberline E-600 Instrument Calibration

The Eberline E-600 was calibrated daily by the RCT before local background levels for radioactivity were measured. The instrument was calibrated using plutonium-239 and chloride-36 sources for alpha and beta emissions, respectively. The following five checks were performed as part of the calibration procedures:

- calibration date
- physical damage
- battery
- response to a source of radioactivity
- background

All calibrations performed for the Eberline E-600 met the manufacturer's specifications and the applicable radiation detection instrument manual.

B-5.0 SURFACE AND SUBSURFACE SAMPLING

This section summarizes the methods used for collecting surface and subsurface samples, including soil, fill, and tuff samples.

B-5.1 Surface Sampling Methods

Surface and shallow subsurface samples were collected using either hand-auger or spade-and-scoop methods in accordance with approved subcontractor procedures technically equivalent to SOP-06.10, Hand Auger and Thin Tube Sampler, or SOP-06.09, Spade and Scoop Method for the Collection of Soil Samples.

A hand auger or spade and scoop were used to collect material in approximately 6-in. increments. Samples for volatile organic compound (VOC) analysis were collected immediately to minimize the loss of subsurface VOCs during the sample collection process. Containers for VOC samples were filled as completely as possible, leaving no or minimal headspace, and sealed with a Teflon-lined cap. Table B-1.0-1 provides additional details on the collection of samples for VOC analysis. The description provided is specific to the sampling method rather than to the media (e.g., soil samples are collected using the spade-and-scoop method in the same manner as sediment samples). The remaining sample material was placed in a stainless-steel bowl with a stainless-steel scoop, after which it was transferred to sterile sample collection jars or bags. Samples were preserved using coolers to maintain the required temperature and chemical preservatives, such as nitric acid, in accordance with an approved subcontractor procedure technically equivalent to EP-ERSS-SOP-5056, Sample Containers and Preservation.

Samples were appropriately labeled, sealed with custody seals, and documented before they were transported to the SMO. Samples were managed in accordance with an approved subcontractor procedures technically equivalent to EP-ERSS-SOP-5057, Handling, Packaging, and Transporting Field Samples, and WES-EDA-QP-219, Sample Control and Field Documentation.

Sample collection tools were decontaminated (see section B-5.5) immediately before each sample was collected in accordance with a subcontractor procedure technically equivalent to EP-ERSS-SOP-5061, Field Decontamination of Equipment.

B-5.2 Subsurface Tuff Sampling Methods

Subsurface samples were collected in accordance with an approved subcontractor procedures technically equivalent to SOP-06.10, Hand Auger and Thin Tube Sampler.

Subsurface samples were collected using the hand-auger method, assisted by a power auger where necessary. Samples for VOC analysis were collected immediately to minimize the loss of subsurface VOCs during the sample collection process. Containers for VOC samples were filled as completely as possible, leaving no or minimal headspace, and sealed with a Teflon-lined cap. Table B-1.0-1 provides additional details on collection of samples for VOC analysis. The description provided is specific to the sampling method rather than to the media (e.g., soil samples are collected using the hand auger method in the same manner as sediment samples). The remaining sample material was placed in a stainless-steel bowl with a stainless-steel scoop, after which it was transferred to sterile sample collection jars or bags. Samples were preserved using coolers to maintain the required temperature and chemical preservatives, such as nitric acid, in accordance with an approved subcontractor procedure technically equivalent to SOP-5056, Sample Containers and Preservation.

Samples were appropriately labeled, sealed with custody seals, and documented before they were transported to the SMO. Samples were managed in accordance with an approved subcontractor procedures technically equivalent to EP-ERSS-SOP-5057, Handling, Packaging, and Transporting Field Samples, and WES-EDA-QP-219, Sample Control and Field Documentation.

Sample collection tools were decontaminated (see section B-5.5) immediately before each sample was collected in accordance with a subcontractor procedure technically equivalent to EP-ERSS-SOP-5061, Field Decontamination of Equipment.

B-5.3 Quality Control Samples

Quality control (QC) samples were collected in accordance with an approved subcontractor procedure technically equivalent to EP-ERSS-SOP-5059, Field Quality Control Samples. QC samples included field duplicates, field rinsate blanks, and field trip blanks. Field duplicate samples were collected from the same material as a regular investigation sample and submitted for the same analyses. Field duplicate samples were collected at a frequency of at least 1 duplicate sample for every 10 samples.

Field rinsate blanks were collected to evaluate field decontamination procedures. Rinsate blanks were collected by rinsing sampling equipment (i.e., auger buckets, sampling bowls and spoons) with deionized water after decontamination. The rinsate water was collected in a sample container and submitted to the SMO. Field rinsate blank samples were analyzed for inorganic chemicals (target analyte list metals, perchlorate, and total cyanide) and were collected from sampling equipment at a frequency of at least 1 rinsate sample for every 10 solid samples.

Field trip blanks also were collected at a frequency of 1 per day at the time samples were collected for VOCs. Trip blanks consisted of containers of certified clean sand opened and kept with the other sample containers during the sampling process.

B-5.4 Sample Documentation and Handling

Field personnel completed a SCL/COC form for each sample. Sample containers were sealed with signed COC seals and placed in coolers at approximately 4°C. Samples were packed with preservatives, if necessary, and handled and shipped in accordance with the most current versions of SOP-5057, Handling, Packaging, and Transporting Field Samples and EP-ERSS-SOP-5056, Sample Containers and Preservation. Samples were transported to the SMO on ice, in sealed coolers, before they were shipped to the analytical laboratory. The SMO personnel reviewed and approved the SCL/COC forms before taking custody of the sample.

B-5.5 Decontamination of Sampling Equipment

All sampling equipment was decontaminated immediately before each sample was collected to avoid outside contamination and cross-contamination between samples. Decontamination included cleaning the equipment with Fantastik and clean paper towels. Decontamination activities were performed in accordance with an approved subcontractor procedure technically equivalent to SOP-5061, Field Decontamination of Equipment. To evaluate decontamination activities, rinsate blank samples were collected in accordance with the most current version of EP-ERSS-SOP-5059, Field Quality Control Samples.

B-6.0 GEODETIC SURVEYING

Geodetic surveys of all sample locations were performed using a Trimble RTK 5700 differential global positioning system (DGPS) referenced from published and monumented external Laboratory survey control points in the vicinity. All sampling locations were surveyed in accordance with an approved subcontractor procedure technically equivalent to EP-ERSS-SOP-5028, Coordinating and Evaluating Geodetic Surveys. Horizontal accuracy of the monumented control points is within 0.1 ft. The DGPS instrument referenced from Laboratory control points is accurate within 0.2 ft. The surveyed coordinates are presented in Table 3.1-1.

B-7.0 IDW STORAGE AND DISPOSAL

All IDW generated during the field investigation was managed in accordance with EP-DIR-SOP-10021, Characterization and Management of Environmental Program Waste. This procedure incorporates the requirements of all applicable U.S. Environmental Protection Agency (EPA) and New Mexico Environment Department (NMED) regulations, U.S. Department of Energy orders, and Laboratory implementation requirements. Investigation-derived waste (IDW) was also managed in accordance with the approved waste characterization strategy form and the IDW management appendix of the approved investigation work plan (LANL 2006, 091916; LANL 2006, 094200; NMED 2006, 095460). Details of IDW management are presented in Appendix C.

B-8.0 DEVIATIONS

Locations 01-117, 01-115, and 01-114 were relocated 18 ft east because of a health and safety hazard (water utility line).

Locations 01-112, 01-113, 01-110, and 01-111 were relocated to an adjacent property where an approved Los Alamos National Security, LLC (LANS) access agreement with the property owner had been executed.

Other locations on the east and west ends of the site were not sampled because LANS was unable to execute access agreements with the property owners. Not sampling the locations did not affect the results and conclusions of this report.

B-9.0 REFERENCES

The following list includes all documents cited in this appendix. Parenthetical information following each reference provides the author(s), publication date, and ER ID. This information is also included in text citations. ER IDs are assigned by the Environmental Programs Directorate's Records Processing Facility (RPF) and are used to locate the document at the RPF and, where applicable, in the master reference set.

Copies of the master reference set are maintained at the New NMED Hazardous Waste Bureau and the 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.

LANL (Los Alamos National Laboratory), April 2006. "Investigation Work Plan for Upper Los Alamos Canyon Aggregate Area," Los Alamos National Laboratory document LA-UR-06-2464, Los Alamos, New Mexico. (LANL 2006, 091916)

LANL (Los Alamos National Laboratory), August 22, 2006. "Response to the Notice of Disapproval for Investigation Work Plan for the Upper Los Alamos Canyon Aggregate Area," Los Alamos National Laboratory document LA-UR-06-6753, Los Alamos, New Mexico. (LANL 2006, 094200)

NMED (New Mexico Environment Department), November 6, 2006. "Approval of the Investigation Work Plan, Upper Los Alamos Canyon Aggregate Area," New Mexico Environment Department letter to D. Gregory (DOE-LASO) and D. McInroy (LANL) from J.P. Bearzi (NMED-HWB), Santa Fe, New Mexico. (NMED 2006, 095460)

Table B-1.0-1
Brief Description of Field Investigation Methods

Method	Summary
Spade and Scoop Collection of Soil Samples	This method is typically used to collect shallow (i.e., approximately 0.0-12.0 in.) soil or sediment samples. The spade-and-scoop method involves digging a hole to the desired depth, as prescribed in the work plan, and collecting a discrete grab sample. Samples for VOC analysis were transferred immediately into sample containers. Containers for VOC analysis were filled as completely as possible and sealed with Teflon-lined caps. The remaining sample material was placed in a clean stainless-steel bowl for transfer into various sample containers.
Hand Auger Sampling	This method is typically used to sample soil or sediment at depths of less than 10.0–15.0 ft but in some cases may be used to collect samples of weathered or nonwelded tuff. The method involves hand-turning a stainless-steel bucket auger (typically 3–4 in. inside diameter [I.D.]), creating a vertical hole that can be advanced to the desired sampling depth. When the desired depth was reached, the auger was decontaminated before the hole was advanced through the sample depth. Samples for VOC analysis were transferred immediately into sample containers. Containers for VOC analysis were filled as completely as possible and sealed with Teflon-lined caps. The remaining sample material was placed in a clean stainless-steel bowl for transfer into various sample containers.
Headspace Vapor Screening	Individual soil, rock, or sediment samples were field screened for VOCs by placing a portion of the sample in a plastic sample bag or in a glass container with a foil-sealed cover. The container was sealed and gently shaken and allowed to equilibrate for 5 min. The sample was then screened by inserting a PID probe into the container and measuring and recording any detected vapors.
Handling, Packaging, and Shipping of Samples	Field team members sealed and labeled samples before packing and ensured the sample containers and the containers used for transport were free of external contamination. Field team members packaged all samples to minimize the possibility of breakage during transport. After all environmental samples were collected, packaged, and preserved, a field team member transported them to the SMO. The SMO arranged for shipping the samples to analytical laboratories.
Sample Control and Field Documentation	The collection, screening, and transport of samples were documented on standard forms generated by the SMO. These included SCLs, COC forms, and sample container labels. SCLs were completed at the time of sample collection, and the logs were signed by the sampler and a reviewer who verified the logs for completeness and accuracy. Corresponding labels were initialed and applied to each sample container, and custody seals were placed around each sample container. COC forms were completed and signed to verify that the samples were not left unattended.

Table B-1.0-1 (continued)

Method	Summary
Field Quality Control Samples	Field quality control samples were collected as follows: *Field Duplicates*: at a frequency 10%; collected at the same time as a regular sample and submitted for the same analyses *Equipment Rinsate Blank*: at a frequency of 10%; collected by rinsing sampling equipment with deionized water that was collected in a sample container and submitted for laboratory analysis *Trip Blanks*: required for all field events that include the collection of samples for VOC analysis. Trip blanks containers of certified clean sand were opened and kept with the other sample containers during the sampling process
Containers and Preservation of Samples	Specific requirements/processes for sample containers, preservation techniques, and holding times are based on EPA guidance for environmental sampling, preservation, and quality assurance. Specific requirements for each sample were printed on the SCL provided by the SMO (size and type of container [e.g., glass, amber glass, and polyethylene]). All samples were preserved by placing them in insulated containers with ice to maintain a temperature of 4°C.
Coordinating and Evaluating Geodetic Surveys	Geodetic surveys focused on obtaining survey data of acceptable quality to use during project investigations. Geodetic surveys were conducted with a Trimble 5700 DGPS. The survey data conformed to Laboratory Information Architecture project standards IA-CB02, GIS Horizontal Spatial Reference System, and IA-D802, Geospatial Positioning Accuracy Standard for A/E/C/ and Facility Management. All coordinates were expressed as State Plain Coordinate System 83, NM Central, U.S. feet. All elevation data were reported relative to the National Geodetic Vertical Datum of 1983.
Management of Environmental Restoration Project Waste, Waste Characterization	IDW is managed, characterized, and stored in accordance with an approved waste characterization strategy form that documents site history, field activities, and characterization approach for each waste stream managed. Waste characterization complied with on- or off-site waste acceptance criteria. All stored IDW was marked with appropriate signage and labels. Drummed IDW was stored on pallets to prevent the containers from deteriorating. A waste storage area was established before waste was generated. Waste storage areas located in controlled areas of the Laboratory were controlled as needed to prevent inadvertent addition to or management of wastes by unauthorized personnel. Each container of waste generated was individually labeled with waste classification, item identification number, and radioactivity (if applicable), immediately following containerization. All waste was segregated by classification and compatibility to prevent cross-contamination. Management of IDW is described in Appendix C.

Table B-1.0-2
SOPs Used for Investigation Activities at AOC 01-007(k)

SOP-5028, Coordinating and Evaluating Geodetic Surveys
SOP-5056, Sample Containers and Preservation
SOP-5057, Handling, Packaging, and Transporting Field Samples
WES-ESA-QP-219, Sample Control and Field Documentation
SOP-5059, Field Quality Control Samples
SOP-5061, Field Decontamination of Equipment
SOP-5181, Notebook and Logbook Documentation for Environmental Directorate Technical and Field Activities
EP-DIR-SOP-10021, Characterization and Management of Environmental Program Waste
SOP-5245, Background Value Comparisons – Inorganic Chemicals
SOP-5246, Background Value Comparisons – Radionuclides
SOP-06.09, Spade and Scoop Method for the Collection of Soil Samples
SOP-06.10, Hand Auger and Thin-Wall Tube Sampler
SOP-06.33, Headspace Vapor Screening with a Photoionization Detector

Note: Procedures used were approved subcontractor procedures technically equivalent to the procedures listed.

Appendix C

Investigation-Derived Waste Management

C-1.0 INTRODUCTION

This appendix contains the waste management records for the investigation-derived waste (IDW) generated during the implementation of the investigation at Area of Concern (AOC) 01-007(k) at Los Alamos National Laboratory (LANL or the Laboratory).

All IDW generated during the field investigation was managed in accordance with standard operating procedure (SOP) EP-DIR-SOP-10021, Characterization and Management of Environmental Program Waste. This procedure incorporates the requirements of applicable U.S. Environmental Protection Agency and New Mexico Environment Department regulations, U.S. Department of Energy orders, and Laboratory policies and procedures.

Consistent with Laboratory procedures, a waste characterization strategy form (WCSF) was prepared to address characterization approaches, on-site management, and final disposition options for wastes. Analytical data and information on wastes generated during previous investigations and/or acceptable knowledge (AK) were used to complete the WCSF. The WCSF is included in this appendix as Attachment C-1 (on CD).

The selection of waste containers was based on appropriate U.S. Department of Transportation requirements, waste types, and estimated volumes of IDW to be generated. Immediately following containerization, each waste container was individually labeled with a unique identification number and with information regarding waste classification, contents, and radioactivity, if applicable.

Wastes were staged in clearly marked, appropriately constructed waste accumulation areas. Waste accumulation area postings, regulated storage duration, and inspection requirements were based on the type of IDW and its classification. Container and storage requirements were detailed in the WCSF and approved before waste was generated.

Investigation activities were conducted in a manner that minimized the generation of waste. Waste minimization was accomplished by implementing the most recent version of the “Los Alamos National Laboratory Hazardous Waste Minimization Report.”

C-2.0 WASTE STREAMS

The IDW streams generated and managed during the investigation at AOC 01-007(k) are described below and are summarized in Table C-2.0-1. The waste stream numbers correspond with those identified in the WCSF.

- WCSF Waste Stream #1: Municipal solid waste (MSW) consisted of noncontact trash and debris and empty sample preservation containers. Less than 0.1 yd^3 of waste was generated and was determined to be nonhazardous, nonradioactive waste. It was stored in plastic-lined trash cans and disposed of at the former Los Alamos County landfill.

- WCSF Waste Stream #2: Contact waste consisted of spent personal protective equipment, material used in dry decontamination of sampling equipment (e.g., paper towels), and sampling equipment and other materials that contacted, or potentially contacted, contaminated environmental media and could not be decontaminated. This waste included, but was not limited to, plastic sheeting (e.g., tarps and liners); gloves; paper towels; plastic and glass sample bottles; and disposable sampling supplies. These wastes were containerized at the point of generation and were characterized based on AK of the waste materials, the methods of generation, and analytical data for the media with which they came into contact. Less than 0.1 yd^3 of contact waste was generated and disposed of at an authorized off-site disposal facility.

Table C-2.0-1
Summary of IDW Generation and Management

Waste Stream	Waste Type	Volume	Characterization Method	On-Site Management	Disposition
Municipal Solid	MSW	<0.1 yd^3	AK	Plastic bags	Off-site municipal landfill
Contact Waste	Industrial	<0.1 yd^3	AK and analytical results of site characterization	5-gal. drums, plastic bags	Authorized off-site disposal facility

Attachment C-1

Waste Characterization Strategy Form
(on CD included with this document)

Appendix D

Analytical Program

D-1.0 INTRODUCTION

This appendix discusses the analytical methods and data-quality review for samples collected during 2008 and 2013 investigations at Area of Concern (AOC) 01-007(k) at Los Alamos National Laboratory (LANL or the Laboratory). Additionally, this appendix summarizes the effects of data-quality issues on the acceptability of the analytical data.

The analytical program for this investigation includes submission of samples to approved contract laboratories, with specific requirements for analytical methods, data quality, and reporting. Quality assurance (QA), quality control (QC), and data validation procedures were implemented in accordance with the Quality Assurance Project Plan Requirements for Sampling and Analysis (LANL 1996, 054609), and the Laboratory's statements of work (SOWs) for analytical laboratories (LANL 2000, 071233; LANL 2008, 109962). The results of the QA/QC procedures were used to estimate the accuracy, bias, and precision of the analytical measurements. Samples for QC include method blanks, matrix spikes (MSs), laboratory control samples (LCSs), internal standards (IS), initial calibration verifications (ICVs) and continuing calibration verifications (CCVs), surrogates, and tracers.

The type and frequency of laboratory QC analyses are described in the SOWs for analytical laboratories (LANL 2000, 071233; LANL 2008, 109962). Other QC factors, such as sample preservation and holding times, were also assessed in accordance with the requirements outlined in standard operating procedure (SOP) EP-ERSS-SOP-5056, Sample Containers and Preservation.

The following SOPs, available at http://www.lanl.gov/community-environment/environmental-stewardship/plans-procedures.php, were used for data validation:

- SOP-5161, Routine Validation of Volatile Organic Data
- SOP-5162, Routine Validation of Semivolatile Organic Compound (SVOC) Analytical Data
- SOP-5163, Routine Validation of Organochlorine Pesticides and PCB Analytical Data
- SOP-5165, Routine Validation of Metals Analytical Data
- SOP-5166, Routine Validation of Gamma Spectroscopy Data, Chemical Separation Alpha Spectrometry, Gas Proportional Counting, and Liquid Scintillation Analytical Data
- SOP-5167, Routine Validation of General Chemistry Data
- SOP-5191, Routine Validation of LC/MS/MS Perchlorate Analytical Data (SW-846 EPA Method 6850)

Routine data validation was performed for each data package (also referred to as request numbers), and analytical data were reviewed and evaluated based on U.S. Environmental Protection Agency (EPA) National Functional Guidelines, where applicable (EPA 1994, 048639; EPA 1999, 066649). As a result of the data validation and assessment efforts, qualifiers are assigned to the analytical records as appropriate. The data-qualifier definitions are provided in Appendix A. Sample collection logs (SCLs), and chain-of-custody (COCs) forms are provided in Appendix E. The analytical data, instrument printouts, and data validation reports are provided in Appendix E.

D-2.0 INORGANIC CHEMICAL ANALYSES

A total of 48 samples (plus 6 field duplicates) collected at AOC 01-007(k) were analyzed for inorganic chemicals. All samples (plus 6 field duplicates) were analyzed for target analyte list (TAL) metals; nitrate; perchlorate; and total cyanide. The analytical methods used for inorganic chemicals are listed in Table D-1.0-1.

Tables within the investigation report summarize all samples collected and the analyses requested from AOC 01-007(k). All inorganic chemical results are provided on CD in Appendix E.

D-2.1 Inorganic Chemical QA/QC Samples

The use of QA/QC samples is designed to produce quantitative measures of the reliability of specific parts of an analytical procedure. The results of the QA/QC analyses performed on a sample provide confidence about whether the analyte is present and whether the concentration reported is accurate. To assess the accuracy and precision of inorganic chemical analyses, LCSs, preparation blanks, MSs, laboratory duplicate samples, interference check samples (ICSs), and serial dilution samples were analyzed as part of the investigation. Each of these QA/QC sample types is defined in the analytical services SOWs (LANL 2000, 071233; LANL 2008, 109962) and is described briefly in the sections below.

The LCS serves as a monitor of the overall performance of each step during the analysis, including sample digestion. For inorganic chemicals in soil/tuff, LCS percent recovery (%R) should fall within the control limits of 75%–125% (LANL 2000, 071233; LANL 2008, 109962).

The preparation blank is an analyte-free matrix to which all reagents are added in the same volumes or proportions as those used in the environmental sample processing; it is extracted and analyzed in the same manner as the corresponding environmental samples. Preparation blanks are used to measure bias and potential cross-contamination. All inorganic chemical results should be below the method detection limit (MDL).

MS samples assess the accuracy of inorganic chemical analyses. These samples are designed to provide information about the effect of the sample matrix on the sample preparation procedures and analytical technique. The MS acceptance criterion is 75%–125%, inclusive, for all spiked analytes (LANL 2000, 071233; LANL 2008, 109962).

Laboratory duplicate samples assess the precision of inorganic chemical analyses. All relative percent differences (RPDs) between the sample and laboratory duplicate should be ±35% for soil (LANL 2000, 071233; LANL 2008, 109962).

The ICSs assess the accuracy of the analytical laboratory's interelement and background correction factors used for inductively coupled plasma emission spectroscopy. The ICS %R should be within the acceptance range of 80%–120%. The QC acceptance limits are ±20%.

Serial dilution samples measure potential physical or chemical interferences and correspond to a sample dilution ratio of 1:5. The chemical concentration in the undiluted sample must be at least 50 times the MDL (100 times for inductively coupled plasma mass spectroscopy) for valid comparison. For sufficiently high concentrations, the RPD should be within 10%.

Details regarding the quality of the inorganic chemical analytical data included in the datasets are summarized in the following subsections.

D-3.2 Data Quality Results for Inorganic Chemicals

The majority of the analytical results were qualified as not detected (U) because the analytes were not detected by the respective analytical methods. No quality issues were associated with the data presented.

Eleven nitrate, 8 perchlorate, and 116 TAL metal results were qualified as estimated (J) because the analytical laboratory qualified the detected result as estimated.

D--3.2.1 Chain of Custody

SCL/COC forms were maintained properly for all samples analyzed for inorganic chemicals (Appendix E).

D-3.2.2 Sample Documentation

All samples analyzed for inorganic chemicals were properly documented on SCL/COC forms in the field (Appendix E).

D-3.2.3 Sample Dilutions

Some samples were diluted for inorganic chemical analyses. No qualifiers were applied to any inorganic chemical sample results because of dilutions.

D-3.2.4 Sample Preservation

Preservation criteria were met for all samples analyzed for inorganic chemicals.

D-3.2.5 Holding Times

Holding times were met for inorganic chemicals analyses.

D-3.2.6 Initial and Continuing Calibration Verifications

Results for samples analyzed for inorganic chemicals were not qualified because of initial or continuing calibration verifications.

D-3.2.7 Interference Check Samples and/or Serial Dilutions

Results for samples analyzed for inorganic chemicals were not qualified because of interference check samples and/or serial dilutions.

D-3.2.8 Laboratory Duplicate Samples

A total of 14 TAL metal results were qualified as estimated (J) because the sample and the duplicate sampling results were greater than or equal to 5 times the reporting limit, and the duplicate RPD was greater than 35% for soil samples.

D-3.2.9 Preparation Blanks

One TAL metal result was qualified as not detected (U) because the sampling results were less than or equal to 5 times the concentration of the related analyte in the method blank.

D-3.2.10 Matrix Spike Samples

One TAL metal result was qualified as estimated not detected (UJ) because a low recovery (%R <75%) was observed in the associated matrix spike sample.

Three TAL metal results were qualified as estimated and biased low (J-) because a low recovery (%R <75%) was observed in the associated matrix spike sample.

Sixteen TAL metal results were qualified as estimated and biased high (J+) because a high recovery (%R >125%) was observed in the associated matrix spike sample.

D-3.2.11 Laboratory Control Sample Recoveries

The results for samples analyzed for inorganic chemicals were not qualified because of LCS recoveries.

D-3.2.12 Detection Limits

Results for samples analyzed for inorganic chemicals were not qualified because of detection limits.

D-3.2.13 Rejected Results

Two chromium results were qualified as rejected (R) because the associated matrix spike recovery was <10%.

The rejected data were not used to characterize the nature and extent or the potential human and ecological risks. However, sufficient data of good quality were available to characterize the site and conduct the risk assessments. The results of other qualified data were used as reported and did not affect the usability of the sampling results.

D-4.0 ORGANIC CHEMICAL ANALYSES

A total of 48 samples (plus 6 field duplicates) collected at AOC 01-007(k) were analyzed for organic chemicals. All samples (plus 6 field duplicates) were analyzed for volatile organic chemicals (VOCs), semivolatile organic chemicals (SVOCs), and polychlorinated biphenyls (PCBs). All QC procedures were followed as required by the analytical laboratory SOWs (LANL 2000, 071233; LANL 2008, 109962). The analytical methods used for organic chemicals are listed in Table D-1.0-1.

Tables within the investigation report summarize all samples collected AOC 01-007(k) and the analyses requested. All organic chemical results are provided on CD in Appendix E.

D-4.1 Organic Chemical QA/QC Samples

The use of QA/QC samples is designed to produce quantitative measures of the reliability of specific parts of an analytical procedure. The results of the QA/QC analyses performed on a sample provide confidence about whether the analyte is present and whether the concentration reported is accurate. Calibration verifications, LCSs, method blanks, MSs, surrogates, and ISs were analyzed to assess the accuracy and precision of organic chemical analyses. Each of these QA/QC sample types is defined in the analytical services SOW (LANL 2000, 071233; LANL 2008, 109962) and described briefly below.

Calibration verification is the establishment of a quantitative relationship between the response of the analytical procedure and the concentration of the target analyte. There are two aspects of calibration verification: initial and continuing. The initial calibration verifies the accuracy of the calibration curve as well as the individual calibration standards used to perform the calibration. The continuing calibration ensures that the initial calibration is still holding and correct as the instrument is used to process samples. The continuing calibration also serves to determine that analyte identification criteria such as retention times and spectral matching are being met.

The LCS is a sample of a known matrix that has been spiked with compounds that are representative of the target analytes, and it serves as a monitor of overall performance on a “controlled” sample. The LCS is the primary demonstration, on a daily basis, of the ability to analyze samples with good qualitative and quantitative accuracy. The LCS recoveries should within the method-specific acceptance criteria.

A method blank is an analyte-free matrix to which all reagents are added in the same volumes or proportions as those used in the environmental sample processing; it is extracted and analyzed in the same manner as the corresponding environmental samples. Method blanks are used to assess the potential for sample contamination during extraction and analysis. All target analytes should be below the contract required detection limit in the method blank (LANL 2000, 071233; LANL 2008, 109962).

MS samples are used to measure the ability to recover prescribed analytes from a native sample matrix and consist of aliquots of the submitted samples spiked with a known concentration of the target analyte(s). Spiking typically occurs before sample preparation and analysis. The spike sample recoveries should be between the lower acceptance limit (LAL) and upper acceptance limit (UAL).

A surrogate compound (a surrogate) is an organic compound used in the analyses of target analytes that is similar in composition and behavior to the target analytes but is not normally found in environmental samples. Surrogates are added to every blank, sample, and spike to evaluate the efficiency with which analytes are recovered during extraction and analysis. The recovery percentage of the surrogates must be within specified ranges or the sample may be rejected or assigned a qualifier.

ISs are chemical compounds added to every blank, sample, and standard extract at a known concentration. They are used to compensate for (1) analyte concentration changes that might occur during storage of the extract, and (2) quantitation variations that can occur during analysis. Internal standards are used as the basis for quantitation of target analytes. The %R for ISs should be within the range of 50%–200%.

Details regarding the quality of the organic chemical analytical data included in the dataset are summarized in the following sections.

D-4.2 Data Quality Results for Organic Chemicals

The majority of the analytical results were qualified as not detected (U) because the analytes were not detected by the respective analytical methods. No quality issues were associated with the data presented.

Sixteen SVOC, 7 VOC, and 8 PCB results were qualified as estimated (J) because the analytical laboratory qualified the detected result as estimated.

D-4.2.1 Maintenance of COC

COC forms were maintained properly for all samples analyzed for organic chemicals (Appendix E).

D-4.2.2 Sample Documentation

All samples analyzed for organic chemicals were properly documented on the SCL in the field (Appendix E).

D-4.2.3 Sample Preservation

Preservation criteria were met for all samples analyzed for organic chemicals.

D-4.2.4 Holding Times

Holding times were met for organic chemicals analyses.

D-4.2.5 Initial and Continuing Calibration Verifications

Results for samples analyzed for organic chemicals were not qualified because of initial or continuing calibration verifications.

D-4.2.6 Surrogate Recoveries

Results for samples analyzed for organic chemicals were not qualified because of surrogate recoveries.

D-4.2.7 IS Responses

Results for samples analyzed for organic chemicals were not qualified because of IS recoveries.

D-4.2.8 Method Blanks

Seventeen SVOC results were qualified as not detected (U) because the associated sample concentration was less than or equal to 5 times (10 times for common laboratory contaminants) the concentration of the related analyte in the method blank.

D-4.2.9 Matrix Spikes

Results for samples analyzed for organic chemicals were not qualified because of matrix spike recoveries.

D-4.2.10 Laboratory Duplicate Samples

Laboratory duplicates collected for organic chemical analyses indicated acceptable precision for all samples.

D-4.2.11 Laboratory Control Sample Recoveries

Results for samples analyzed for organic chemicals were not qualified because of LCS recoveries.

D-4.2.12 Quantitation and Method Detection Limits

Results for samples analyzed for organic chemicals were not qualified because of quantitation and MDLs.

D-4.2.13 Rejected Data

Six 2-butanone results were qualified as rejected (R) because the analyte was analyzed with an relative response factor of <0.05 in the initial calibration and/or continuing calibration verification.

The rejected data were not used to characterize the nature and extent or the potential human and ecological risks. However, sufficient data of good quality were available to characterize the site and conduct the risk assessments. The results of other qualified data were used as reported and did not affect the usability of the sampling results.

D-5.0 RADIONUCLIDE ANALYSES

A total of 48 samples (plus 6 field duplicates) collected at AOC 01-007(k) were analyzed for radionuclides. All samples (plus 6 field duplicates) were analyzed for americium-241, gamma-emitting radionuclides, tritium, isotopic plutonium, isotopic uranium, and strontium-90. The analytical methods used for radionuclides are listed in Table D-1.0-1.

Tables in the investigation report summarize all samples collected at AOC 01-007(k) and the analyses requested. All radionuclide results are provided on CD (Appendix E).

D-5.1 Radionuclide QA/QC Samples

All procedures were followed as required by the analytical services SOWs (LANL 2000, 071233; LANL 2008, 109962). Some sampling results were qualified as not detected (U) because the associated sample concentration was less than or equal to the minimum detectable concentration (MDC). Some sample results were qualified as not detected (U) because the associated sample concentration was less than or equal to 3 times the total propagated uncertainty. This data qualification is related to detection status only not to data quality issues.

To assess the accuracy and precision of the radionuclide analyses, LCSs, method blanks, MS samples, laboratory duplicate samples, and tracers were analyzed as part of the investigations. Each of these QA/QC sample types is defined in the analytical services SOWs (LANL 2000, 071233; LANL 2008, 109962) and is described briefly below.

The LCS serves as a monitor of the overall performance of each step during the analysis, including sample digestion. For radionuclides in soil/tuff, LCS %R should fall between the control limits of 80%–120%.

A method blank is an analyte-free matrix to which all reagents are added in the same volumes or proportions as those used in the environmental sample processing; it is analyzed in the same manner as the corresponding environmental samples. Method blanks are used to assess the potential for sample contamination during analysis. All radionuclide results should be below the MDC.

MS samples assess the accuracy of inorganic chemical analyses. These samples are designed to provide information about the effect of the sample matrix on the sample preparation procedures and analytical technique. The MS acceptance criterion is 75%–125%.

Tracers are radioisotopes added to a sample for the purposes of monitoring losses of the target analyte. The tracer is assumed to behave in the same manner as the target analytes. The tracer recoveries should fall between the LAL and UAL.

Laboratory duplicate samples assess the precision of radionuclide analyses. All RPDs between the sample and laboratory duplicate should be ±35% for soil (LANL 2000, 071233; LANL 2008, 109962).

Details regarding the quality of the radionuclide analytical data included in the dataset are summarized in the following subsections.

D-5.2 Data Quality Results for Radionuclides

D-5.2.1 Chain of Custody

COC forms were maintained properly for all samples (Appendix E).

D-5.2.2 Sample Documentation

All samples were properly documented on the SCL in the field (Appendix E).

D-5.2.3 Sample Dilutions

Some samples were diluted for radionuclide analyses. No qualifiers were applied to any radionuclide sample results because of dilutions.

D-5.2.4 Sample Preservation

Preservation criteria were met for all samples analyzed for radionuclides.

D-5.2.5 Holding Times

Holding-time criteria were met for all samples analyzed for radionuclides.

D-5.2.6 Method Blanks

Results for samples analyzed for radionuclides were not qualified because of blank contamination.

D-5.2.7 Matrix Spike Samples

Results for samples analyzed for radionuclides were not qualified because of MS recoveries.

D-5.2.8 Tracer Recoveries

Results for samples analyzed for radionuclides were not qualified because of tracer recoveries.

D-5.2.9 Laboratory Control Sample Recoveries

Results for samples analyzed for radionuclides were not qualified because of LCS recoveries.

D-5.2.10 Laboratory Duplicate Samples Recoveries

Thirty radionuclide results were qualified as estimated (J) because the associated duplicate sample has the duplicate error ratio or the relative error ratio is greater than the analytical laboratory's acceptance limits.

D-5.2.11 Rejected Data

A total of 24 cesium-134 results were qualified as rejected (R) because spectral interferences prevent positive identification of the analyte.

The rejected data were not used to characterize the nature and extent or the potential human and ecological risks. However, sufficient data of good quality were available to characterize the site and conduct the risk assessments. The results of other qualified data were used as reported and did not affect the usability of the sampling results.

D-6.0 REFERENCES

The following list includes all documents cited in this appendix. Parenthetical information following each reference provides the author(s), publication date, and ER ID. This information is also included in text citations. ER IDs are assigned by the Environmental Programs Directorate's Records Processing Facility (RPF) and are used to locate the document at the RPF and, where applicable, in the master reference set.

Copies of the master reference set are maintained at the New Mexico Environment Department Hazardous Waste Bureau and the 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.

EPA (U.S. Environmental Protection Agency), February 1994. "USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review," EPA-540/R-94/013, Office of Emergency and Remedial Response, Washington, D.C. (EPA 1994, 048639)

EPA (U.S. Environmental Protection Agency), October 1999. "USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review," EPA540/R-99/008, Office of Emergency and Remedial Response, Washington, D.C. (EPA 1999, 066649)

LANL (Los Alamos National Laboratory), March 1996. "Quality Assurance Project Plan Requirements for Sampling and Analysis," Los Alamos National Laboratory document LA-UR-96-441, Los Alamos, New Mexico. (LANL 1996, 054609)

LANL (Los Alamos National Laboratory), December 2000. "University of California, Los Alamos National Laboratory (LANL), I8980SOW0-8S, Statement of Work for Analytical Laboratories," Rev. 1, Los Alamos National Laboratory, Los Alamos, New Mexico. (LANL 2000, 071233)

LANL (Los Alamos National Laboratory), June 30, 2008. "Exhibit "D" Scope of Work and Technical Specifications, Analytical Laboratory Services for General Inorganic, Organic, Radiochemical, Asbestos, Low-Level Tritium, Particle Analysis, Bioassay, Dissolved Organic Carbon Fractionation, and PCB Congeners," Los Alamos National Laboratory document RFP No. 63639-RFP-08, Los Alamos, New Mexico. (LANL 2008, 109962)

Table D-1.0-1
Inorganic Chemical, Organic Chemical, and Radionuclide
Analytical Methods for Samples Collected at AOC 01-007(k)

Analytical Method	Analytical Description	Analytical Suite
EPA 300.0	Ion chromatography	Nitrate
EPA 905.0	Beta counting	Strontium-90
EPA 906.0	Distillation and liquid scintillation	Tritium
EPA SW-846: 6010/6010B	Inductively coupled plasma emission spectroscopy—atomic emission spectroscopy	Aluminum, antimony, arsenic, barium, beryllium, calcium, cadmium, cobalt, chromium, copper, iron, lead, magnesium, manganese, nickel, potassium, selenium, silver, sodium, thallium, vanadium, and zinc (TAL metals)
EPA SW-846:6020	Inductively coupled plasma mass spectrometry	Aluminum, antimony, arsenic, barium, beryllium, calcium, cadmium, cobalt, chromium, copper, iron, lead, magnesium, manganese, nickel, potassium, selenium, silver, sodium, thallium, uranium, vanadium, and zinc (TAL metals)
EPA SW-846: 9012A	Automated colorimetric/off-line distillation	Total cyanide
EPA SW-846:6850	Liquid chromatography–mass spectrometry/mass spectrometry	Perchlorate
EPA SW-846:7470A	Cold vapor atomic absorption (CVAA)	Mercury
EPA SW-846:7471	CVAA	Mercury
EPA SW-846:7471A	CVAA	Mercury
EPA SW-846: 8082	Gas chromatography	PCBs
EPA SW-846: 8260 and 8260B	Gas chromatography–mass spectrometry (GC/MS)	VOCs
EPA TO-15	GC/MS	VOCs
EPA SW-846: 8270 and 8270C	GC/MS	SVOCs
Generic: gamma spectroscopy	Gamma spectroscopy	Americium-241, cesium-137, cobalt-60, sodium-22, uranium-235
HASL Method 300	Chemical separation alpha spectrometry	Isotopic uranium, isotopic plutonium, americium-241

Appendix E

Analytical Suites and Results and Analytical Reports
(on CD included with this document)

Appendix F

Box Plots and Statistical Results

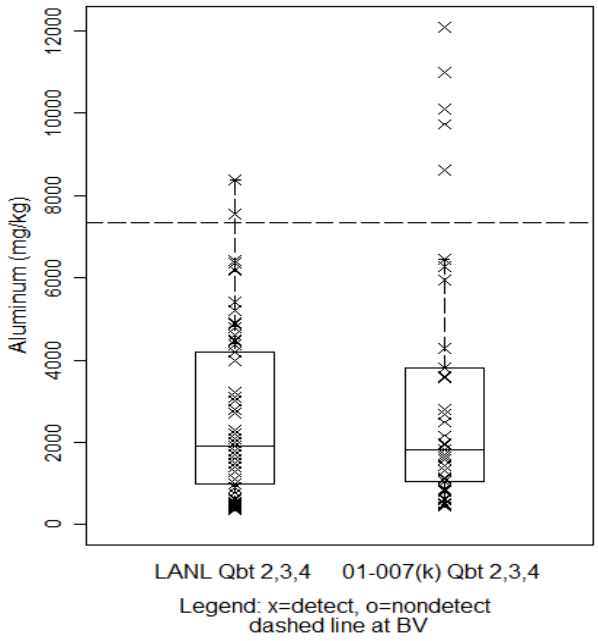


Figure F-1 Box plot of aluminum in tuff at AOC 01-007(k)

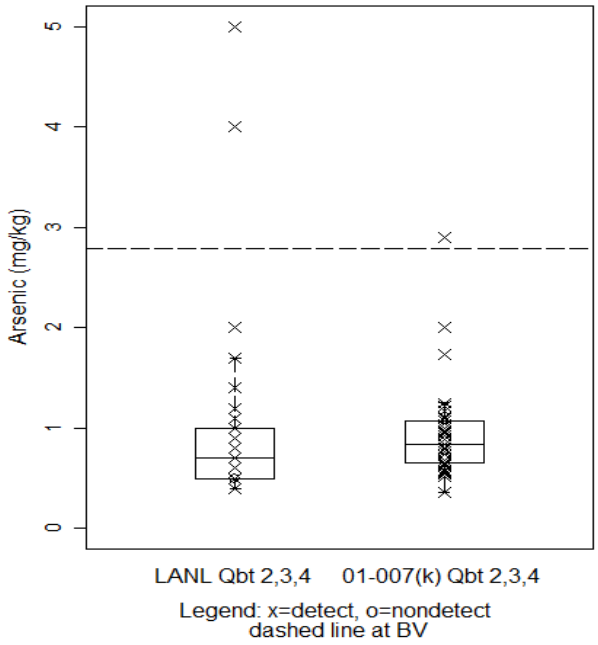


Figure F-2 Box plot of arsenic in tuff at AOC 01-007(k)

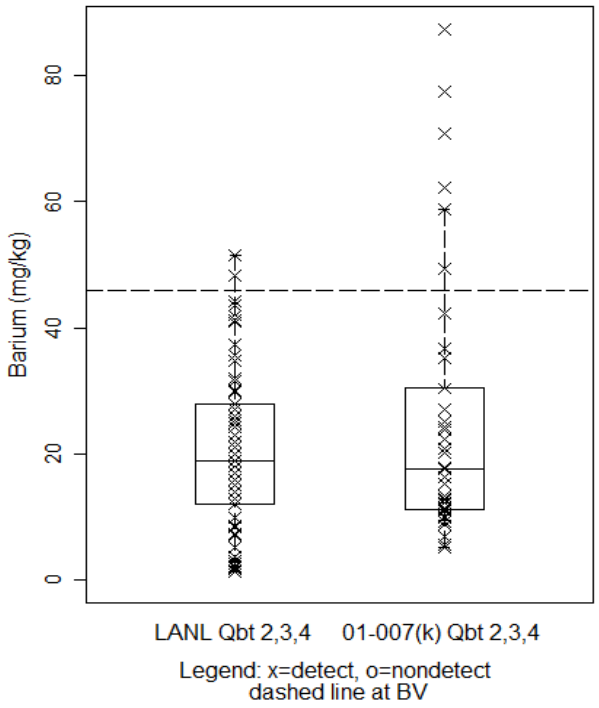


Figure F-3 Box plot of barium in tuff at AOC 01-007(k)

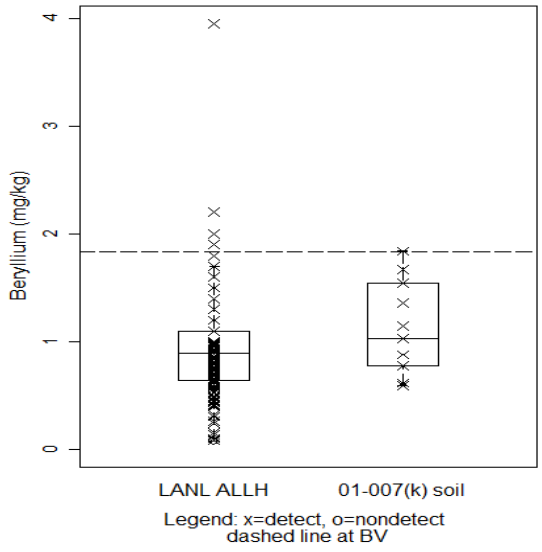


Figure F-4 Box plot of beryllium in soil at AOC 01-007(k)

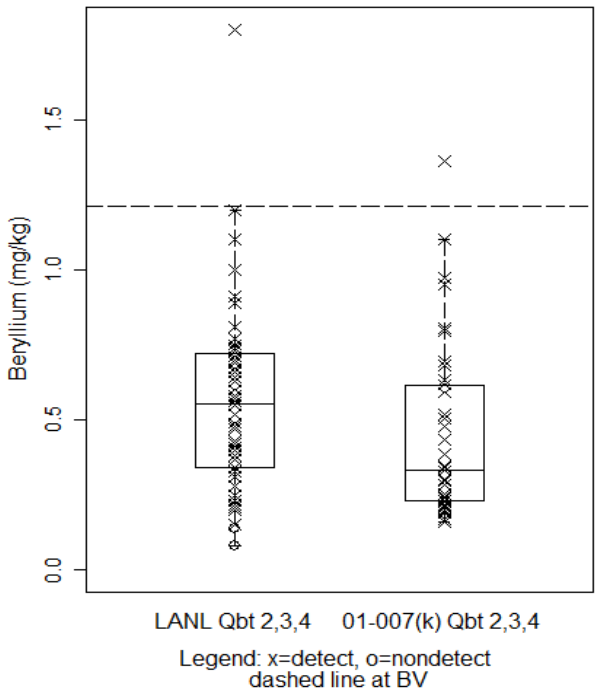


Figure F-5 Box plot of beryllium in tuff at AOC 01-007(k)

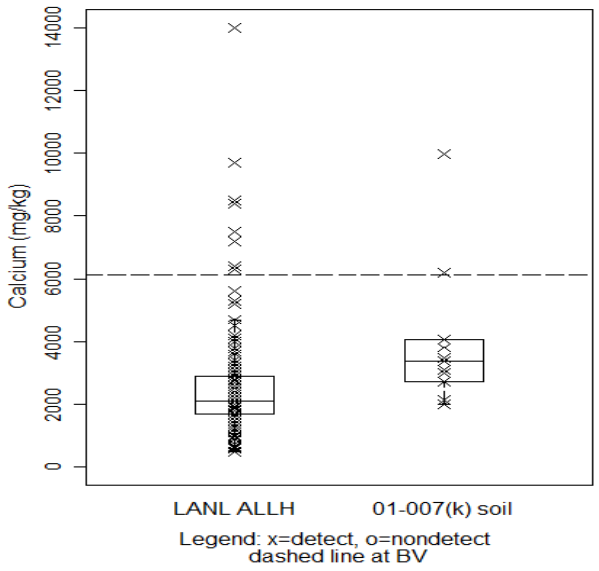


Figure F-6 Box plot of calcium in soil at AOC 01-007(k)

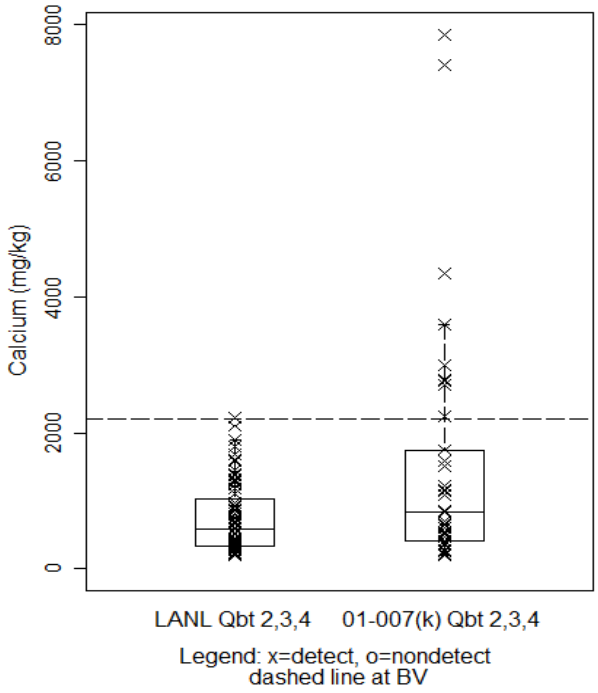


Figure F-7 Box plot of calcium in tuff at AOC 01-007(k)

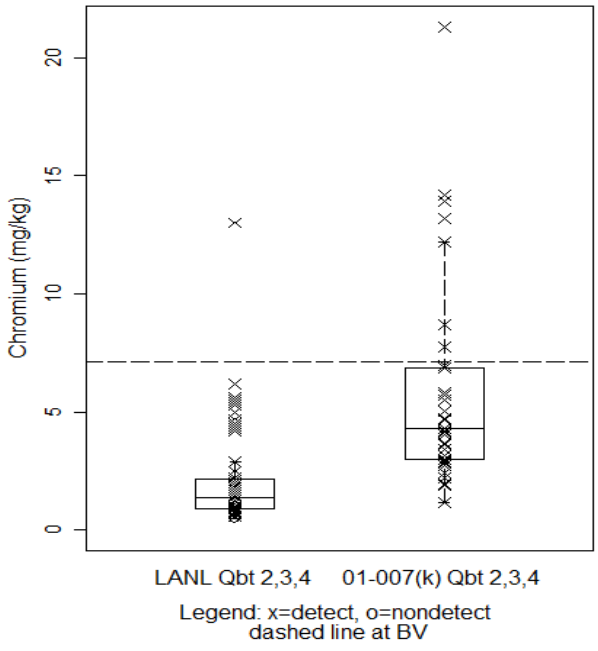


Figure F-8 Box plot of chromium in tuff at AOC 01-007(k)

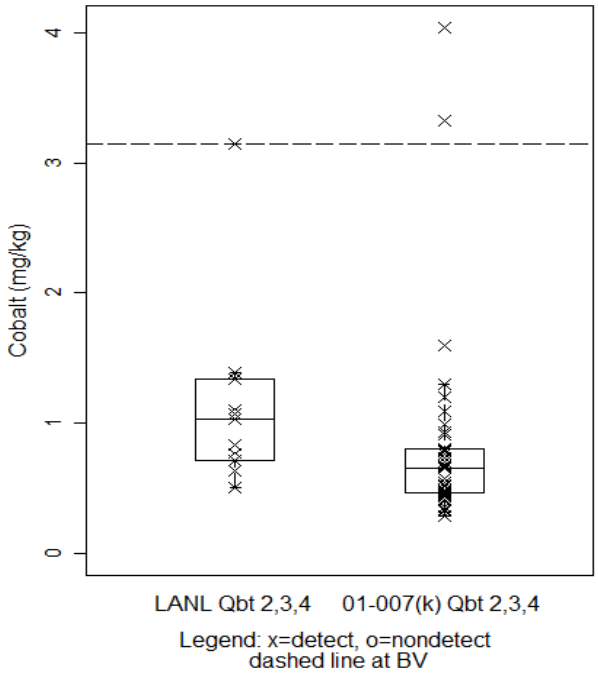


Figure F-9 Box plot of cobalt in tuff at AOC 01-007(k)

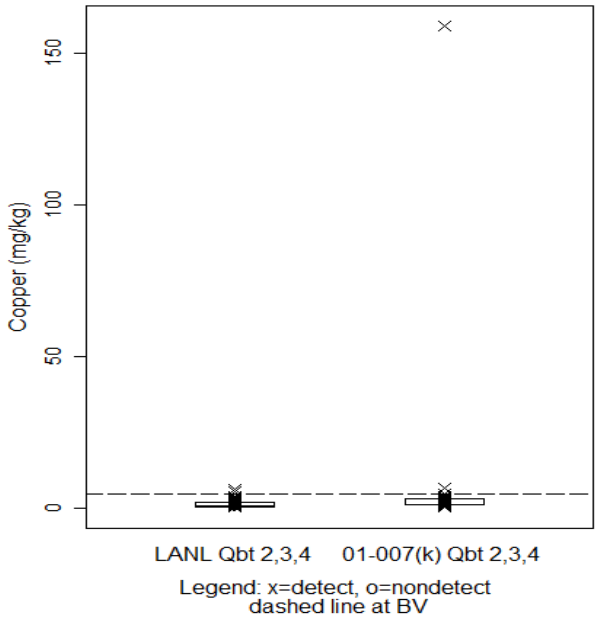


Figure F-10 Box plot of copper in tuff at AOC 01-007(k)

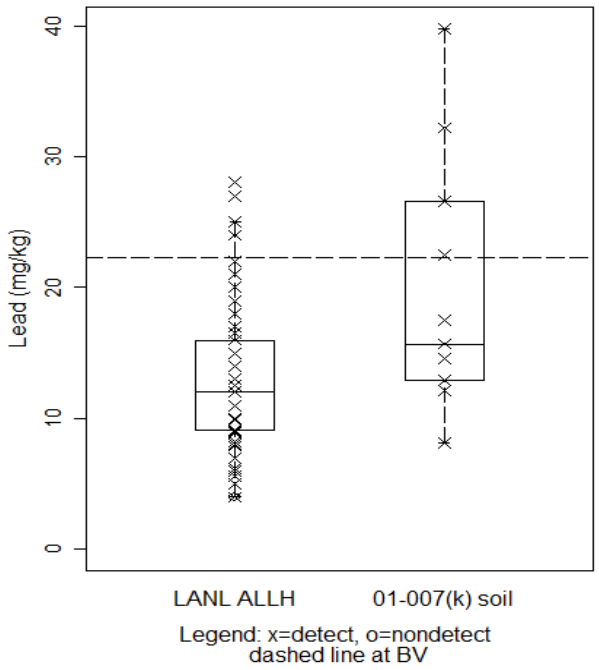


Figure F-11 Box plot of lead in soil at AOC 01-007(k)

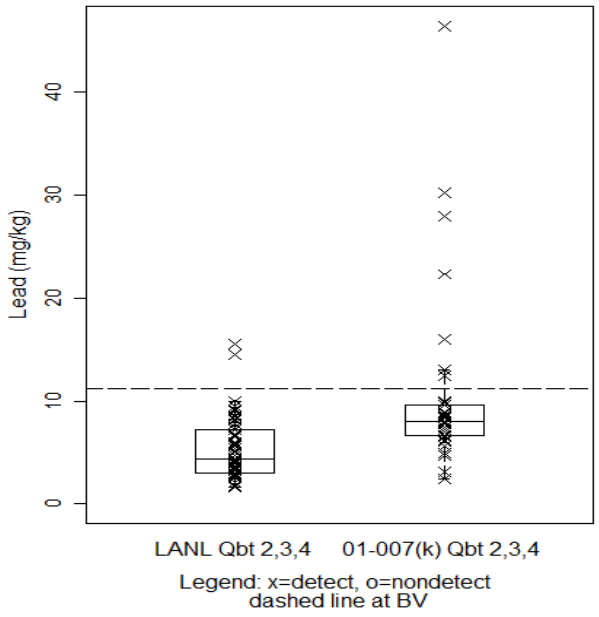


Figure F-12 Box plot of lead in tuff at AOC 01-007(k)

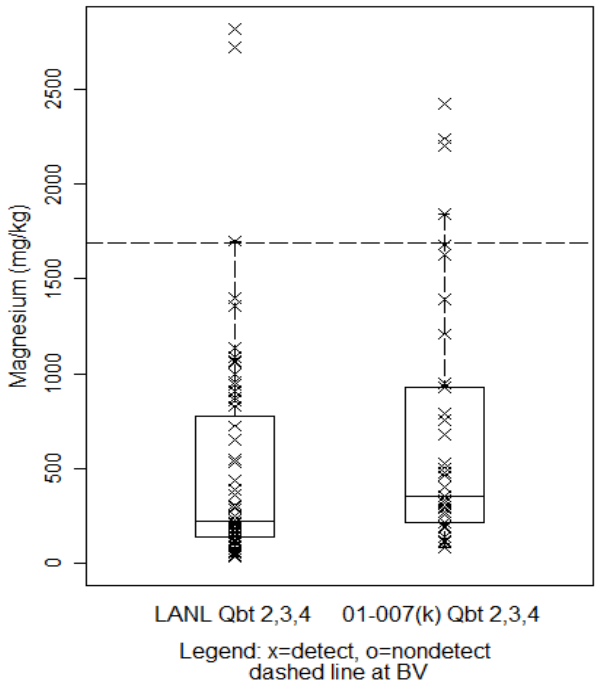


Figure F-13 Box plot of magnesium in tuff at AOC 01-007(k)

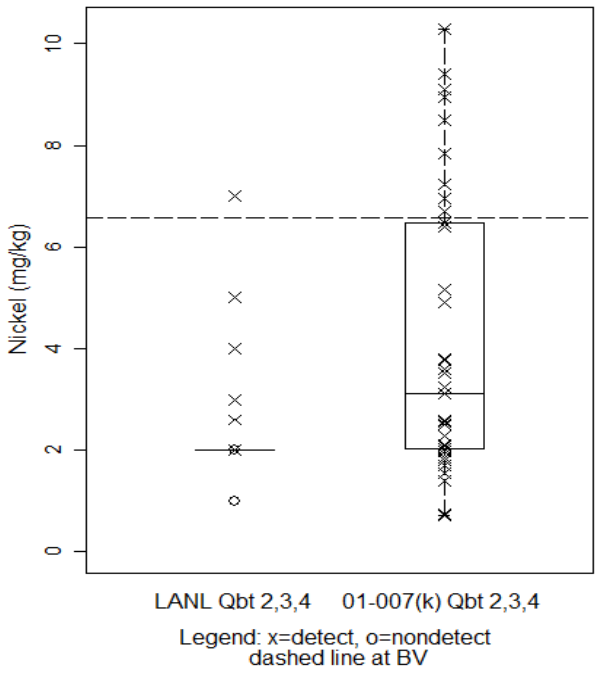


Figure F-14 Box plot of nickel in tuff at AOC 01-007(k)

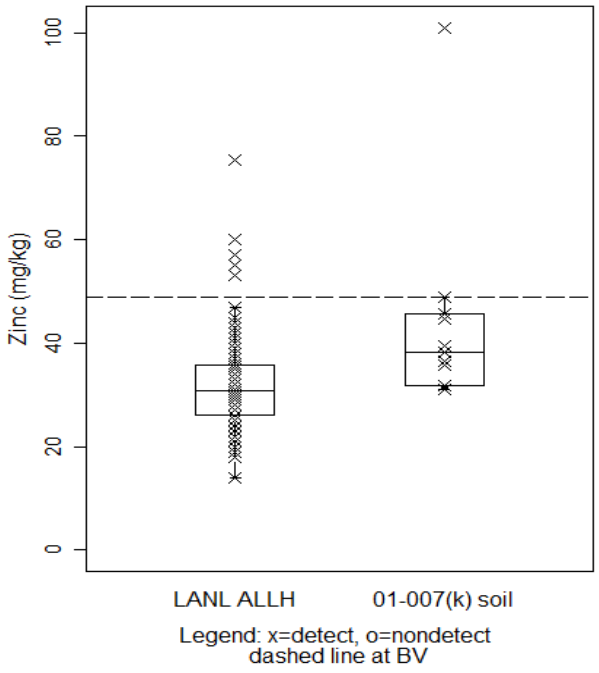


Figure F-15 Box plot of zinc in soil at AOC 01-007(k)

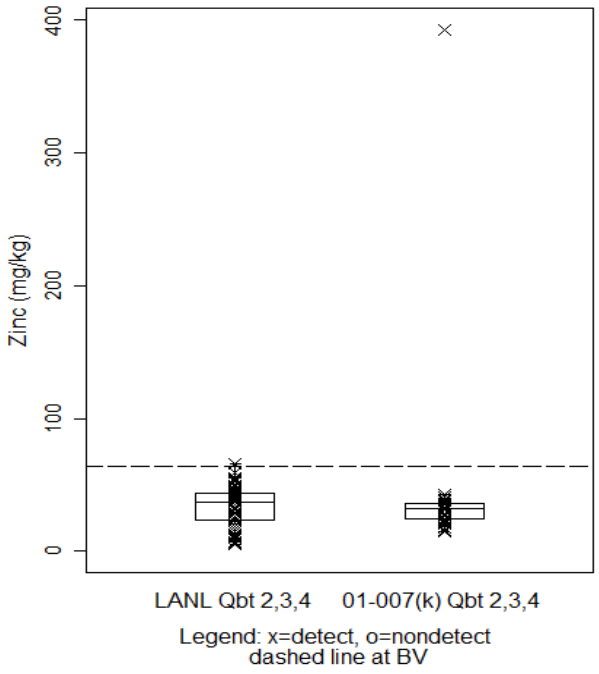


Figure F-16 Box plot of zinc in tuff at AOC 01-007(k)

Table F-1
Results of Statistical Tests for Inorganic Chemicals in Tuff at AOC 01-007(k)

Analyte	Gehan Test p-Value	Quantile Test p-Value	Slippage p-Value	COPC?
Aluminum	0.283	0.474	n/a*	No
Arsenic	0.027	0.459	1.00	No
Barium	0.44	0.282	n/a	No
Beryllium	0.979	0.828	n/a	No
Calcium	0.026	0.016	n/a	Yes
Chromium	0.00000000141	0.001	n/a	Yes
Cobalt	0.993	0.98	n/a	No
Copper	0.00033	0.131	0.0466	Yes
Lead	0.00000101	0.018	n/a	Yes
Magnesium	0.02	0.269	1.00	No
Nickel	n/a	0.005	0.0006	Yes
Zinc	0.899	1.00	n/a	No

* n/a = Not applicable.

Table F-2
Results of Statistical Tests for Inorganic Chemicals in Soil at AOC 01-007(k)

Analyte	Gehan Test p-Value	Quantile Test p-Value	Slippage p-Value	COPC?
Beryllium	0.042	0.082	1.00	No
Calcium	0.0011	0.145	1.00	No
Lead	0.004	0.041	n/a*	Yes
Zinc	0.0005	0.009	n/a	Yes

* n/a = Not applicable.

Appendix G

Risk Assessments

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Attachments

Attachment G-1 ProUCL Files (on CD included with this document)

Attachment G-2 Vapor-Intrusion Model Spreadsheets (on CD included with this document)

Attachment G-3 Ecological Scoping Checklist

G-1.0 INTRODUCTION

This appendix presents the results of the human health and ecological risk-screening evaluations conducted in support of environmental characterization of Area of Concern (AOC) 01-007(k) at Los Alamos National Laboratory (LANL or the Laboratory). The AOC discussed in this appendix is located in former Technical Area 01 (TA-01) (Figure 1.1-1 of the investigation report). This appendix evaluates the potential risk at this site based on decision-level data from the 2008 and 2013 investigations.

G-2.0 BACKGROUND

A brief description of the AOC assessed for potential risk is presented in this section.

G-2.1 Site Descriptions and Operational History

Former TA-01 is a residential, commercial, and industrial-use area made up of private, Los Alamos County, and U.S. Department of Energy (DOE) lands. It includes both mesa-top and canyon-slope areas.

Starting in 1976, land located in former TA-01 was transferred from DOE to Los Alamos County and private parties. Except for the sites located on the slope of Los Alamos Canyon that are still on DOE land, the majority of these sites are located within the Los Alamos townsite on private land or county property. These sites have been backfilled, regraded, and recontoured, and have undergone significant construction since the property transfer. No evidence of previous TA-01 Laboratory structures exists in the area.

The former TA-01 sites are located on or next to county, commercial, and private property as well as DOE property. Many sites are paved with either concrete or asphalt, are under buildings, or are in lawns next to private residences. Some sites are located on both the mesa-top and south-facing slope in Los Alamos Canyon, while others are entirely on south-facing slope or entirely on the mesa top.

Much of the natural mesa-top soil in former TA-01 has been replaced by fill material during various remediation, construction, and landscaping activities (LANL 2006, 091915; LANL 2006, 091916). The canyon slope consists mainly of bare tuff with only small, isolated pockets of soil and sediment. Media encountered during surface and near-surface sampling at former TA-01 included soil, fill, sediment, and tuff (Qbt 3 and Qbt 1g).

Vegetation at mesa-top sites consists of nonnative grasses, trees, and shrubs planted by property owners. Vegetation on the canyon slope and in the canyon bottom consists of widely scattered native trees and shrubs, including ponderosa pine, piñon pine, juniper, and an understory of native grasses.

G-2.1.1 AOC 01-007(k), Soil Contamination

AOC 01-007(k) is a suspected soil-contamination area located near the former U and W Buildings (LANL 1992, 043454, p. 1-13) (Figure 6.2-1). Constructed in 1943, Buildings U and W contained physics laboratories used to conduct experiments involving uranium-235, uranium-238, radium-226, carbon-14, polonium-210, and tritium. In 1959, Buildings U and W were removed from service and subsequently destroyed. Currently, the area of AOC 01-007(k) is occupied by the building footprint and parking lot of the former Los Alamos Inn.

G-2.2 Investigation Sampling

The final data set used to identify chemicals of potential concern (COPCs) for AOC 01-007(k) and used in this appendix to evaluate the potential risks to human health and the environment are the qualified analytical results from the 2008 and 2013 investigations. Only those data determined to be of decision-level quality following the data-quality assessment (Appendix D) are included in the final data set evaluated in this appendix.

G-2.3 Determination of COPCs

Section 5.0 of the report summarizes the COPC selection process. Only COPCs detected above background (inorganic chemicals and radionuclides), with detection limits greater than background values (BVs) (inorganic chemicals), and detected (organic chemicals, inorganic chemicals with no BVs, and radionuclides) were retained. The industrial scenario typically uses data from 0.0–1.0 ft below ground surface (bgs). However, no surface samples were collected at the site because of the presence of asphalt and rubble from the Los Alamos Inn. The industrial scenario for this site used data for samples collected from 1.0–2.25 ft bgs to evaluate human health risk. The ecological screening used data for samples collected from 1.0–5.0 ft bgs. The construction worker and the residential scenarios used data for samples collected from 1.0–6.0 ft bgs. However, sampling depths often overlapped because of multiple investigations; therefore, samples with a starting depth less than the lower bound of the interval were included in the risk-screening assessments for a given scenario, as appropriate.

Tables G-2.3-1 to G-2.3-3 summarize the COPCs evaluated for potential risk for AOC 01-007(k). Some of the COPCs identified in this report may not be evaluated for potential risk under one or more scenarios because they were not within the specified depth intervals associated with a given scenario.

G-3.0 CONCEPTUAL SITE MODEL

The primary mechanisms of release are related to historical contaminant sources described in detail in the Upper Los Alamos Canyon Aggregate Area historical investigation report (LANL 2008, 100693) and are summarized in section 2.3 of the approved investigation work plan (LANL 2008, 103404.43). Releases may have occurred as a result of surface and subsurface leaks or spills.

G-3.1 Receptors and Exposure Pathways

The primary exposure pathway for human receptors is surface soil and subsurface soil/tuff that may be brought to the surface through intrusive activities. Migration of contamination to groundwater through the vadose zone is unlikely given the depth to groundwater (greater than 1000 ft bgs). Human receptors (industrial worker, construction worker, and resident) may be exposed through direct contact with soil or suspended particulates by ingestion, inhalation, dermal contact, and external irradiation pathways. Direct contact exposure pathways from subsurface contamination to human receptors are complete for the resident and the construction worker, where appropriate. Migration of contamination to groundwater through the vadose zone is unlikely given the depth to groundwater (greater than 1000 ft bgs) at the site. The exposure pathways are the same as those for surface soil. Sources, exposure pathways, and receptors are shown in the conceptual site model (CSM) (Figure G-3.1-1).

The site is in a commercial/industrial area within the Los Alamos townsite. The site and the surrounding area are developed and provide minimal or no potential habitat for ecological receptors, especially where the site is covered with asphalt. Weathering of tuff is the only viable natural process that may result in the exposure of receptors to COPCs in tuff. However, because of the slow rate of weathering expected for

tuff, exposure to COPCs in tuff is negligible, although it is included in the assessments. Exposure pathways to subsurface contamination below 5.0 ft (ecological) are not complete unless contaminated soil or tuff were excavated and brought to the surface.

Considering unpaved sites or areas where potential habitat is present, exposure pathways are complete to surface soil and tuff for ecological receptors. The potential pathways are root uptake by plants, inhalation of vapors (burrowing animals only), inhalation of dust, dermal contact, incidental ingestion of soil, external irradiation, and food web transport. Pathways from subsurface releases may be complete for plants. Surface water exposure was not evaluated because of the lack of surface water features. Sources, exposure pathways, and receptors are presented in the CSM (Figure G-3.1-1).

G-3.2 Environmental Fate and Transport

The evaluation of environmental fate addresses the chemical processes affecting the persistence of chemicals in the environment, and the evaluation of transport addresses the physical processes affecting mobility along a migration pathway. Migration into soil and tuff depends on precipitation or snowmelt, soil moisture content, depth of soil, soil hydraulic properties, and properties of the COPCs. Migration into and through tuff also depends on the unsaturated flow properties of the tuff and the presence of joints and fractures.

The most important factor with respect to the potential for COPCs to migrate to groundwater is the presence of saturated conditions. Downward migration in the vadose zone is also limited by a lack of hydrostatic pressure as well as the lack of a source for the continued release of contamination. Without sufficient moisture and a source, little or no potential migration of materials through the vadose zone to groundwater occurs.

Contamination at depth is addressed in the discussion of nature and extent in the investigation report. Results from the deepest samples collected at most sites showed either no detected concentrations of COPCs or low- to trace-level concentrations of only a few inorganic, radionuclide, and/or organic COPCs in tuff. The limited extent of contamination is related to the absence of the key factors that facilitate migration, as discussed above. Given how long the contamination has been present in the subsurface, the physical and chemicals properties of the COPCs, and the lack of saturated conditions, the potential for contaminant migration to groundwater is very low.

The New Mexico Environment Department (NMED) guidance (NMED 2012, 219971) contains screening levels that consider the potential for contaminants in soil to result in groundwater contamination. These screening levels consider equilibrium partitioning of contaminants among solid, aqueous, and vapor phases and account for dilution and attenuation in groundwater through the use of dilution attenuation factors (DAFs). These DAF soil screening levels (SSLs) may be used to identify chemical concentrations in soil that have the potential to contaminate groundwater (EPA 1996, 059902). Screening contaminant concentrations in soil against these DAF SSLs does not, however, provide an indication of the potential for contaminants to migrate to groundwater. The assumptions used in the development of these DAF SSLs include the uniformity of contaminant concentrations from the contaminant source to the water table (i.e., it is assumed that migration to groundwater has already occurred). Furthermore, this assumption is inappropriate for cases such as AOC 01-007(k) where sampling has shown that contamination is vertically bounded near the surface and the distance from the surface to the water table is large. For these reasons, screening of contaminant concentrations in soil against the DAF SSLs was not performed.

The relevant release and transport processes of the COPCs are a function of chemical-specific properties that include the relationship between the physical form of the constituents and the nature of the constituent transport processes in the environment. Specific properties include the degree of saturation

and the potential for ion exchange (barium and other inorganic chemicals) or sorption and the potential for natural bioremediation. The transport of volatile organic compounds (VOCs) occurs primarily in the vapor phase by diffusion or advection in subsurface air.

Current potential transport mechanisms that may lead to exposure include

- dissolution and/or particulate transport of surface contaminants during precipitation and runoff events,
- airborne transport of contaminated surface soil,
- continued dissolution and advective/dispersive transport of chemical contaminants contained in subsurface soil and tuff as a result of past operations,
- disturbance of contaminants in shallow soil and subsurface tuff by Laboratory operations, and
- disturbance and uptake of contaminants in shallow soil by plants and animals.

Contaminant distributions at the sites indicate that after the initial deposition of contaminants from operational activities and historical remediation efforts, elevated levels of COPCs tend to remain concentrated in the vicinity of the original release points. The primary potential release and transport mechanisms identified for AOC 01-007(k) include direct discharge; precipitation, sorption, and mechanical transport; dissolution and advective transport in water; and volatilization, diffusion, and dispersion. Less significant transport mechanisms include wind entrainment and, given the asphalt pavement covering most sites, dispersal of surface soil and uptake of contaminants from soil and water by biota.

Gas or vapor-phase contaminants such as VOCs are likely to volatilize to the atmosphere from near-surface soil and/or migrate by diffusion through air-filled pores in the vadose zone. Migration of vapor-phase contaminants from tuff into ambient air may occur by diffusion or advection driven by barometric pressure changes.

G-3.2.1 Inorganic Chemicals

In general, and particularly in a semiarid climate, inorganic chemicals are not highly soluble or mobile in the environment, although there are exceptions. The physical and chemical factors that determine the distribution of inorganic COPCs within the soil and tuff at AOC 01-007(k) are the soil-water partition coefficient (K_d) of the inorganic chemicals, the pH of the soil, soil characteristics (such as sand or clay content), and the oxidation-reduction potential (Eh). The interaction of these factors is complex, but the K_d values provide a general assessment of the potential for migration through the subsurface; chemicals with higher K_d values are less likely to be mobile than those with lower ones. Chemicals with K_d values greater than 40 are very unlikely to migrate through soil towards the water table (Kincaid et al. 1998, 093270). Table G-3.2-1 presents the K_d values and water solubility for the inorganic COPCs identified at AOC 01-007(k). Based on this criterion, the following COPCs have a low potential to mobilize and migrate through soil and the vadose zone: antimony, chromium, lead, mercury, nickel, and zinc. The K_d values for copper, nitrate, perchlorate, and selenium are less than 40 and may indicate a greater potential to mobilize and migrate through soil and the vadose zone beneath the sites.

It is important to note that other factors besides the K_d values (e.g., speciation in soil, oxidation-reduction potential, pH, and soil mineralogy) also play significant roles in the likelihood that inorganic chemicals will migrate. The COPCs with K_d values less than 40 are discussed further below. Information about the fate and transport properties of inorganic chemicals was obtained from individual chemical profiles published by the Agency for Toxic Substances and Disease Registry (ATSDR) (ATSDR 1997, 056531, and http://www.atsdr.cdc.gov/toxpro2).

Copper movement in soil is determined by physical and chemical interactions with the soil components. Most copper deposited in soil will be strongly adsorbed and remains in the upper few centimeters of soil. Copper will adsorb to organic matter, carbonate minerals, clay minerals, or hydrous iron, and manganese oxides. In most temperate soil, pH, organic matter, and ionic strength of the soil solutions are the key factors affecting adsorption. Soil in the area is alkaline to neutral, so the leaching of copper is not a concern at this site. Copper binds to soil much more strongly than other divalent cations, and the distribution of copper in the soil solution is less affected by pH than other metals. Copper is expected to be bound to the soil and move in the system by way of transport of soil particles by water as opposed to movement as dissolved species.

Nitrate (and to a lesser degree perchlorate) is soluble in water and may migrate with water molecules in saturated soil. As noted above, the subsurface material beneath the sites has low moisture content, which inhibits the mobility of nitrate and perchlorate as well as most other inorganic chemicals.

Selenium is not often found in the environment in its elemental form but is usually combined with sulfide minerals or with silver, copper, lead, and nickel minerals. In soil, pH and Eh are determining factors in the transport and partitioning of selenium. In soil with a pH of greater than 7.5, selenates, which have high solubility and a low tendency to adsorb onto soil particles, are the major selenium species and are very mobile. The average soil pH at the site is 8.3, indicating that selenium has the potential to migrate. However, selenium was detected in only three samples at concentrations similar to background indicating that selenium is not a contaminant at this site.

G-3.2.2 Organic Chemicals

Table G-3.2-2 presents the physical and chemical properties (organic carbon-water partition coefficient [K_{oc}], logarithm to the base 10 octanol-water partition coefficient [log K_{ow}], and solubility) of the organic COPCs identified for AOC 01-007(k). The physical and chemical properties of organic chemicals are important when evaluating their fate and transport. The following discussion about the physiochemical properties of organic COPCs is presented to illustrate some aspects of the fate and transport tendencies of the COPCs. The information is summarized from Ney (1995, 058210).

Water solubility is perhaps the most important chemical characteristic used to assess mobility of organic chemicals. The higher the water solubility of a chemical, the more likely it is to be mobile and the less likely it is to accumulate, bioaccumulate, volatilize, or persist in the environment. A highly soluble chemical (water solubility greater than 1000 mg/L) is prone to biodegradation and metabolism that may detoxify the parent chemical. Several organic chemicals identified at AOC 01-007(k) have water solubilities greater than 1000 mg/L, including acetone, benzoic acid, diethylphthalate, di-n-butylphthalate, and methylene chloride.

The lower the water solubility of a chemical, especially below 10 mg/L, the more likely it will be immobilized by adsorption. Chemicals with lower water solubilities are likely to accumulate or bioaccumulate and persist in the environment, to be slightly prone to biodegradation, and may be metabolized in plants and animals. The COPCs identified as having water solubilities less than 10 mg/L are primarily Aroclor-1248, Aroclor-1254, Aroclor-1260, bis(2-ethylhexyl)phthalate, butylbenzylphthalate, and most of the polycyclic aromatic hydrocarbons (PAHs).

Vapor pressure is a chemical characteristic used to evaluate the tendency of organic chemicals to volatize. Chemicals with vapor pressure greater than 0.01 mmHg are likely to volatilize and, therefore, concentrations at the site are reduced over time; vapors of these chemicals are more likely to travel toward the atmosphere and not migrate towards groundwater. Acetone and methylene chloride have vapor pressures greater than 0.01 mmHg.

Chemicals with vapor pressures less than 0.000001 mm Hg are less likely to volatilize and, therefore, tend to remain immobile. Many of the PAHs, bis(2-ethylhexyl)phthalate, and butylbenzylphthalate have vapor pressures less than 0.000001 mm Hg.

The K_{ow} is an indicator of a chemical's potential to bioaccumulate or bioconcentrate in the fatty tissues of living organisms. The unitless K_{ow} value is an indicator of water solubility, mobility, sorption and bioaccumulation. The higher the K_{ow} above 1000, the greater the affinity the chemical has for bioaccumulation/bioconcentration in the food chain, the greater the potential for sorption in the soil, and the lower the mobility (Ney 1995, 058210). The PAHs, polychlorinated biphenyls (PCBs), and phthalates all have a K_{ow} greater than 1000. A K_{ow} of less than 500 indicates high water solubility, mobility, little to no affinity for bioaccumulation, and degradability by microbes, plants, and animals. Acetone, benzoic acid, and methylene chloride all have a K_{ow} much less than 500.

The K_{oc} measures the tendency of a chemical to adsorb to organic carbon in soil. K_{oc} values above 500 cm^3/g indicate a strong tendency to adsorb to soil, leading to low mobility (NMED 2012, 219971). Most organic COPCs have K_{oc} values above 500 cm^3/g, indicating a very low potential to migrate toward groundwater. The organic COPCs with K_{oc} values less than 500 cm^3/g include acetone, benzoic acid, diethylphthalate, di-n-butyl phthalate, and methylene chloride.

G-3.2.3 Radionuclides

Radionuclides are generally not highly soluble or mobile in the environment, particularly in the semiarid climate of the Laboratory. The physical and chemical factors that determine the distribution of radionuclides within soil and tuff are the K_d, the pH of the soil and other soil characteristics (e.g., sand or clay content), and the Eh. The interaction of these factors is complex, but K_d values provide a general assessment of the potential for migration through the subsurface: chemicals with higher K_d values are less likely to be mobile than those with lower values. Radionuclides with K_d values greater than 40 are very unlikely to migrate through soil towards the water table (Kincaid et al. 1998, 093270).

Table G-3.2-3 gives physical and chemical properties of the radionuclide COPCs identified at AOC 01-007(k). Based on K_d values, plutonium-239/240 has a very low potential to migrate towards groundwater. The K_d values for tritium and uranium-235/236 are less than 40 and indicate a potential to migrate towards groundwater.

Uranium is a natural and commonly occurring radioactive element that is present in nearly all rock and soil. The mobility of uranium in soil and its vertical transport to groundwater depend on properties of the soil such as pH, Eh, concentration of complexing anions, porosity of the soil, soil-particle size, and sorption properties as well as the amount of water available. In general, the actinide nuclides form comparatively insoluble compounds in the environment and therefore are not considered biologically mobile. The actinides are transported in ecosystems mainly by physical and sometimes chemical processes. They tend to attach, sometimes strongly, to surfaces; and tend to accumulate in soil and sediment, which ultimately serve as strong reservoirs. Subsequent movement is largely associated with geological processes such as erosion and sometimes leaching.

Tritium's initial behavior in the environment is determined by the source. If it is released as a gas or vapor to the atmosphere, substantial dispersion can be expected, and the rapidity of deposition is dependent on climatic factors. If tritium is released in liquid form, it is diluted in surface water and is subject to physical dispersion, percolation, and evaporation (Whicker and Schultz 1982, 058209, p. 147). Tritium concentrations in the subsurface at the area of elevated radioactivity are low (<1 pCi/g), indicating the area of elevated radioactivity is not a significant source of tritium, although this radionuclide is relatively

mobile. Because tritium migrates in association with moisture, the low moisture content of the subsurface limits the potential for tritium to migrate to groundwater.

G-3.3 Exposure Point Concentration Calculations

The exposure point concentrations (EPCs) represent upper bound concentrations of COPCs. For comparison to risk-screening levels, the upper confidence limit (UCL) of the arithmetic mean was calculated when possible and used as the EPC. The UCLs were calculated using all available decision-level data within the depth range of interest. If an appropriate UCL of the mean could not be calculated or if the UCL exceeded the maximum concentration, the maximum detected concentration of the COPC was used as the EPC (maximum detection limits were used as the EPCs for some inorganic COPCs). The summary statistics, including the EPC for each COPC for the human health and the ecological risk-screening assessments and the distribution used for the calculation, are presented in Tables G-2.3-1 to G-2.3-3.

Calculation of UCLs of the mean concentrations was done using the U.S. Environmental Protection Agency (EPA) ProUCL 5.0.00 software (EPA 2013, 251074), which is based on EPA guidance (EPA 2002, 085640). The ProUCL program calculates 95%, 97.5%, and 99% UCLs and recommends a distribution and UCL. The 95% UCL for the recommended calculation method was used as the EPC. The ProUCL software performs distributional tests on the data set for each COPC and calculates the most appropriate UCL based on the distribution of the data set. Environmental data may have a normal, lognormal, or gamma distribution but are often nonparametric (no definable shape to the distribution). The ProUCL documentation strongly recommends against using the maximum detected concentration for the EPC. The maximum detected concentration was used to represent the EPC for COPCs only when the detects were too few to calculate a UCL. Input and output data files for ProUCL calculations are provided on CD as Attachment G-1.

G-4.0 HUMAN HEALTH RISK SCREENING ASSESSMENT RESULTS

The human health risk-screening assessments were conducted for AOC 01-007(k). The site was screened for the construction worker and residential scenarios using data from 1.0–6.0 ft bgs. Sites were also screened for the industrial scenario using data from 1.0–2.25 ft bgs. The human health risk-screening assessments compare either the 95% UCL of the mean concentration, the maximum detected concentration, or the maximum detection limit of each COPC with SSLs for chemicals and screening action levels (SALs) for radionuclides.

G-4.1 Human Health SSLs and SALs

Human health risk-screening assessments for chemicals were conducted using SSLs for the industrial, construction worker, and residential scenarios obtained from NMED guidance (NMED 2012, 219971). The NMED SSLs are based on a target noncarcinogenic hazard quotient (HQ) of 1 and a target cancer risk of 1×10^{-5} (NMED 2012, 219971). If SSLs were not available from NMED guidance, values from the EPA regional screening tables（http://www.epa.gov/region06/6pd/rcra_c/pd-n/screen.htm） were used. The EPA SSLs for carcinogens were multiplied by 10 to adjust from a 10^{-6} cancer risk level to the NMED target cancer risk level of 10^{-5}. EPA regional screening levels are not available for construction workers; therefore, when regional screening levels were used, the construction worker SSLs were calculated using toxicity values from the EPA regional screening tables (http://www.epa.gov/earth1r6/6pd/rcra_c/pd-n/screen.htm) and NMED exposure parameters and equation (NMED 2012, 219971). Exposure parameters used to calculate the industrial, construction worker, and residential SSLs are presented in Table G-4.1-1.

Radionuclide SALs are used for comparison with radionuclide COPC EPCs and were derived using the RESRAD model, Version 6.5 (LANL 2012, 228852). The SALs are based on a 25-mrem/yr dose as authorized by DOE Order 458.1. Exposure parameters used to calculate the SALs are presented in Tables G-4.1-2 and G-4.1-3.

G-4.2 Results of Human Health Risk Screening Evaluation

The EPC of each COPC in soil was compared with the SSLs for the industrial, construction worker, and residential scenarios. For carcinogenic chemicals, the EPCs were divided by the SSL and multiplied by 1×10^{-5}. The sum of the carcinogenic risks was compared with the NMED target cancer risk level of 1×10^{-5}. For noncarcinogenic chemicals, an HQ was generated for each COPC by dividing the EPC by the SSL. The HQs were summed to generate a hazard index (HI). The HI was compared with the NMED target HI of 1. The radionuclide EPCs were divided by the SAL and multiplied by 25 mrem/yr. The total doses were compared with the DOE target level of 25 mrem/yr, as authorized by DOE Order 458.1. The results are presented in Tables G-4.2-1 to G-4.2-9 and are described below.

G-4.2.1 AOC 01-007(k)

Calcium was retained as a COPC because it was detected above background in soil and tuff; however, it does not have a published toxicity value. Calcium is among those elements identified in section 5.9.4 of EPA's Risk Assessment Guidance for Superfund (EPA 1989, 008021) as an essential macronutrient, which can be eliminated as a COPC on the basis of best professional judgment. As an essential nutrient, calcium may be compared with the recommended daily allowance (RDA) for adults and children. The RDA is 1200 mg/d of calcium for an adult and 800 mg/d for a child (National Research Council 1989, 064000). If all the daily incidental ingestion of soil were to occur at the location of the maximum detected concentration (9960 mg/kg) at the EPA default adult soil ingestion rate of 100 mg/d of soil, an adult would ingest approximately 1.4 mg/d of calcium. At the intake level of 1.4 mg/d, the adult's ingestion of calcium is far less than the RDA for calcium of 1200 mg/d. If all the daily incidental ingestion of soil were to occur at the location of the maximum detected concentration at the EPA default child soil ingestion rate of 200 mg/d of soil, a child would ingest approximately 3.3 mg/d. At the intake level of 3.3 mg/d, the child's ingestion of calcium is far less than the RDA for calcium of 800 mg/d. Therefore, no adverse health effects are expected from calcium at 9960 mg/kg, and calcium is eliminated as a COPC.

The results of the risk-screening assessment for the industrial scenario are presented in Tables G-4.2-1, G-4.2-2, and G-4.2-3. The total excess cancer risk is 1×10^{-7}, which is less than the NMED target risk of 1×10^{-5} (NMED 2012, 219971). The industrial HI is 0.02, which is less than the NMED target of 1 (NMED 2012, 219971). The total dose is 0.002 mrem/yr, which is less than the target dose of 25 mrem/yr as authorized by DOE Order 458.1.

The results of the risk-screening assessment for the construction worker scenario are presented in Tables G-4.2-4, G-4.2-5, and G-4.2-6. The total excess cancer risk is 7×10^{-9}, which is less than the NMED target risk of 1×10^{-5} (NMED 2012, 219971). The construction worker HI is 0.04, which is less than the NMED target of 1 (NMED 2012, 219971). The total dose is 0.01 mrem/yr, which is less than the target dose of 25 mrem/yr as authorized by DOE Order 458.1.

The results of the risk-screening assessment for the residential scenario are presented in Tables G-4.2-7, G-4.2-8, and G-4.2-9. The total excess cancer risk for the residential scenario is approximately 3×10^{-7}, which is less than the NMED target risk of 1×10^{-5} (NMED 2012, 219971). The residential HI is 0.1, which is less than the NMED target of 1 (NMED 2012, 219971). The total dose is 0.02 mrem/yr, which is less than the target dose of 25 mrem/yr as authorized by DOE Order 458.1.

G-4.3 Vapor-Intrusion Pathway

The potential for vapor-intrusion of VOCs into a building was evaluated for the residential scenario. The potential risk was assessed using the Johnson and Ettinger model (http://www.epa.gov/swerrims/riskassessment/airmodel/johnson_ettinger.htm) for subsurface vapor intrusion into buildings (EPA 2002, 094114). Because only soil data are available for AOC 01-007(k), the advanced soil model (SL-ADV-REV2-4.xls) was used to calculate risk-based soil concentrations for VOCs at sites, where appropriate. The maximum detected concentration of each VOC COPC was compared with the risk-based concentration generated by the model. The model inputs and risk-based concentrations generated are provided on CD as Attachment G-2. HQs and HIs were calculated for noncarcinogenic COPCs and total excess cancer risks for carcinogenic COPCs. The NMED target risk level of 1×10^{-5} and NMED target HI of 1 were applied.

G-4.3.1 AOC 01-007(k)

The results of the residential vapor-intrusion screening assessments are presented in Tables G-4.3-1 and G-4.3-2. The HI is approximately 0.0000006, which is less than the NMED target HI of 1 (NMED 2012, 219971). The total excess cancer risk is approximately 1×10^{-12}, which is less than the NMED target cancer risk level of 1×10^{-5} (NMED 2012, 219971). These results do not change the HI and cancer risk calculated as a result of exposure to soil discussed in section G-4.2.

G-4.4 Uncertainty Analysis

The human health risk-screening evaluations are subject to varying degrees and types of uncertainty. Aspects of data evaluation and COPC identification, exposure evaluation, toxicity evaluation, and the additive approach all contribute to uncertainties in the risk evaluation process.

G-4.4.1 Data Evaluation and COPC Identification Process

A primary uncertainty associated with the COPC identification process is the possibility that a chemical may be inappropriately identified as a COPC when it is actually not a COPC or that a chemical may not be identified as a COPC when it actually should be identified as a COPC. All detected organic chemicals were retained for analysis. Inorganic chemicals were appropriately identified as COPCs because those that were detected or that had detection limits above background were retained for further analysis. However, background concentrations may not be representative of certain subunits of the Bandelier Tuff (e.g., fractured, clay-rich material) because such samples are not included in the background data set.

Other uncertainties may include errors in sampling, laboratory analysis, and data analysis. However, because concentrations used in the risk-screening evaluations include those detected less than estimated quantitation limits and nondetects above BVs, data evaluation uncertainties are expected to have little effect on the risk-screening results.

G-4.4.2 Exposure Evaluation

The current and reasonably foreseeable future land use is industrial. To the degree actual activity patterns are not represented by those activities assumed by the industrial scenario, uncertainties are introduced in the assessment, and the evaluation presented in this assessment overestimates potential risk. An individual may be subject to exposures in a different manner than the exposure assumptions used to derive the industrial and construction worker SSLs. For the site evaluated, individuals might not be on-site at present or in the future for that frequency and duration. The industrial assumptions for the

SSLs are that the potentially exposed individual is outside on-site for 8 h/d, 225 d/yr, and 25 yr (NMED 2012, 219971), while the construction worker SSLs are based on exposure of 8 h/d, 250 d/yr, and 1 yr (NMED 2012, 219971). The residential SSLs are based on exposure of 24 h/d, 350 d/yr, and 30 yr (NMED 2012, 219971). As a result, the industrial, construction worker, and residential scenarios evaluated at this site likely overestimate the exposure and risk.

A number of assumptions are made relative to exposure pathways, including input parameters, completeness of a given pathway, the contaminated media to which an individual may be exposed, and intake rates for different routes of exposure. In the absence of site-specific data, the exposure assumptions used were consistent with default values (NMED 2012, 219971). When several upper-bound values (as are found in NMED guidance [2012, 219971]) are combined to estimate exposure for any one pathway, the resulting risk estimate can exceed the 99th percentile, and therefore can exceed the range of risk that may be reasonably expected. Also, the assumption that residual concentrations of chemicals in the tuff are available and result in exposure in the same manner as if they were in soil overestimates the potential exposure and risk to receptors.

Uncertainty is introduced in the concentration aggregation of data for estimating the EPCs at a site. Risk from a single location or area with relatively high COPC concentrations may be underestimated by using a representative site-wide value. The use of a UCL is intended to provide a protective upper-bound (i.e., conservative) COPC concentration and is assumed to be representative of the average exposure to a COPC across the entire site. Potential risk and exposure from a single location or area with relatively high COPC concentrations may be overestimated if a representative site-wide value is used. The use of the maximum detected concentration for the EPC overestimates the exposure to contamination because receptors are not consistently exposed to the maximum detected concentration across the site. In addition, the maximum detection limit was used as the EPC for some inorganic COPCs with elevated detection limits above BVs.

G-4.4.3 Toxicity Evaluation

The primary uncertainty associated with the SSLs is related to the derivation of toxicity values used in their calculation. Toxicity values (reference doses [RfDs] and slope factors [SFs]) were used to derive the SSLs used in this risk-screening evaluation (NMED 2012, 219971). Uncertainties were identified in four areas with respect to the toxicity values: (1) extrapolation from other animals to humans, (2) interindividual variability in the human population, (3) the derivation of RfDs and SFs, and (4) the chemical form of the COPC.

Extrapolation from Animals to Humans. The SFs and RfDs are often determined by extrapolation from animal data to humans, which may result in uncertainties in toxicity values because differences exist in chemical absorption, metabolism, excretion, and toxic responses between animals and humans. Differences in body weight, surface area, and pharmacokinetic relationships between animals and humans are taken into account to address these uncertainties in the dose-response relationship. However, conservatism is usually incorporated in each of these steps, resulting in the overestimation of potential risk.

Individual Variability in the Human Population. For noncarcinogenic effects, the degree of variability in human physical characteristics is important both in determining the risks that can be expected at low exposures and in defining the no observed adverse effect level (NOAEL). The NOAEL uncertainty factor approach incorporates a 10-fold factor to reflect individual variability within the human population that can contribute to uncertainty in the risk evaluation; this factor of 10 is generally considered to result in a conservative estimate of risk to noncarcinogenic COPCs.

Derivation of RfDs and SFs. The RfDs and SFs for different chemicals are derived from experiments conducted by different laboratories that may have different accuracy and precision that could lead to an over- or underestimation of the risk. The uncertainty associated with the toxicity factors for noncarcinogens is measured by the uncertainty factor, the modifying factor, and the confidence level. For carcinogens, the weight of evidence classification indicates the likelihood that a contaminant is a human carcinogen. Toxicity values with high uncertainties may change as new information is evaluated.

Chemical Form of the COPC. COPCs may be bound to the environment matrix and are not available for absorption into the human body. However, it is assumed that the COPCs are bioavailable. This assumption can lead to an overestimation of the total risk.

G-4.4.4 Additive Approach

For noncarcinogens, the effects of exposure to multiple chemicals are generally not known, and possible interactions could be synergistic or antagonistic, resulting in either an over- or underestimation of the potential risk. Additionally, RfDs used in the risk calculations typically are not based on the same endpoints with respect to severity, effects, or target organs. Therefore, the potential for noncarcinogenic effects may be overestimated for individual COPCs that act by different mechanisms and on different target organs but are addressed additively.

G-4.5 Interpretation of Human Health Risk-Screening Results

G-4.5.1 AOC 01-007(k)

Industrial Scenario

The total excess cancer risk for the industrial scenario is 1×10^{-7}, which is less than the NMED target risk level of 1×10^{-5}. The industrial HI is 0.02, which is less than the NMED target HI of 1. The total dose is 0.002 mrem/yr, which is less than the DOE target dose of 25 mrem/yr. The total dose is equivalent to a total risk of 1×10^{-7}, based on a comparison with EPA's outdoor worker preliminary remediation goals (PRGs) for radionuclides (http://epa-prgs.ornl.gov/radionuclides/download/rad_master_prg_table_pci.xls).

Construction Worker Scenario

The total excess cancer risk for the construction worker scenario is 7×10^{-9}, which is less than the NMED target risk level of 1×10^{-5}. The construction worker HI is 0.04, which is less than the NMED target HI of 1. The total dose is 0.01 mrem/yr, which is less than the DOE target dose of 25 mrem/yr. The total dose is equivalent to a total risk of 9×10^{-8}, based on a comparison with EPA's outdoor worker PRGs for radionuclides (http://epa-prgs.ornl.gov/radionuclides/download/rad_master_prg_table_pci.xls).

Residential Scenario

The total excess cancer risk for the residential scenario is 3×10^{-7}, which is less than the NMED target risk level of 1×10^{-5}. The residential HI is 0.1, which is less than the NMED target HI of 1. The total dose is 0.02 mrem/yr, which is less than the DOE target dose of 25 mrem/yr. The total dose is equivalent to a total risk of 2×10^{-7}, based on a comparison with EPA's residential PRGs for radionuclides (http://epa-prgs.ornl.gov/radionuclides/download/rad_master_prg_table_pci.xls).

G-5.0 ECOLOGICAL RISK SCREENING EVALUATIONS

The approach for conducting ecological evaluations is described in the "Screening Level Ecological Risk Evaluation Methods, Revision 3" (LANL 2012, 226715). The evaluation consists of four parts: a scoping evaluation, a screening evaluation, an uncertainty analysis, and an interpretation of the results.

G-5.1 Scoping Evaluation

The scoping evaluation establishes the breadth and focus of the screening evaluation. The ecological scoping checklist (Attachment G-3 on CD) is a useful tool for organizing existing ecological information. The information was used to determine whether ecological receptors might be affected, identify the types of receptors that might be present, and develop the ecological CSM for AOC 01-007(k) (Attachment G-3). Most of the area on the mesa top is developed and typically provides minimal potential habitat for ecological receptors. The quality of the habitat varies and, in some cases, includes minimal amounts of native grasses, forbs, and trees that can be suitable habitat for ecological receptors.

The scoping evaluation indicated that terrestrial receptors were appropriate for evaluating the concentrations of COPCs in soil and tuff. Exposure is assessed across a site to a depth of 0.0–5.0 ft bgs. Aquatic receptors were not evaluated because no aquatic communities and no aquatic habitat or perennial source of water exist at the site. The depth of the regional aquifer (greater than 1000 ft bgs) and the semiarid climate limit transport to groundwater. The potential exposure pathways for terrestrial receptors in soil and tuff are root uptake, inhalation, soil ingestion, dermal contact, external irradiation, and food web transport (Attachment G-3). The weathering of tuff is the only viable natural process that may result in the exposure of receptors to contaminants in tuff. Because of the slow rate of weathering expected for tuff, exposure in tuff is negligible, although it is included in the assessment. Plant exposure in tuff is largely limited to fractures near the surface, which does not produce sufficient biomass to support an herbivore population. Consequently, the contaminants in tuff are unavailable to receptors.

The potential risk was evaluated in the risk-screening assessments for the following ecological receptors representing several trophic levels:

- a plant
- soil dwelling invertebrates (represented by the earthworm)
- the deer mouse (mammalian omnivore)
- the montane shrew (mammalian insectivore)
- desert cottontail (mammalian herbivore)
- red fox (mammalian carnivore)
- American robin (avian insectivore, avian omnivore, and avian herbivore)
- American kestrel (avian insectivore and avian carnivore [surrogate for threatened and endangered (T&E) species (primarily the Mexican spotted owl)])

The rationale for using these receptors is presented in "Screening Level Ecological Risk Evaluation Methods, Revision 3" (LANL 2012, 226715). The Mexican spotted owl is the only T&E species known to frequent the Laboratory area. The owl's primary habitat is densely forested canyons, and it has not been observed roosting in the vicinity of the Los Alamos townsite. However, the owl may use the canyons and surrounding areas to forage.

G-5.2 Assessment Endpoints

An assessment endpoint is an explicit expression of the environmental value to be protected. These endpoints are ecologically relevant and help sustain the natural structure, function, and biodiversity of an ecosystem or its components (EPA 1998, 062809). In a screening-level evaluation, assessment endpoints are any adverse effects on ecological receptors, where receptors are populations and communities (EPA 1997, 059370). The purpose of the ecological screening evaluation is to protect populations and communities of biota rather than individual organisms, except for listed or candidate T&E species or treaty-protected species (EPA 1999, 070086) because populations of protected species tend to be small and the loss of an individual adversely affects the species as a whole (EPA 1997, 059370).

In accordance with this guidance, the Laboratory developed generic assessment endpoints (LANL 1999, 064137) to ensure that values at all levels of ecological organization are considered in the ecological screening process. These general assessment endpoints can be measured using impacts on reproduction, growth, and survival to represent categories of effects that may adversely impact populations. In addition, specific receptor species were chosen to represent each functional group. The receptor species were chosen because of their presence at the site, their sensitivity to the COPCs, and their potential for exposure to those COPCs. These categories of effects and the chosen receptor species were used to select the types of effects seen in toxicity studies considered in the development of the toxicity reference values (TRVs). Toxicity studies used in the development of TRVs included only studies in which the adverse effect evaluated affected reproduction, survival, and/or growth.

The selection of receptors and assessment endpoints is designed to be protective of both the representative species used as screening receptors and the other species within their feeding guilds and the overall food web for the terrestrial and aquatic ecosystems. Focusing the assessment endpoints on the general characteristics of species that affect populations (rather than the biochemical and behavioral changes that may affect only the studied species) also ensures the applicability to the ecosystem of concern.

G-5.3 Ecological Risk Screening Evaluation

The ecological screening evaluation identifies chemicals of potential ecological concern (COPECs) and is based on the comparison of EPCs (95% UCLs, maximum detected concentrations, or maximum detection limits) to ecological screening levels (ESLs). The EPCs used in the assessments are presented in Table G-2.3-2.

The ESLs were obtained from the ECORISK Database, Version 3.1 (LANL 2012, 226667) and are presented in Table G-5.3-1. The ESLs are based on similar species and are derived from experimentally determined NOAELs, 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 TRVs, are presented in the ECORISK Database, Version 3.1 (LANL 2012, 226667).

The analysis begins with a comparison of the minimum ESL for a given COPC to the EPC. The HQ is defined as the ratio of the EPC to the concentration that has been determined to be acceptable to a given ecological receptor (i.e., the ESL). The higher the contaminant levels relative to the ESLs, the higher the potential risk to receptors; conversely, the higher the ESLs relative to the contaminant levels, the lower the potential risk to receptors. HQs greater than 0.3 are used to identify COPECs requiring additional evaluation (LANL 2012, 226715). Individual HQs for a receptor are summed to derive an HI; COPCs without ESLs are retained as COPECs and evaluated further in the uncertainty section. An HI greater than 1 indicates further assessment may be needed to ensure exposure to multiple COPECs at a site will

not lead to potential adverse impacts to a given receptor population. The HQ and HI analysis is a conservative indication of potential adverse effects and is designed to minimize the potential of overlooking possible COPECs at the site.

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The results of the minimum ESL comparisons are presented in Table G-5.3-2. Antimony, copper, lead, mercury, nickel, selenium, zinc, Aroclor-1248, Aroclor-1254, bis(2-ethylhexyl)phthalate, and di-n-butyl phthalate are retained as COPECs because the HQs were greater than 0.3.

Calcium, nitrate, and perchlorate do not have ESLs, are retained as COPECs, and are discussed in the uncertainty section.

The HQs and HIs for each COPEC and receptor combination are presented in Table G-5.3-3. The HI analysis indicates that the kestrel (both feeding guilds), robin (all feeding guilds), deer mouse, shrew, earthworm, and plant have HIs greater than 1, and the red fox and cottontail have HIs equivalent to 1. The COPECs and receptors are discussed in the uncertainty section.

G-5.4 Uncertainty Analysis

The uncertainty analysis describes the key sources of uncertainty related to the screening evaluations. This analysis can result in either adding or removing chemicals from the list of COPECs for the site. The following narrative contains a qualitative uncertainty analysis of the issues relevant to evaluating the potential ecological risk at AOC 01-007(k).

G-5.4.1 Chemical Form

The assumptions used in the ESL derivations were conservative and not necessarily representative of actual conditions. These assumptions include maximum chemical bioavailability, maximum receptor ingestion rates, minimum bodyweight, and additive effects of multiple COPECs. Most of these factors tend to result in conservative estimates of the ESLs, which may lead to an overestimation of the potential risk. The assumption of additive effects for multiple COPECs may result in an over- or underestimation of the potential risk to receptors.

The chemical form of the individual COPCs was not determined as part of the investigation, largely a limitation on analytical quantitation of individual chemical species. Toxicological data are typically based on the most toxic and bioavailable chemical species not likely found in the environment. The inorganic, organic, and radionuclide COPECs are generally not 100% bioavailable to receptors in the natural environment because of the adsorption of chemical constituents to matrix surfaces (e.g., soil) or rapid oxidation or reduction changes that render harmful chemical forms unavailable to biotic processes. The ESLs were calculated to ensure a conservative indication of potential risk (LANL 2012, 226715), and the values were biased toward overestimating the potential risk to receptors.

G-5.4.2 Exposure Assumptions

The EPCs used in the calculations of HQs were the 95% UCL, the maximum detected concentration, or the maximum detection limit to a depth of 5 ft, thereby conservatively estimating the exposure to each COPC. As a result, the exposure of individuals within a population was evaluated using this specific concentration, which was assumed constant throughout the exposure area. The sampling also focused on areas of known contamination, and receptors were assumed to ingest 100% of their food and spend 100% of their time at the site. The assumptions made regarding exposure for terrestrial receptors results

in an overestimation of the potential exposure and risk because COPECs varied across the site and were infrequently detected.

G-5.4.3 Toxicity Values

The HQs were calculated using ESLs, which are based on NOAELs as threshold effect levels; actual risk for a given COPEC/receptor combination occurs at a higher level, somewhere between the NOAEL-based threshold and the threshold based on the LOAEL. The use of NOAELs leads to an overestimation of potential risk to ecological receptors. ESLs are based on laboratory studies requiring extrapolation to wildlife receptors. Laboratory studies are typically based on "artificial" and maintained populations with genetically similar individuals and are limited to single chemical exposures in isolated and controlled conditions using a single exposure pathway. Wild species are concomitantly exposed to a variety of chemical and environmental stressors, potentially rendering them more susceptible to chemical stress. On the other hand, wild populations are likely more genetically diverse than laboratory populations, making wild populations, as a whole, less sensitive to chemical exposure than laboratory populations. The uncertainties associated with the ESLs may result in an under- or overestimation of potential risk.

G-5.4.4 Area Use Factors

In addition to the direct comparison of the EPC with the ESLs, area use factors (AUFs) are used to account for the amount of time that a receptor is likely to spend within the contaminated areas based on the size of the receptor's home range (HR). The AUFs for individual organisms were developed by dividing the size of the site by the HR for that receptor. Because T&E species must be assessed on an individual basis (EPA 1999, 070086), the AUF is used for the Mexican spotted owl. The kestrel (top carnivore) is used as the surrogate receptor for the Mexican spotted owl. The AUF for the Mexican spotted owl is estimated by dividing the site area (0.43 ha) by the HR (366 ha). The AUF for the Mexican spotted owl is 0.0012.

The kestrel (top carnivore) had an HI of 7. Application of the AUF for the Mexican spotted owl to the HI results in an adjusted HI of 0.008. Therefore, there are no potential adverse impacts to the Mexican spotted owl at the site.

G-5.4.5 Population Area Use Factors

EPA guidance is to manage the ecological risk to populations rather than to individuals, with the exception of T&E species (EPA 1999, 070086). One approach to address the potential effects on populations is to estimate the spatial extent of the area inhabited by the local population that overlaps with the contaminated area. The population area for a receptor is based on the individual receptor HR and its dispersal distance. Bowman et al. (2002, 073475) estimate that the median dispersal distance for mammals is 7 times the linear dimension of the HR (i.e., the square root of the HR area). If only the dispersal distances for the mammals with HRs within the range of the screening receptors are used (Bowman et al. 2002, 073475), the median dispersal distance becomes 3.6 times the square root of the HR (R^2=0.91). If it is assumed that the receptors can disperse the same distance in any direction, the population area is circular and the dispersal distance is the radius of the circle. Therefore, the population area can be derived by $\pi(3.6\sqrt{HR})^2$ or approximately 40HR.

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The area of AOC 01-007(k) is approximately 0.43 ha. The population area use factors (PAUFs) are estimated by dividing the site area by the population area of each receptor population (Table G-5.4-1).

The HQs and HIs are recalculated using the PAUFs. The HIs for the plant and earthworm are not adjusted by PAUFs because these receptors do not have HRs.

The adjusted HIs for AOC 01-007(k) are less than 1 for all receptors, except for the robin (insectivore) and the deer mouse. The earthworm and plant had unadjusted HIs of 3 and 27 (Table G-5.4-2).

G-5.4.6 LOAEL Analysis

The site has HIs equivalent to or greater than 1 for four receptors. To address the HIs and reduce the associated uncertainty, analyses were conducted using ESLs calculated based on a LOAEL rather than a NOAEL. The LOAEL-based ESLs were calculated based on toxicity information in the ECORISK Database, Version 3.1 (LANL 2012, 226667) and are presented in Table G-5.4-3. The analyses address some of the uncertainties and conservativeness of the ESLs used in the initial screening assessments. HI analyses and adjusted HI analyses were conducted using the LOAEL-based ESLs.

G-5.4.7 Site Discussions

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The HIs are greater than 1 for the robin (insectivore), earthworm, and plant, and equivalent to 1 for the deer mouse. Antimony is the primary COPEC for the plant, mercury is the primary COPEC for the earthworm, antimony and Aroclor-1248 are the primary COPECs for the deer mouse, and di-n-butyl phthalate is the primary COPEC for the robin (insectivore). The HI analysis using LOAEL-based ESLs resulted in HIs of approximately 3 for the plant, 4 for the robin (insectivore), and less than 1 for the earthworm and deer mouse (Table G-5.4-4). The adjusted HI for the robin (insectivore) was less than 1 (Table G-5.4-5).

The plant HI is primarily from antimony (HQ = 2.5). Antimony was not detected at the site, and the EPC is the maximum detection limit, which overestimates the potential exposure. The antimony detection limits ranged from 0.077 mg/kg to 1.23 mg/kg, which are below the BVs or similar to the maximum soil background concentration (1 mg/kg); the maximum detection limit is only 0.23 mg/kg above this concentration. The results indicate antimony is not present above background at the site. The LOAEL-based plant ESL for antimony (0.5 mg/kg) is below the soil BV (0.83 mg/kg), the same as the Qbt 2,3,4 BV, and below the maximum soil background concentration, indicating the potential ecological risk to the plant is overestimated.

In addition, field observations made during the site visit found no indication of adverse effects from COPECs on the plant community (Attachment G-3). Field observations indicated the area in and around the site is paved and developed with little habitat available for ecological receptors, including plants. Therefore, the HI does not indicate potential risk to the plants.

G-5.4.8 Chemicals without ESLs

Several COPECs do not have ESLs for any receptor in the ECORISK Database, Version 3.1 (LANL 2012, 226667). In an effort to address this uncertainty and to provide a quantitative assessment of potential ecological risk, several online toxicity databases searches were conducted to determine if any relevant toxicity information is available. The online searches of the following databases were conducted: EPA Ecotox Database, EPA Office of Pesticide Programs Aquatic Life Benchmarks, U.S. Army Corps of Engineers/EPA Environmental Residue-Effects, California Cal/Ecotox Database, Pesticide Action Network Pesticide Database, U.S. Army Wildlife Toxicity Assessment Program, U.S. Department of Agriculture Integrated Pesticide Management Database, American Bird Conservancy Pesticide Toxicity

Database, and Oak Ridge National Laboratory Risk Assessment Information System. Some COPECs without ESLs do not have chemical-specific toxicity data or surrogate chemicals to be used in the screening assessments and cannot be assessed quantitatively for potential ecological risk.

Toxicity data are not available for calcium, nitrate, and perchlorate, and no surrogate or other toxicity information is available.

Calcium was detected above soil and Qbt 2,3,4 BVs (6120 mg/kg and 2200 mg/kg) in 2 soil samples and 9 tuff samples, with a maximum concentration of 9960 mg/kg. As discussed in section G-4.2, calcium at the maximum concentration is not a health issue for an adult or a child. Therefore, calcium is eliminated as a COPEC.

Nitrate was detected in 13 samples from 1.0−5.0 ft with concentrations ranging from 0.381 mg/kg to 3.1 mg/kg. The NMED residential SSL for nitrate is 125,000 mg/kg, indicating that potential toxicity is very low. Nitrate is also naturally occurring and the detected concentrations likely reflect naturally occurring levels. Because of the potential very low toxicity and infrequent detection as well as nitrate being naturally occurring, nitrate is eliminated as a COPEC.

Perchlorate was detected in 12 samples from 1.0−5.0 ft with concentrations ranging from 0.000621 mg/kg to 0.00499 mg/kg. The NMED residential SSL for perchlorate is 54.5 mg/kg, indicating that potential toxicity is low. Because of the potential low toxicity and infrequent detection, perchlorate is eliminated as a COPEC.

G-5.5 Interpretation of Ecological Risk Screening Results

G-5.5.1 Receptor Lines of Evidence

Based on the ecological risk-screening assessments, several COPECs (including COPECs without an ESL) were identified. Receptors were evaluated using several lines of evidence: minimum ESL comparisons, HI analyses, potential effects to populations (individuals for T&E species), LOAEL analyses, and the relationship of detected concentrations and detection limits to background concentrations.

Plant

- Initial screening using the minimum ESLs eliminated a number of COPECs because the HQs for all of the receptors, including the plant, were less than 0.3.
- The HI was greater than 1 for the plant.
- The HI analysis using the LOAEL-based ESL resulted in an HI greater than 1.
- Field observations made during the site visit found no indication of adverse effects on the plant community from COPECs. The area in and/or around the site is paved and developed with several structures and a parking lot present and does not provide good-quality habitat.
- As discussed in section G-5.4.7, the potential risks (as represented by the HQs/HIs) to the plant are overestimated and/or are not representative of the site.

These lines of evidence support the conclusion no potential ecological risk to the plants exist at AOC 01-007(k).

Earthworm (Invertebrate)

- Initial screening using the minimum ESLs eliminated a number of COPECs because the HQs for all of the receptors, including the earthworm, were less than 0.3.
- The HI was greater than 1 for the earthworm.
- The HI analysis using the LOAEL-based ESL resulted in an HI less than 1.

These lines of evidence support the conclusion no potential ecological risk to the earthworm exists at AOC 01-007(k).

Montane Shrew (Insectivore)

- Initial screening using the minimum ESLs eliminated a number of COPECs because the HQs for all of the receptors, including the shrew, were less than 0.3.
- The HI was greater than 1 for the shrew.
- The HI adjusted by the PAUF, which is the ratio of the site area to the shrew's population area, was less than 1.

These lines of evidence support the conclusion that no potential ecological risk to the montane shrew exists at AOC 01-007(k).

Deer Mouse (Omnivore)

- Initial screening using the minimum ESLs eliminated a number of COPECs because the HQs for all of the receptors, including the deer mouse, were less than 0.3.
- The HI was greater than 1 for the deer mouse.
- The HI adjusted by the PAUF, which is the ratio of the site area to the deer mouse's population area, was equivalent to 1.
- The HI analysis using the LOAEL-based ESL resulted in an HI less than 1.

These lines of evidence support the conclusion that no potential ecological risk to the deer mouse exists at AOC 01-007(k).

Desert Cottontail (Herbivore)

- Initial screening using the minimum ESLs eliminated a number of COPECs because the HQs for all of the receptors, including the cottontail, were less than 0.3.
- The HI was equivalent to 1 for the cottontail.
- The HI adjusted by the PAUF, which is the ratio of the site area to the cottontail's population area, was less than 1.

These lines of evidence support the conclusion that no potential ecological risk to the cottontail exists at AOC 01-007(k).

Red Fox (Carnivore)

- Initial screening using the minimum ESLs eliminated a number of COPECs because the HQs for all of the receptors, including the fox, were less than 0.3.
- The HI was equivalent to 1 for the red fox.
- The HI adjusted by the PAUF, which is the ratio of the site area to the red fox's population area, was less than 1.

These lines of evidence support the conclusion that no potential ecological risk to the fox exists at AOC 01-007(k).

Robin (All Feeding Guilds)

- Initial screening using the minimum ESLs eliminated a number of COPECs because the HQs for all of the receptors, including the robin, were less than 0.3.
- The HIs were greater than 1 for the robin (all feeding guilds).
- The HIs by the PAUF, which is the ratio of the site area to the robin's population area, were less than 1 for the herbivore and omnivore feeding guilds, but greater than 1 for the robin (insectivore).
- The HI analysis using the LOAEL-based ESL resulted in an HI greater than 1 for the robin (insectivore).
- The LOAEL-based ESL analysis adjusted by the PAUF resulted in an HI less than 1 for the robin (insectivore).

These lines of evidence support the conclusion that no potential ecological risk to the robin (all feeding guilds) exists at AOC 01-007(k).

Kestrel (Intermediate Carnivore)

- Initial screening using the minimum ESLs eliminated a number of COPECs because the HQs for all of the receptors, including the kestrel (intermediate carnivore), were less than 0.3.
- The HI was greater than 1 for the kestrel (intermediate carnivore).
- The HI adjusted by the PAUF, which is the ratio of the site area to the kestrel's population area, was less than 1.

These lines of evidence support the conclusion that no potential ecological risk to the kestrel (intermediate carnivore) exists at AOC 01-007(k).

Kestrel (Top Carnivore)

- Initial screening using the minimum ESLs eliminated a number of COPECs because the HQs for all of the receptors, including the kestrel (top carnivore), were less than 0.3.
- The HI was greater than 1 for the kestrel (top carnivore).
- The HI adjusted by the PAUF, which is the ratio of the site area to the kestrel's population area, was less than 1.
- The kestrel (top carnivore) is a surrogate for the Mexican spotted owl. The HI adjusted by the owl's AUF was less than 1.

These lines of evidence support the conclusion that no potential ecological risks to the kestrel (top carnivore) and the Mexican spotted owl exist at AOC 01-007(k).

G-5.5.2 COPECs with No ESLs

COPECs with no ESLs were not evaluated for each receptor. All COPECs without ESLs were eliminated based on comparisons with surrogate ESLs, human health SSLs, and background concentrations. The analysis of COPECs with no ESLs supports the conclusion that no potential ecological risk to receptors exists at AOC 01-007(k).

G-5.5.3 Summary

Based on evaluations of the minimum ESLs, HI analyses, potential effects to populations (individuals for T&E species), LOAEL analyses, and the relationship of detected concentrations and detection limits to background concentrations, no potential ecological risks to the ecological receptors exist at the site.

G-6.0 CONCLUSIONS

G-6.1 Human Health Risk

The human health risk-screening assessments found no potential unacceptable risks under the industrial, construction worker, and residential scenarios at AOC 01-007(k). Total cancer risks ranged from 7×10^{-9} to 3×10^{-7} and HIs ranged from 0.02 to 0.1, which are less than the NMED target levels (NMED 2012, 219971).

The total doses were below the DOE target dose limit of 25 mrem/yr for all three scenarios at AOC 01-007(k). The total doses ranged from 0.002 to 0.02 mrem/yr and were equivalent to total risks ranging from 9×10^{-8} to 2×10^{-7}, based on a comparison with EPA's PRGs for radionuclides (http://epa-prgs.ornl.gov/radionuclides/download/rad_master_prg_table_pci.xls).

The Laboratory's as low as reasonably achievable (ALARA) program description states that quantitative ALARA evaluations are not necessary for Laboratory activities that have a potential for annual public exposure less than a 3-mrem total effective dose equivalent individual dose ("Los Alamos National Laboratory Environmental ALARA Program," PD410, p. 7, effective November 8, 2008). The calculated radiation dose for the residential scenario was 0.02 mrem/yr. Therefore, radiation exposures to the public at AOC 01-007(k) are ALARA.

G-6.2 Ecological Risk

Based on evaluations of the minimum ESLs, HI analyses, potential effects to populations (individuals for T&E species), LOAEL analyses, and the relationship of detected concentrations and detection limits to background concentrations, no potential ecological risks to the earthworm, plant, American robin, American kestrel, deer mouse, montane shrew, desert cottontail, red fox, and Mexican spotted owl exist at AOC 01-007(k).

G-7.0 REFERENCES

The following list includes all documents cited in this appendix. Parenthetical information following each reference provides the author(s), publication date, and ER ID. This information is also included in text citations. ER IDs are assigned by the Environmental Programs Directorate's Records Processing Facility (RPF) and are used to locate the document at the RPF and, where applicable, in the master reference set.

Copies of the master reference set are maintained at the NMED Hazardous Waste Bureau and the 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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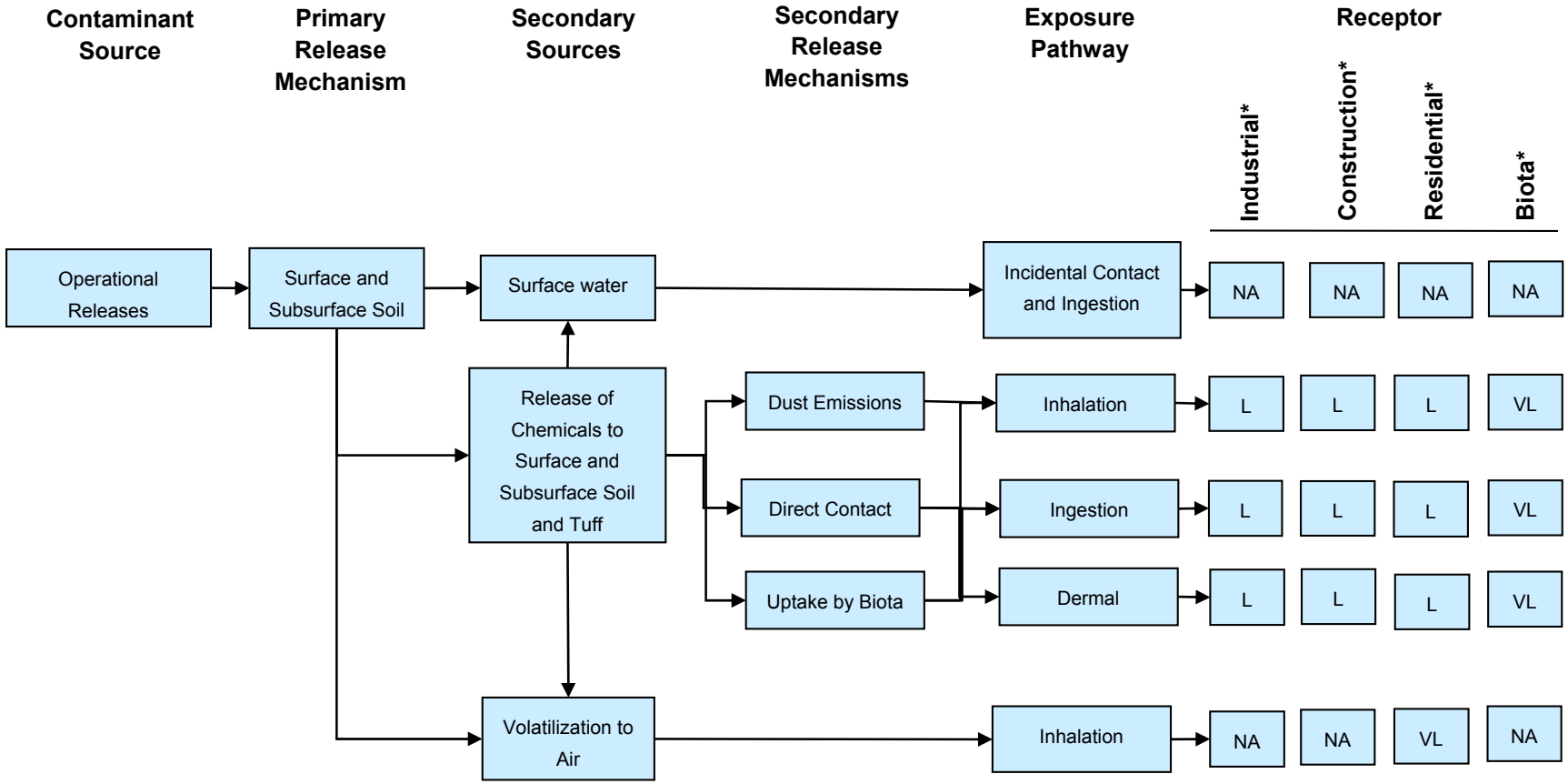
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* Very Low (VL), Low (L), and Moderate (M) designations indicate the pathway is a potentially complete pathway and is evaluated in the risk assessments.
Not Applicable (NA) indicates the pathway is incomplete and is not evaluated in the risk assessments.

Figure G-3.1-1 Conceptual site model for AOC 01-007(k)

Table G-2.3-1
EPCs for AOC 01-007(k) for the Industrial Scenario

COPC	Number of Analyses	Number of Detects	Minimum Concentration	Maximum Concentration	Distribution	EPC	EPC Method
Inorganic Chemicals (mg/kg)							
Antimony	16	0	0.098	1.23	n/a*	1.23(U)	Maximum detection limit
Chromium	16	16	2.44	13.9	Normal	8.46	95% Student's-t
Copper	16	16	0.98	159	Nonparametric	56.1	95% Chebyshev (Mean, Sd)
Lead	16	16	4.9	26.6	Normal	15.5	95% Student's-t
Mercury	16	13	0.00684	0.716	Nonparametric	0.258	95% KM (Chebyshev)
Nickel	16	16	1.8	11.2	Normal	7.23	95% Student's-t
Nitrate	16	8	0.12(U)	3.1	Nonparametric	1.19	95% KM (t)
Perchlorate	16	5	0.00092	0.0061(U)	Nonparametric	0.00202	95% KM (t)
Selenium	16	0	0.59(U)	1.15(U)	n/a	1.15(U)	Maximum detection limit
Zinc	16	16	14.7	393	Nonparametric	158.5	95% Chebyshev (Mean, Sd)
Organic Chemicals (mg/kg)							
Acetone	16	1	0.00229	0.025(U)	n/a	0.00229	Maximum detected concentration
Aroclor-1248	16	1	0.0037(U)	0.0415	n/a	0.0415	Maximum detected concentration
Aroclor-1254	16	3	0.0017	0.04(U)	n/a	0.0339	Maximum detected concentration
Aroclor-1260	16	1	0.00188	0.04(U)	n/a	0.0132	Maximum detected concentration
Bis(2-ethylhexyl)phthalate	16	1	0.15(U)	4.17(U)	n/a	0.154	Maximum detected concentration
Butylbenzylphthalate	16	1	0.37(U)	4.17(U)	n/a	0.746	Maximum detected concentration
Di-n-butyl phthalate	16	2	0.117	4.17(U)	n/a	0.404	Maximum detected concentration
Methylene chloride	16	2	0.00545(UJ)	0.02	n/a	0.02	Maximum detected concentration
Radionuclides (pCi/g)							
Plutonium-239/240	16	2	−0.00948(U)	0.145(U)	n/a	0.0848	Maximum detected concentration
Tritium	16	7	−0.06(U)	0.634	Nonparametric	0.16	95% KM (t)

Note: Data qualifiers are defined in Appendix A.
*n/a = Not applicable.

Table G-2.3-2
EPCs for AOC 01-007(k) for the Ecological Risk

COPC	Number of Analyses	Number of Detects	Minimum Concentration	Maximum Concentration	Distribution	EPC	EPC Method
Inorganic Chemicals (mg/kg)							
Antimony	34	0	0.077(U)	1.23(U)	n/a*	1.23(U)	Maximum detection limit
Chromium	32	32	1.15	21.3	Normal	8.23	95% Student's-t
Copper	34	34	0.514	159	Nonparametric	28.2	95% Chebyshev (Mean, Sd)
Lead	34	34	2.4	46.4	Lognormal	19.4	95% Chebyshev (MVUE)
Mercury	34	26	0.00459	0.716	Lognormal	0.0891	95% KM (BCA)
Nickel	34	34	0.719	11.2	Normal	6.81	95% Student's-t
Nitrate	34	13	0.12(U)	3.1	Nonparametric	0.833	95% KM (t)
Perchlorate	34	9	0.000621	0.0062(U)	Lognormal	0.00172	95% KM (t)
Selenium	34	3	0.32	1.17(U)	n/a	0.557	Maximum detected concentration
Zinc	34	34	14.7	393	Nonparametric	91.5	95% Chebyshev (Mean, Sd)
Organic Chemicals (mg/kg)							
Acetone	34	4	0.00229	0.025(U)	n/a	0.00883	Maximum detected concentration
Arcolor-1248	34	2	0.00359(U)	0.0415	n/a	0.0415	Maximum detected concentration
Aroclor-1254	34	4	0.0017	0.041(U)	n/a	0.0339	Maximum detected concentration
Aroclor-1260	34	2	0.00188	0.041(U)	n/a	0.0132	Maximum detected concentration
Bis(2-ethylhexyl)phthalate	34	1	0.15(U)	4.17(U)	n/a	0.154	Maximum detected concentration
Butylbenzylphthalate	34	2	0.359(U)	4.17(U)	n/a	0.746	Maximum detected concentration
Di-n-butyl phthalate	34	1	0.117	4.17(U)	n/a	0.404	Maximum detected concentration
Methylene chloride	34	6	0.0025	0.026	Normal	0.00643	95% KM (t)
Radionuclides (pCi/g)							
Plutonium-239/240	34	2	−0.008(U)	0.062(U)	n/a	0.038	Maximum detected concentration
Tritium	34	14	−0.06(U)	0.634	Approx. Normal	0.098	95% KM (t)
Uranium-235/236	34	7	−0.0248	0.195	Approx. Normal	0.0213	95% KM (t)

Note: Data qualifiers are defined in Appendix A.
*n/a = Not applicable.

Table G-2.3-3
EPCs for AOC 01-007(k) for the Construction Worker and Residential Scenarios

COPC	Number of Analyses	Number of Detects	Minimum Concentration	Maximum Concentration	Distribution	EPC	EPC Method
Inorganic Chemicals (mg/kg)							
Antimony	48	0	0.077(U)	1.23(U)	n/a*	1.23(U)	Maximum detection limit
Chromium	46	46	1.15	21.3	Approx. gamma	7.28	95% Adjusted gamma
Copper	48	48	0.514	159	Nonparametric	20.8	95% Chebyshev (Mean, Sd)
Lead	48	48	2.4	46.4	Nonparametric	18.6	95% Chebyshev (Mean, Sd)
Mercury	48	34	0.00459	0.716	Nonparametric	0.102	95% KM (Chebyshev)
Nickel	48	48	0.719	11.2	Approx. gamma	6.19	95% Adjusted gamma
Nitrate	48	18	0.12(U)	3.1	Nonparametric	0.747	95% KM (t)
Perchlorate	48	12	0.000621	0.0062(U)	Lognormal	0.00166	95% KM (t)
Selenium	48	3	0.32	1.17(U)	n/a	0.557	Maximum detected concentration
Zinc	48	48	14.7	393	Normal	55.02	95% Student's-t
Organic Chemicals (mg/kg)							
Acetone	48	5	0.00229	0.025(U)	Normal	0.00318	95% KM (t)
Aroclor-1248	48	3	0.00359(U)	0.0415	n/a	0.0415	Maximum detected concentration
Aroclor-1254	48	5	0.0017	0.041(U)	Approx. Gamma	0.00461	95% KM (t)
Aroclor-1260	48	2	0.00188	0.041(U)	n/a	0.0132	Maximum detected concentration
Benzoic acid	48	1	0.47	8.33(U)	n/a	0.47	Maximum detected concentration
Bis(2-ethylhexyl)phthalate	48	2	0.14(U)	4.17(U)	n/a	0.386	Maximum detected concentration
Butylbenzylphthalate	48	2	0.359(U)	4.17(U)	n/a	0.746	Maximum detected concentration
Diethylphthalate	48	1	0.139	4.17(U)	n/a	0.139	Maximum detected concentration
Di-n-butyl phthalate	48	5	0.117	4.17(U)	Normal	0.262	95% KM (t)
Methylene chloride	48	6	0.0025	0.026	Normal	0.00543	95% KM (t)
Radionuclides (pCi/g)							
Plutonium-239/240	48	3	−0.008(U)	0.062(U)	n/a	0.038	Maximum detected concentration
Tritium	48	18	−0.06(U)	0.634	Gamma	0.0647	95% KM (t)
Uranium-235/236	48	9	−0.0248(U)	0.197	Approx. Normal	0.0129	95% KM (t)

Note: Data qualifiers are defined in Appendix A.
*n/a = Not applicable.

Table G-3.2-1
Physical and Chemical Properties of Inorganic COPCs for AOC 01-007(k)

COPC	K_d[a] (cm^3/g)	Water Solubility[a,b] (g/L)
Antimony	45	Insoluble
Chromium	850	Insoluble
Copper	35	Insoluble
Lead	900	Insoluble
Mercury	52	Insoluble
Nickel	65	Insoluble
Nitrate	0.0356	Soluble
Perchlorate	na[c]	245
Selenium	5	Insoluble
Zinc	62	Insoluble

[a] Information from http://rais.ornl.gov/cgG-bin/tox/TOX_select?select=nrad.

[b] Denotes reference information from http://www.epa.gov/superfund/sites/npl/hrsres/tools/scdm.htm.

[c] na = Not available.

Table G-3.2-2
Physical and Chemical Properties of Organic Chemicals at AOC 01-007(k)

COPC	Water Solubility[a] (mg/L)	Organic Carbon Coefficient K_{oc}[a] (L/kg)	Log Octanol-Water Partition Coefficient K_{ow}[a]	Vapor Pressure[a] (mm Hg at 25°C)
Acetone	1.00E+06[b]	1.98E+00	−2.40E-01[b]	2.31E+02[b]
Aroclor-1248	5.32E-02	4.39E+04	6.34E+00	4.94E-04
Aroclor-1254	3.40E-03[b]	5.30E+05[c]	6.79E+00[b]	6.53E-06[b]
Aroclor-1260	2.84E-04[b]	5.30E+05[c]	8.27E+00[b]	4.05E-05[b]
Benzo(a)anthracene	9.43E-03	1.77E+05	5.76E+00	2.10E-07
Benzo(b)fluoranthene	1.50E-03	5.99E+05	5.78E+00	5.00E-07
Benzoic acid	3.40E+03[b]	1.45E+01	1.87E+00[b]	7.00E-04[b]
Bis(2-ethylhexyl)phthalate	2.70E-01[b]	1.65E+05	7.60E+00[b]	1.42E-07[b]
Butylbenzylphthalate	2.69E+00	9.36E+03	4.73E+00	8.25E-06
Chrysene	2.00E-03	1.81E+05	5.81E+00	6.23E-09
Diethylphthalate	1.08E+03	1.05E+02	2.42E+00	2.10E-03
Di-n-butyl phthalate	1.46E+03	4.50E+00	4.70E+00[b]	2.01E-05
Fluoranthene	2.60E-01	5.55E+04	5.16E+00	9.22E-06
Methylene chloride	1.30E+04[b]	2.37E+01	1.30E+00[b]	4.30E+02[b]
Pyrene	1.35E-01	5.43E+04	4.88E+00	4.50E-06

[a] Information from http://rais.ornl.gov/cgG-bin/tools/TOX_search, unless noted otherwise.

[b] Information from http://www.epa.gov/superfund/sites/npl/hrsres/tools/scdm.htm.

[c] Information from NMED (2102, 219971).

Table G-3.2-3
Physical and Chemical Properties of Radionuclide COPCs for AOC 01-007(k)

COPC	Soil-Water Partition Coefficient, K_d[a] (cm^3/g)	Water Solubility[b] (g/L)
Plutonium-239/240	4500	Insoluble
Tritium	9.9	Soluble
Uranium-235/236	0.4	Insoluble

[a] Superfund Chemical Data Matrix (EPA 1996, 064708).

[b] Information from http://www.epa.gov/superfund/sites/npl/hrsres/tools/scdm.htm.

Table G-4.1-1
Exposure Parameter Values Used to Calculate
Chemical SSLs for the Industrial, Construction Worker, and Residential Scenarios

Parameters	Residential Values	Industrial Values	Construction Worker Values
Target HQ	1	1	1
Target cancer risk	10^{-5}	10^{-5}	10^{-5}
Averaging time (carcinogen/mutagen)	70 yr × 365 d	70 yr × 365 d	70 yr × 365 d
Averaging time (noncarcinogen)	Exposure duration × 365 d	Exposure duration × 365 d	Exposure duration × 365 d
Skin absorption factor	Semivolatile organic compound (SVOC) = 0.1	SVOC = 0.1	SVOC = 0.1
	Chemical-specific	Chemical-specific	Chemical-specific
Adherence factor–child	0.2 mg/cm^2	n/a[a]	n/a
Body weight–child	15 kg (0–6 yr of age)	n/a	n/a
Cancer slope factor–oral (chemical-specific)	$(mg/kg\text{-}d)^{-1}$	$(mg/kg\text{-}d)^{-1}$	$(mg/kg\text{-}d)^{-1}$
Inhalation unit risk (chemical-specific)	$(\mu g/m^3)$	$(\mu g/m^3)$	$(\mu g/m^3)$
Exposure frequency	350 d/yr	225 d/yr	250 d/yr
Exposure time	24 h/d	8 h/day	8 h/d
Exposure duration–child	6 yr[b]	n/a	n/a
Age-adjusted ingestion factor for carcinogens	114 mg-yr/kg-d	n/a	n/a
Age-adjusted ingestion factor for mutagens	489.5 mg-yr/kg-d	n/a	n/a
Soil ingestion rate–child	200 mg/d	n/a	n/a
Particulate emission factor	6.61×10^9 m^3/kg	6.61×10^9 m^3/kg	2.1×10^6 m^3/kg
Reference dose–oral (chemical-specific)	(mg/kg-d)	(mg/kg-d)	(mg/kg-d)
Reference dose–inhalation (chemical-specific)	(mg/kg-d)	(mg/kg-d)	(mg/kg-d)
Exposed surface area–child	2800 cm^2/d	n/a	n/a

Table G-4.1-1 (continued)

Parameters	Residential Values	Industrial Values	Construction Worker Values
Age-adjusted skin contact factor for carcinogens	361 mg-yr/kg-d	n/a	n/a
Age-adjusted skin contact factor for mutagens	1445 mg-yr/kg-d	n/a	n/a
Volatilization factor for soil (chemical-specific)	(m^3/kg)	(m^3/kg)	(m^3/kg)
Body weight–adult	70 kg	70 kg	70 kg
Exposure duration[c]	30 yr[d]	25 yr	1 yr
Adherence factor–adult	0.07 mg/cm^2	0.2 mg/cm^2	0.3 mg/cm^2
Soil ingestion rate–adult	100 mg/d	100 mg/d	330 mg/d
Exposed surface area–adult	5700 cm^2/d	3300 cm^2/d	3300 cm^2/d

Note: Parameter values from NMED (2012, 219971).

[a] n/a = Not applicable.

[b] The child exposure duration for mutagens is subdivided into 0–2 yr and 2–6 yr.

[c] Exposure duration for lifetime resident is 30 yr. For carcinogens, the exposures are combined for child (6 yr) and adult (24 yr).

[d] The adult exposure duration for mutagens is subdivided into 6–16 yr and 16–30 yr.

Table G-4.1-2
Parameters Values Used to Calculate Radionuclide SALs for the Residential Scenario

Parameters	Residential, Child	Residential, Adult
Inhalation rate (m^3/yr)	4712[a]	7780[b]
Mass loading (g/m^3)	1.5×10^{-7}[c]	1.5×10^{-7}[c]
Outdoor time fraction	0.0926[d]	0.0934[e]
Indoor-time fraction	0.8656[f]	0.8648[g]
Soil ingestion (g/yr)	73[h]	36.5[i]

[a] Calculated as 12.9 m^3/d × 365.25 d/yr, where 12.9 m^3/d is the mean upper percentile daily inhalation rate of a child (EPA 2011, 208374, Table 6-1).

[b] Calculated as 21.3 m^3/d × 365.25 d/yr, where 21.3 m^3/d is the mean upper percentile daily inhalation rate of an adult from 21 to less than 61 yr old (EPA 2011, 208374, Table 6-1).

[c] Calculated as (1 / 6.6×10^9 m^3/kg) × 1000 g/kg, where 6.6×10^9 m^3/kg is the particulate emission factor (NMED 2012, 219971).

[d] Calculated as (2.32 h/d × 350 d/yr) / 8766 h/yr, where 2.32 h/d (139 min) is the largest amount of time spent outdoors for child age groups between 1 to less than 3 mo and 3 to less than 6 yr (EPA 2011, 208374, Table 16-1) and is comparable with the adult time spent outdoors at a residence.

[e] Calculated as (2.34 h/d × 350 d/yr) / 8766 h/yr, where 4.68 h/d is the average total time spent outdoors for adults age 18 to less than 65 yr in all environments (EPA 2011, 208374, Table 16-1); 50% of this value (2.34 h/d) was applied to time spent outdoors at a residence and is similar to mean time outdoors at a residence for this age group (EPA 2011, 208374, Table 16-22).

[f] Calculated as [(24 h/d–2.32 h/d) × 350 d/yr] / 8766 h/yr.

[g] Calculated as [(24 h/d–2.34 h/d) × 350 d/yr] / 8766 h/yr.

[h] The soil ingestion rate compensates for the time-based occupancy factor applied by RESRAD in calculating exposure from the soil ingestion pathway. Calculated as [0.2 g/d × 350 d/yr] / [indoor + outdoor time fractions], where 0.2 g/d is the upper percentile site-related daily child soil ingestion rate (NMED 2012, 219971; EPA 2011, 208374, Table 5-1).

[i] The soil ingestion rate compensates for the time-based occupancy factor applied by RESRAD in calculating exposure from the soil ingestion pathway. Calculated as [0.1 g/d × 350 d/yr] / [indoor + outdoor time fractions], where 0.1 g/d is the site-related daily adult soil ingestion rate (NMED 2012, 219971).

Table G-4.1-3
Parameter Values Used to Calculate Radionuclide SALs
for the Industrial and Construction Worker Scenarios

Parameters	Industrial, Adult	Construction Worker, Adult
Inhalation rate (m^3/yr)	7780[a]	7780[a]
Mass loading (g/m^3)	1.5×10^{-7}[b]	0.0004[c]
Outdoor time fraction	0.2053[d]	0.2282[e]
Indoor time fraction	0[f]	0
Soil ingestion (g/yr)	109.6[g]	362[h]

[a] Calculated as [21.3 m^3/d × 365.25 d/yr], where 21.3 m^3/d is the upper percentile daily inhalation rate of an adult from 21 to less than 61 yr old (EPA 2011, 208374, Table 6-1).

[b] Calculated as (1 / 6.6×10^9 m^3/kg) x 1000 g/kg, where 6.6×10^9 m^3/kg is the particulate emission factor (NMED 2012, 219971).

[c] Calculated as (1 / 2.1×10^6 m^3/kg) × 1000 g/kg, where 2.1×10^6 m^3/kg is the particulate emission factor (NMED 2012, 219971).

[d] Calculated as (8 h/d × 225 d/yr) / 8766 h/yr, where 8 h/d is an estimate of the average length of the work day and 225 d/yr is the exposure frequency (NMED 2012, 219971).

[e] Calculated as (8 h/d × 250 d/yr) / 8766 h/yr, where 8 h/d is an estimate of the average length of the work day and 250 d/yr is the exposure frequency (NMED 2012, 219971).

[f] The commercial/industrial worker is defined as someone who "spends most of the work day conducting maintenance or manual labor activities outdoors" (NMED 2012, 219971, p. 13).

[g] The soil-ingestion rate compensates for the time-based occupancy factor applied by RESRAD in calculating exposure from the soil-ingestion pathway. Calculated as [0.1 g/d × 225 d/yr] / [indoor + outdoor time fractions], where 0.1 g/d is the site-related daily adult soil-ingestion rate (NMED 2012, 219971).

[h] The soil-ingestion rate compensates for the time-based occupancy factor applied by RESRAD in calculating exposure from the soil ingestion pathway. Calculated as [0.33 g/d × 250 d/yr] / [indoor + outdoor time fractions], where 0.33 g/d is the site-related daily soil ingestion rate for a construction worker (NMED 2012, 219971).

Table G-4.2-1
Industrial Carcinogenic
Screening Evaluation for AOC 01-007(k)

COPC	EPC (mg/kg)	Industrial SSL[a] (mg/kg)	Excess Cancer Risk
Aroclor-1248	0.0415	8.26	5.02E-08
Aroclor-1254	0.0339	8.26	4.40E-08
Aroclor-1260	0.0132	8.26	1.60E-08
Bis(2-ethylhexyl)phthalate	0.154	1370	1.12E-09
Butylbenzylphthalate	0.746	9100[b]	8.20E-10
Methylene chloride	0.02	4700	4.26E-11
Total Excess Cancer Risk			**1E-07**

[a] SSLs from NMED (2012, 219971).

[b] EPA regional screening level (http://www.epa.gov/region06/6pd/rcra_c/pd-n/screen.htm).

Table G-4.2-2
Industrial Noncarcinogenic
Screening Evaluation for AOC 01-007(k)

COPC	EPC (mg/kg)	Construction Worker SSL[a] (mg/kg)	HQ
Antimony	1.23(U)	454	0.0027
Chromium	8.46	1,700,000[b]	0.000005
Copper	56.1	45,400	0.0012
Lead	15.5	800	0.019
Mercury	0.258	341	0.00076
Nickel	7.23	22,500	0.00032
Nitrate	1.19	1820000	0.00000065
Perchlorate	0.00202	795	0.0000025
Selenium	1.15(U)	5680	0.0002
Zinc	158.5	341,000	0.00046
Acetone	0.00229	868,000	0.0000000026
Di-n-butyl phthalate	0.404	68,400	0.0000059
		HI	**0.02**

[a] SSLs from NMED (2012, 219971).

[b] EPA regional screening level (http://www.epa.gov/region06/6pd/rcra_c/pd-n/screen.htm).

Table G-4.2-3
Industrial Radionuclide Screening Evaluation for AOC 01-007(k)

COPC	EPC (pCi/g)	Industrial SAL* (pCi/g)	Dose (mrem/yr)
Plutonium 239/240	0.0848	1200	0.0018
Tritium	0.16	200,000	0.00002
		Total Dose	**0.002**

*SALs from LANL (2012, 228852).

Table G-4.2-4
Construction Worker Carcinogenic
Screening Evaluation for AOC 01-007(k)

COPC	EPC (mg/kg)	Construction Worker SSL[a] (mg/kg)	Excess Cancer Risk
Aroclor-1248	0.0415	75.8	5.47E-09
Aroclor-1260	0.0132	75.8	1.74E-09
Butylbenzylphthalate	0.746	47600[b]	1.57E-10
Total Excess Cancer Risk			**7E-09**

[a] SSLs from NMED (2012, 219971).

[b] EPA regional screening level (http://www.epa.gov/region06/6pd/rcra_c/pd-n/screen.htm).

Table G-4.2-5
Construction Worker Noncarcinogenic
Screening Evaluation for AOC 01-007(k)

COPC	EPC (mg/kg)	Construction Worker SSL[a] (mg/kg)	HQ
Antimony	1.23(U)	124	0.0099
Chromium	7.28	465,000[b]	0.000016
Copper	20.8	12,400	0.0017
Lead	18.6	800	0.023
Mercury	0.102	92.9	0.0011
Nickel	6.19	6190	0.001
Nitrate	0.747	496000	0.0000015
Perchlorate	0.00166	217	0.0000076
Selenium	0.557	1550	0.00036
Zinc	55.02	92,900	0.00059
Acetone	0.00318	221,000	0.000000014
Aroclor-1254	0.00461	4.36	0.0011
Benzoic acid	0.47	952,000[c]	0.00000049
Bis(2-ethylhexyl)phthalate	0.386	4760	0.000081
Diethylphthalate	0.139	191,000	0.00000073
Di-n-butyl phthalate	0.262	23,800	0.000011
Methylene chloride	0.00543	1120	0.0000048
HI			**0.04**

[a] SSLs from NMED (2012, 219971).

[b] SSL for chromium(III) (NMED 2012, 219971).

[c] Construction worker SSL calculated using toxicity value from EPA regional screening tables (http://www.epa.gov/region06/6pd/rcra_c/pd-n/screen.htm) and equation and parameters from NMED (2012, 219971).

Table G-4.2-6
Construction Worker Radionuclide Screening Evaluation for AOC 01-007(k)

COPC	EPC (pCi/g)	Construction Worker SAL* (pCi/g)	Dose (mrem/yr)
Plutonium 239/240	0.038	120	0.0079
Tritium	0.0647	62,000	0.000026
Uranium-235/236	0.0129	100	0.0022
		Total Dose	**0.01**

* SALs from LANL (2012, 228852).

Table G-4.2-7
Residential Carcinogenic
Screening Evaluation for AOC 01-007(k)

COPC	EPC (mg/kg)	Residential SSL[a] (mg/kg)	Excess Cancer Risk
Aroclor-1248	0.0415	2.22	1.87E-07
Aroclor-1260	0.0132	2.22	5.95E-08
Bis(2-ethylhexyl)phthalate	0.386	347	1.11E-08
Butylbenzylphthalate	0.746	2600[b]	2.87E-09
		Total Excess Cancer Risk	**3E-07**

[a] SSLs from NMED (2012, 219971).

[b] EPA regional screening level (http://www.epa.gov/region06/6pd/rcra_c/pd-n/screen.htm).

Table G-4.2-8
Residential Noncarcinogenic
Screening Evaluation for AOC 01-007(k)

COPC	EPC (mg/kg)	Residential SSL[a] (mg/kg)	HQ
Antimony	1.23(U)	31.3	0.039
Chromium	7.28	117,000[b]	0.000062
Copper	20.8	3130	0.0066
Lead	18.6	400	0.047
Mercury	0.102	23.5	0.0043
Nickel	6.19	1560	0.004
Nitrate	0.747	125000	0.000006
Perchlorate	0.00166	54.8	0.00003
Selenium	0.557	391	0.0014
Zinc	55.02	23,500	0.0023
Acetone	0.00318	66,600	0.000000048
Aroclor-1254	0.00461	1.12	0.0041
Benzoic acid	0.47	240,000[c]	0.000002
Diethylphthalate	0.139	48,900	0.0000028
Di-n-butyl phthalate	0.262	6110	0.000043
Methylene chloride	0.00543	409	0.000013
		HI	**0.1**

[a] SSLs from NMED (2012, 219971).

[b] SSL for chromium(III) (NMED 2012, 219971).

[c] EPA regional screening level (http://www.epa.gov/region06/6pd/rcra_c/pd-n/screen.htm).

Table G-4.2-9
Residential Radionuclide Screening Evaluation for AOC 01-007(k)

COPC	EPC (pCi/g)	Residential SAL* (pCi/g)	Dose (mrem/yr)
Plutonium 239/240	0.038	79	0.012
Tritium	0.0647	850	0.0019
Uranium-235/236	0.0129	39	0.0083
		Total Dose	**0.02**

*SALs from LANL (2012, 228852).

Table G-4.3-1
Residential Noncarcinogenic Screening of Vapor Intrusion for AOC 01-007(k)

COPC	EPC[a] (mg/kg)	Vapor-Intrusion Risk-Based Concentration[b] (mg/kg)	HQ
Acetone	0.00883	1,940,000	0.0000000046
Methylene chloride	0.026	47,000	0.00000055
		HI	**0.0000006**

[a] Maximum detected concentration.

[b] Vapor intrusion risk values generated by the Johnson and Ettinger advanced soil model.

Table G-4.3-2
Residential Carcinogenic Screening of Vapor Intrusion for AOC 01-007(k)

COPC	EPC[a] (mg/kg)	Vapor-Intrusion Risk-Based Concentration[b] (mg/kg)	Cancer Risk
Methylene chloride	0.026	183,000	1.42E-12
		Total Excess Cancer Risk	**1E-12**

[a] Maximum detected concentration.

[b] Vapor-intrusion risk values generated by the Johnson and Ettinger advanced soil model.

Table G-5.3-1
ESLs for Terrestrial Receptors

COPC	Red Fox (Mammalian top carnivore)	American Kestrel (Avian top carnivore)	American Kestrel (Avian intermediate carnivore)	American Robin (Avian herbivore)	American Robin (Avian omnivore)	American Robin (Avian insectivore)	Desert Cottontail (Mammalian herbivore)	Montane Shrew (Mammalian)	Deer Mouse (Mammalian omnivore)	Earthworm (Soil dwelling invertebrate insectivore)	Plant (Terrestrial autotroph producer)
Inorganic Chemicals (mg/kg)											
Antimony	45	na*	na	na	na	na	2.9	0.26	0.48	78	0.05
Chromium	1800	1200	260	68	40	28	840	45	110	na	na
Copper	3800	1600	110	38	22	15	270	38	64	80	70
Lead	3700	810	120	21	16	14	370	72	120	1700	120
Mercury	46	0.28	0.082	0.07	0.022	0.013	22	1.7	3	0.05	34
Nickel	1200	2900	160	160	38	21	500	9.7	20	280	38
Selenium	84	97	5.6	1	0.87	0.75	2.1	0.66	0.83	4.1	0.52
Zinc	6000	2400	320	350	85	48	1800	98	170	120	160
Organic Chemicals (mg/kg)											
Acetone	2900	30000.00	1200.00	7.50	14.00	170.00	1.4	15	1.2	na	na
Aroclor-1248	0.075	0.34	0.2	1	0.079	0.041	0.59	0.0072	0.014	na	na
Aroclor-1254	0.15	0.22	0.17	1.3	0.08	0.041	52	0.44	0.88	na	160
Aroclor-1260	0.14	4.60	3.7	46	1.7	0.88	3000	10	20	na	na
Benzoic acid	350	na	na	na	na	na	4.2	1.0	1.3	na	na
Bis(2-ethylhexyl)phthalate	1.2	0.033	0.045	20	0.040	0.02	2700	0.59	1.1	na	na
Butylbenzylphthalate	1900	na	na	na	na	na	2300	90	160	na	na
Diethylphthalate	650,000	na	na	na	na	na	8000	3600	3600	na	100
Di-n-butyl phthalate	5000	0.24	0.068	0.39	0.021	0.011	160,00	180	370	na	160

Table G-5.3-1 (concluded)

COPC	Red Fox (Mammalian top carnivore)	American Kestrel (Avian top carnivore)	American Kestrel (Avian intermediate carnivore)	American Robin (Avian herbivore)	American Robin (Avian omnivore)	American Robin (Avian insectivore)	Desert Cottontail (Mammalian herbivore)	Montane Shrew (Mammalian)	Deer Mouse (Mammalian omnivore)	Earthworm (Soil dwelling invertebrate insectivore)	Plant (Terrestrial autotroph-producer)
Methylene chloride	1700	na	na	na	na	na	3.4	9	2.6	na	1600
Radionuclides (pCi/g)											
Plutonium-239/240	33,000	160,000	34,000	8600	2100	2100	170,000	110,000	150,000	47	160,000
Tritium	190,000	580,000	630,000	300,000	440,000	600,000	230,000	340,000	330,000	48,000	36,000
Uranium-235/236	4800	10,000	10,000	9000	6400	6400	5100	5100	5100	55	4000

*na = Not available.

Table G-5.3-2
Minimum ESL Comparison for AOC 01-007(k)

COPC	EPC	ESL	Receptor	HQ
Inorganic Chemicals (mg/kg)				
Antimony	1.23(U)	0.05	Plant	**24.6**
Chromium	8.23	28	Robin (insectivore)	0.29
Copper	28.2	15	Robin (insectivore)	**1.88**
Lead	19.4	14	Robin (insectivore)	**1.39**
Mercury	0.0891	0.013	Robin (insectivore)	**6.85**
Nickel	6.81	9.7	Montane shrew	**0.7**
Selenium	0.557	0.52	Plant	**1.07**
Zinc	91.5	48	Robin (insectivore)	**1.91**
Organic Chemicals (mg/kg)				
Acetone	0.00883	1.2	Deer mouse	0.0074
Arcolor-1248	0.0415	0.0072	Montane shrew	**5.76**
Aroclor-1254	0.0339	0.041	Robin (insectivore)	**0.83**
Aroclor-1260	0.0132	0.14	Red fox	0.094
Bis(2-ethylhexyl)phthalate	0.154	0.02	Robin (insectivore)	**7.7**
Butylbenzylphthalate	0.746	90	Montane shrew	0.0083
Di-n-butyl phthalate	0.404	0.011	Robin (insectivore)	**36.7**
Methylene chloride	0.00643	2.6	Deer mouse	0.0025
Radionuclides (pCi/g)				
Plutonium-239/240	0.038	47	Earthworm	0.00081
Tritium	0.098	36,000	Plant	0.0000027
Uranium-235/236	0.0213	55	Earthworm	0.00039

Notes: Bolded values indicate HQ greater than 0.3. Data qualifiers are defined in Appendix A.

Table G-5.3-3
HI Analysis for AOC 01-007(k)

COPEC	EPC (mg/kg)	Red Fox (Mammalian top carnivore)	American Kestrel (Avian top carnivore)	American Kestrel (Avian intermediate carnivore)	American Robin (Avian herbivore)	American Robin (Avian omnivore)	American Robin (Avian insectivore)	Desert Cottontail (Mammalian herbivore)	Montane Shrew (Mammalian)	Deer Mouse (Mammalian omnivore)	Earthworm (Soil dwelling invertebrate insectivore)	Plant (Terrestrial autotroph producer)
Antimony	1.23(U)	0.027	na*	na	na	na	na	**0.42**	**4.73**	**2.56**	0.016	**24.6**
Copper	28.2	0.0074	0.018	0.26	**0.74**	**1.28**	**1.88**	0.1	**0.74**	**0.44**	**0.35**	**0.4**
Lead	19.4	0.0052	0.024	0.16	**0.92**	**1.21**	**1.39**	0.052	0.27	0.16	0.011	0.16
Mercury	0.0891	0.0019	**0.32**	**1.09**	**1.27**	**4.05**	**6.85**	0.0041	0.052	0.03	**1.78**	0.0026
Nickel	6.81	0.0057	0.0023	0.043	0.043	0.18	**0.32**	0.014	**0.7**	**0.34**	0.024	0.18
Selenium	0.557	0.0066	0.0057	0.099	**0.56**	**0.64**	**0.74**	0.27	**0.84**	**0.67**	0.14	**1.07**
Zinc	91.5	0.015	0.038	0.29	0.26	**1.08**	**1.91**	0.051	**0.93**	**0.54**	**0.76**	**0.57**
Aroclor-1248	0.0415	**0.55**	0.12	0.21	0.042	**0.53**	**1.01**	0.07	**5.76**	**2.96**	na	na
Aroclor-1254	0.0339	0.23	0.15	0.2	0.026	**0.42**	**0.83**	0.00065	0.077	0.039	na	0.00021
Bis(2-ethylhexyl)phthalate	0.154	0.13	**4.67**	**3.42**	0.0077	**3.85**	**7.7**	0.000057	0.26	0.14	na	na
Di-n-butyl phthalate	0.404	0.000081	**1.68**	**5.94**	**1.04**	**19.2**	**36.7**	0.000025	0.0022	0.0011	na	0.0025
HI		1	**7**	**12**	**5**	**32**	**59**	1	**14**	**8**	**3**	**27**

Notes: Bolded values indicate HQ greater than 0.3 or HI greater than 1. Data qualifiers are defined in Appendix A.
*na = Not available.

Table G-5.4-1
PAUFs for Ecological Receptors for AOC 01-007(k)

Receptor	HR (ha)[a]	Population Area (ha)	PAUF[b]
American Kestrel	106	4240	0.0001
American Robin	0.42	16.8	0.026
Deer Mouse	0.077	3	0.14
Desert Cottontail	3.1	124	0.0035
Montane Shrew	0.39	15.6	0.028
Red Fox	1038	41,520	0.00001

[a] Values from EPA (1993, 059384).

[b] PAUF is calculated as the area of the site (0.43 ha) divided by the population area.

Table G-5.4-2
Adjusted HIs at AOC 01-007(k)

COPECs	EPC (mg/kg)	Red Fox (Mammalian top carnivore)	American Kestrel (Avian top carnivore)	American Kestrel (Avian intermediate carnivore)	American Robin (Avian herbivore)	American Robin (Avian omnivore)	American Robin (Avian insectivore)	Desert Cottontail (Mammalian herbivore)	Montane Shrew (Mammalian)	Deer Mouse (mammalian omnivore)	Earthworm (soil dwelling invertebrate insectivore)	Plant (terrestrial autotroph-producer)
Antimony	1.23(U)	2.7E-07	na*	na	na	na	na	0.0015	0.13	**0.36**	0.016	**24.6**
Copper	28.2	7.4E-08	1.8E-06	2.6E-05	0.019	0.033	0.049	3.5E-04	0.021	0.062	**0.35**	**0.4**
Lead	19.4	5.2E-08	2.4E-06	1.6E-05	0.024	0.031	0.036	1.8E-04	0.0076	0.022	0.011	0.16
Mercury	0.0891	1.9E-08	3.2E-05	1.1E-04	0.033	0.11	0.18	1.4E-05	0.0015	0.0042	**1.78**	0.0026
Nickel	6.81	5.7E-08	2.3E-07	4.3E-06	0.0011	0.0047	0.0083	4.9E-05	0.02	0.048	0.024	0.18
Selenium	0.557	6.6E-08	5.7E-07	9.9E-06	0.015	0.017	0.019	9.5E-04	0.024	0.094	0.14	**1.07**
Zinc	91.5	1.5E-07	3.8E-06	2.9E-05	0.0068	0.028	0.05	1.8E-04	0.026	0.076	**0.76**	**0.57**
Aroclor-1248	0.0415	4.2E-07	1.2E-05	2.1E-05	0.0011	0.014	0.026	2.5E-04	0.16	**0.41**	na	na
Aroclor-1254	0.0339	3.4E-07	1.5E-05	2.0E-05	0.00068	0.011	0.022	2.3E-06	0.0022	0.0055	na	0.00021
Bis(2-ethylhexyl)phthalate	0.154	1.5E-06	4.7E-04	3.4E-04	0.0002	0.1	0.2	2.0E-07	0.0073	0.02	na	na
Di-n-butyl phthalate	0.404	4.0E-06	1.7E-04	5.9E-04	0.027	**0.5**	**0.95**	8.8E-08	0.000062	0.00015	na	0.0025
Adjusted HI		0.000007	0.0007	0.001	0.1	0.8	**2**	0.003	0.4	1	**3**	**27**

Notes: Bolded values indicate HQ greater than 0.3 or HI greater than 1. Data qualifiers are defined in Appendix A.
*na = Not available.

Table G-5.4-3
LOAEL-Based ESLs for Terrestrial Receptors

COPEC	Receptor	LOAEL–Based ESL* (mg/kg)
Antimony	Plant	0.5
	Deer mouse	4.8
Copper	Earthworm	530
	Plant	490
Mercury	Earthworm	0.5
Selenium	Plant	3.4
Zinc	Earthworm	930
	Plant	810
Aroclor-1248	Deer mouse	0.14
Di-n-butyl phthalate	Robin (insectivore)	0.11

*LOAEL-based ESLs from ECORISK Database, Version 3.1 (LANL 2012, 226667).

Table G-5.4-4
HI Analysis Using LOAEL-Based ESLs at AOC 01-007(k)

COPEC	EPC (mg/kg)	Robin (Insectivore)	Deer Mouse	Earthworm	Plant
Antimony	1.23(U)	na[a]	0.26	n/a[b]	**2.46**
Copper	28.2	n/a	n/a	0.053	0.058
Mercury	0.0891	n/a	n/a	0.18	na
Selenium	0.557	n/a	n/a	na	0.16
Zinc	91.5	n/a	n/a	0.098	0.11
Aroclor-1248	0.0415	n/a	0.3	na	na
Di-n-butyl phthalate	0.404	**3.67**	n/a	na	n/a
HI		**4**	0.6	0.3	**3**

Notes: Bolded values indicate HQ greater than 0.3 or HI greater than 1. Data qualifiers are defined in Appendix A.

[a] na = Not available.

[b] n/a = Not applicable.

Table G-5.4-5
Adjusted HI Analysis Using LOAEL-Based ESLs at AOC 01-007(k)

COPEC	EPC (mg/kg)	Robin (Insectivore)
Di-n-butyl phthalate	0.404	0.1
Adjusted HQ		0.1

Attachment G-1

ProUCL Files
(on CD included with this document)

Attachment G-2

Vapor Intrusion Model Spreadsheets
(on CD included with this document)

Attachment G-3

Ecological Scoping Checklist for Area of Concern 01-007(k)

G-3-1.0 PART A—SCOPING MEETING DOCUMENTATION

Site ID	Area of Concern 01-007(k)
Form of site releases (solid, liquid, vapor). Describe all relevant known or suspected mechanisms of release (spills, dumping, material disposal, outfall, explosive testing, etc.) and describe potential areas of release. Reference locations on a map as appropriate.	Area of Concern (AOC) 01-007(k) is a suspected soil-contamination area located near Buildings U and W in former Technical Area 01 (TA-01). Constructed in 1943, Buildings U and W contained physics laboratories used to conduct experiments involving uranium-235, uranium-238, radium-226, carbon-14, polonium-210, and tritium. In 1959, Buildings U and W were removed from service and subsequently destroyed. The suspected soil contamination could have resulted from original Laboratory operations or from demolition and removal of buildings.
List of Primary Impacted Media **(Indicate all that apply.)**	**Surface soil –** X **Surface water/sediment –** n/a **Subsurface –** X **Groundwater –** n/a **Other, explain –** n/a
Vegetation class based on GIS vegetation coverage **(Indicate all that apply.)**	**Water –** n/a **Bare Ground/Unvegetated –** n/a **Spruce/fir/aspen/mixed conifer –** n/a **Ponderosa pine – n/a** **Piñon juniper/juniper savannah –** n/a **Grassland/shrubland –** n/a **Developed –** X **Burned –** n/a Former TA-01 is almost completely developed. Roads and large paved parking areas surround the buildings. Unpaved areas are usually landscaped. Currently, the area of AOC 01-007(k) is occupied by the building footprint and parking lot of the former Los Alamos Inn.
Is T&E Habitat Present? **If applicable, list species known or suspected of using the site for breeding or foraging.**	There is no threatened and endangered (T&E) species habitat present at the site.
Provide list, of Neighboring/ Contiguous/ Upgradient sites, include a brief summary of COPCs and the form of releases for relevant sites and reference a map as appropriate. **(Use this information to evaluate the need to aggregate sites for screening.)**	No other solid waste management units or AOCs are associated with AOC 01-007(k). Chemicals of potential concern (COPCs) include radionuclides and possibly some inorganic chemicals.
Surface Water Erosion Potential Information **Summarize information from SOP 2.01, including the total score and the run-off sub-score (maximum of 46); terminal point of surface water transport; slope; and surface water run-on sources.**	The terminal point of surface water transport is Los Alamos Canyon. The mesa ground surface is mostly covered with asphalt and is flat (<10% slope). Erosion is not present because of the flatness and the pavement.

G-3-2.0 PART B—SITE VISIT DOCUMENTATION

Site ID	AOC 01-007(k)
Date of Site Visit	January 30, 2014
Site Visit Conducted by	Richard Mirenda

Receptor Information:

Estimate cover	**Relative vegetative cover (high, medium, low, none)** = none **Relative wetland cover (high, medium, low, none)** = none **Relative structures/asphalt, etc., cover (high, medium, low, none)** = high
Field notes on the GIS vegetation class to assist in verifying the Arcview information	Vegetation at AOC 01-007(k) consists of a few weeds. The majority of area is paved.
Are ecological receptors present at the site? (yes/no/uncertain) **Describe the general types of receptors present at the site (terrestrial and aquatic), and make notes on the quality of habitat present at the site.**	No. No habitat exists to support terrestrial receptors. Some bare ground is present, which is surrounded by asphalt and other structures. No aquatic community exists on-site.

Contaminant Transport Information:

Surface water transport **Field notes on the erosion potential, including a discussion of the terminal point of surface water transport (if applicable).**	Surface water transport is low because of the asphalt and relatively flat terrain. The terminal point of surface water transport is Los Alamos Canyon to the west of the site.
Are there any off-site transport pathways (surface water, air, or groundwater)? (yes/no/uncertain) **Provide explanation**	Yes. Runoff from the site may occur, the amount of which is expected to be in direct proportion to the amount and intensity of precipitation events. Transport of potential contamination via the air is minimal because the site the area is developed and much of the site is covered in asphalt. Depth to groundwater at the site is approximately 1000 ft below ground surface (bgs), which precludes this transport pathway.

Ecological Effects Information:

Physical Disturbance **(Provide list of major types of disturbances, including erosion and construction activities, review historical aerial photos where appropriate.)**	There has been major physical disturbance at the site because of commercial development. The relatively flat area within and around the site consists of an asphalt parking lot and is adjacent to various building structures.
Are there obvious ecological effects? **(yes/no/uncertain)** **Provide explanation and apparent cause (e.g., contamination, physical disturbance, other).**	Yes. The disturbance from commercial development and the use of the area surrounding the site as a parking lot have negatively impacted the habitat quality at the site.

Adequacy of Site Characterization:

Do existing or proposed data provide information on the nature and extent of contamination? **(yes/no/uncertain)** **Provide explanation** **(Consider if the maximum value was captured by existing sample data.)**	Yes. The nature and extent of any potential contamination are defined.
Do existing or proposed data for the site address potential transport pathways of site contamination? **(yes/no/uncertain)** **Provide explanation** **(Consider if other sites should be aggregated to characterize potential ecological risk.)**	Yes. The sampling addressed the potential transport pathway of contamination.

No Exposure/Transport Pathways:

If there are no complete exposure pathways to ecological receptors onsite and no transport pathways to off-site receptors, the remainder of the checklist should not be completed. Stop here and provide additional explanation/justification for proposing an ecological No Further Action recommendation (if needed). At a minimum, the potential for future transport should include the likelihood that future construction activities could make contamination more available for exposure or transport.

Not applicable.

Additional Field Notes:

Provide additional field notes on the site setting and potential ecological receptors.

No additional notes are provided.

G-3-3.0 PART C—ECOLOGICAL PATHWAYS CONCEPTUAL EXPOSURE MODEL

Provide answers to Questions A to V to develop the Ecological Pathways Conceptual Exposure Model

Question A:

Could soil contaminants reach receptors through vapors?

- **Volatility of the hazardous substance (volatile chemicals generally have Henry's Law constant >10^{-5} atm-m^3/mol and molecular weight <200 g/mol).**

Answer (likely/unlikely/uncertain): Unlikely.

Provide explanation: Only two volatile organic chemicals (VOCs) were detected at trace concentrations orders of magnitude below the screening levels.

Question B:

Could the soil contaminants reach receptors through fugitive dust carried in air?

- **Soil contamination would have to be on the actual surface of the soil to become available for dust.**
- **In the case of dust exposures to burrowing animals, the contamination would have to occur in the depth interval where these burrows occur.**

Answer (likely/unlikely/uncertain): Unlikely.

Provide explanation: The area is highly developed and most parts are covered with asphalt and structures. Air transport via fugitive dust of potential surface contamination or to burrowing animals is unlikely given the high disturbance, asphalt paving, and adjacent roadway.

Question C:

Can contaminated soil be transported to aquatic ecological communities (use SOP 2.01 run-off score and terminal point of surface water runoff to help answer this question)?

- **If the SOP 2.01 run-off score* for each SWMU and/or AOC included in the site is equal to zero, this suggests that erosion at the site is not a transport pathway. (* note that the runoff score is not the entire erosion potential score, rather it is a subtotal of this score with a maximum value of 46 points).**
- **If erosion is a transport pathway, evaluate the terminal point to see if aquatic receptors could be affected by contamination from this site.**

Answer (likely/unlikely/uncertain): Unlikely.

Provide explanation: There are no aquatic ecological communities on or nearby the site.

Question D:

Is contaminated groundwater potentially available to biological receptors through seeps or springs or shallow groundwater?

Known or suspected presence of contaminants in groundwater.

- **The potential for contaminants to migrate through groundwater and discharge into habitats and/or surface waters.**
- **Contaminants may be taken up by terrestrial and rooted aquatic plants whose roots are in contact with groundwater present within the root zone.**
- **Terrestrial wildlife receptors generally will not contact groundwater unless it is discharged to the surface.**

Answer (likely/unlikely/uncertain): Unlikely.

Provide explanation: There are no seeps, springs, or perched groundwater present on or near the site. The depth of groundwater is approximately 1000 ft bgs.

Question E:

Is infiltration/percolation from contaminated subsurface material a viable transport and exposure pathway?

- **The potential for contaminants to migrate to groundwater.**
- **The potential for contaminants to migrate through groundwater and discharge into habitats and/or surface waters.**
- **Contaminants may be taken up by terrestrial and rooted aquatic plants whose roots are in contact with groundwater present within the root zone.**
- **Terrestrial wildlife receptors generally will not contact groundwater unless it is discharged to the surface.**

Answer (likely/unlikely/uncertain): Unlikely.

Provide explanation: Contaminants are unlikely to migrate to the regional aquifer given the depth to groundwater. The lack of a significant hydraulic driver (e.g., no standing surface water) facilitating infiltration also mitigates the potential for contaminants reaching groundwater.

Question F:

Might erosion or mass wasting events be a potential release mechanism for contaminants from subsurface materials or perched aquifers to the surface?

- **This question is only applicable to release sites located on or near the mesa edge.**
- **Consider the erodability of surficial material and the geologic processes of canyon/mesa edges.**

Answer (likely/unlikely/uncertain): Unlikely.

Provide explanation: Potential contamination is limited to the subsurface soil and tuff and the site is not located on or near the mesa edge. Additionally, the surface material surrounding the site is mostly asphalt, which has a very low erosion potential. There are no perched aquifers on or near the site.

Question G:

Could airborne contaminants interact with receptors through the respiration of vapors?

- **Contaminants must be present as volatiles in the air.**
- **Consider the importance of the inhalation of vapors for burrowing animals.**
- **Foliar uptake of vapors is typically not a significant exposure pathway**.

Provide quantification of exposure pathway (0=no pathway, 1=unlikely pathway, 2=minor pathway, 3=major pathway):

Terrestrial Plants: 1 Unlikely Pathway

Terrestrial Animals: 1 Unlikely Pathway

Provide explanation: VOCs are infrequently detected and at extremely low concentrations. No evidence of burrowing observed at the site.

Question H:

Could airborne contaminants interact with plants through the deposition of particulates or with animals through the inhalation of fugitive dust?

- **Contaminants must be present as particulates in the air or as dust for this exposure pathway to be complete.**
- **Exposure through the inhalation of fugitive dust is particularly applicable to ground-dwelling species that would be exposed to dust disturbed by their foraging or burrowing activities or by wind movement**.

Provide quantification of exposure pathway (0=no pathway, 1=unlikely pathway, 2=minor pathway, 3=major pathway):

Terrestrial Plants: 1 Unlikely Pathway

Terrestrial Animals: 1 Unlikely Pathway

Provide explanation: There was little evidence of burrowing, and much of the ground is covered with asphalt and structures.

Question I:

Could contaminants interact with plants through root uptake or rain splash from surficial soils?

- **Contaminants in bulk soil may partition into soil solution, making them available to roots.**
- **Exposure of terrestrial plants to contaminants present in particulates deposited on leaf and stem surfaces by rain striking contaminated soils (i.e., rain splash).**

Provide quantification of exposure pathway (0=no pathway, 1=unlikely pathway, 2=minor pathway, 3=major pathway):

Terrestrial Plants: 1 Unlikely Pathway

Provide explanation: Low concentrations of COPCs were detected in surface soil. Also, there are few if any plants (mainly weeds) established in the portion of the site not covered with asphalt.

Question J:

Could contaminants interact with receptors through food-web transport from surficial soils?

- **The chemicals may bio-accumulate in animals.**
- **Animals may ingest contaminated food items.**

Provide quantification of exposure pathway (0=no pathway, 1=unlikely pathway, 2=minor pathway, 3=major pathway):

Terrestrial Animals: 2 Minor Pathway

Provide explanation: COPCs were detected at low concentrations in near surface soil and the habitat is minimal.

Question K:

Could contaminants interact with receptors through the incidental ingestion of surficial soils?

- **Incidental ingestion of contaminated soil could occur while animals grub for food resident in the soil, feed on plant matter covered with contaminated soil, or while grooming themselves clean of soil.**

Provide quantification of exposure pathway (0=no pathway, 1=unlikely pathway, 2=minor pathway, 3=major pathway):

Terrestrial Animals: 2 Minor Pathway

Provide explanation: COPCs were detected at low concentrations in near surface soil and the habitat is minimal.

Question L:

Could contaminants interact with receptors through dermal contact with surficial soils?

- **Significant exposure through dermal contact would generally be limited to organic contaminants that are lipophilic and can cross epidermal barriers.**

Provide quantification of exposure pathway (0=no pathway, 1=unlikely pathway, 2=minor pathway, 3=major pathway):

Terrestrial Animals: 1 Unlikely Pathway

Provide explanation: Lipophilic chemicals were detected at low concentrations at the site, but surface soil was not sampled and much of the area is paved.

Question M:

Could contaminants interact with plants or animals through external irradiation?

- **External irradiation effects are most relevant for gamma-emitting radionuclides.**
- **Burial of contamination attenuates radiological exposure.**

Provide quantification of exposure pathway (0=no pathway, 1=unlikely pathway, 2=minor pathway, 3=major pathway):

Terrestrial Plants: 0 No Pathway

Terrestrial Animals: 0 No Pathway

Provide explanation: No gamma-emitting radionuclides were detected.

Question N:

Could contaminants interact with plants through direct uptake from water and sediment or sediment rain splash?

- **Contaminants may be taken up by terrestrial plants whose roots are in contact with surface waters.**
- **Terrestrial plants may be exposed to particulates deposited on leaf and stem surfaces by rain striking contaminated sediments (i.e., rain splash) in an area that is only periodically inundated with water.**
- **Contaminants in sediment may partition into soil solution, making them available to roots.**

Provide quantification of exposure pathway (0=no pathway, 1=unlikely pathway, 2=minor pathway, 3=major pathway):

Terrestrial Plants: 0 No Pathway

Provide explanation: There are no aquatic environments on-site.

Question O:

Could contaminants interact with receptors through food-web transport from water and sediment?

- **The chemicals may bioconcentrate in food items.**
- **Animals may ingest contaminated food items.**

Provide quantification of exposure pathway (0=no pathway, 1=unlikely pathway, 2=minor pathway, 3=major pathway):

Terrestrial Animals: 0 No Pathway

Provide explanation: There are no aquatic environments on-site.

Question P:

Could contaminants interact with receptors through the ingestion of water and suspended sediments?

- **If sediments are present in an area that is only periodically inundated with water, terrestrial receptors may incidentally ingest sediments.**
- **Terrestrial receptors may ingest water-borne contaminants if contaminated surface waters are used as a drinking water source.**

Provide quantification of exposure pathway (0=no pathway, 1=unlikely pathway, 2=minor pathway, 3=major pathway):

Terrestrial Animals: 0 No Pathway

Provide explanation: There are no aquatic environments on-site.

Question Q:

Could contaminants interact with receptors through dermal contact with water and sediment?

- **If sediments are present in an area that is only periodically inundated with water, terrestrial species may be dermally exposed during dry periods.**
- **Terrestrial organisms may be dermally exposed to water-borne contaminants as a result of wading or swimming in contaminated waters.**

Provide quantification of exposure pathway (0=no pathway, 1=unlikely pathway, 2=minor pathway, 3=major pathway):

Terrestrial Animals: 0 No Pathway

Provide explanation: There are no aquatic environments on-site.

Question R:

Could suspended or sediment-based contaminants interact with plants or animals through external irradiation?

- **External irradiation effects are most relevant for gamma-emitting radionuclides.**
- **Burial of contamination attenuates radiological exposure.**

Provide quantification of exposure pathway (0=no pathway, 1=unlikely pathway, 2=minor pathway, 3=major pathway):

Terrestrial Plants: 0 No Pathway

Terrestrial Animals: 0 No Pathway

Provide explanation: There are no aquatic environments on-site.

Question S:

Could contaminants bio-concentrate in free-floating aquatic, attached aquatic plants, or emergent vegetation?

- **Aquatic plants are in direct contact with water.**
- **Contaminants in sediment may partition into pore water, making them available to submerged roots.**

Provide quantification of exposure pathway (0=no pathway, 1=unlikely pathway, 2=minor pathway, 3=major pathway):

Aquatic Plants/Emergent Vegetation: 0 No Pathway

Provide explanation: There are no aquatic environments on-site.

Question T:

Could contaminants bio-concentrate in sedimentary or water-column organisms?

- **Aquatic receptors may actively or incidentally ingest sediment while foraging.**
- **Aquatic receptors may be directly exposed to contaminated sediments or may be exposed to contaminants through osmotic exchange, respiration, or ventilation of sediment pore waters.**
- **Aquatic receptors may be exposed through osmotic exchange, respiration, or ventilation of surface waters.**

Provide quantification of exposure pathway (0=no pathway, 1=unlikely pathway, 2=minor pathway, 3=major pathway):

Aquatic Animals: 0 No Pathway

Provide explanation: There are no aquatic environments on-site.

Question U:

Could contaminants bio-accumulate in sedimentary or water column organisms?

- **Lipophilic organic contaminants and some metals may concentrate in an organism's tissues.**
- **Ingestion of contaminated food items may result in contaminant bioaccumulation through the food web.**

Provide quantification of exposure pathway (0=no pathway, 1=unlikely pathway, 2=minor pathway, 3=major pathway):

Aquatic Animals: 0 No Pathway

Provide explanation: There are no aquatic environments on-site.

Question V:

Could contaminants interact with aquatic plants or animals through external irradiation?

- **External irradiation effects are most relevant for gamma-emitting radionuclides.**
- **The water column acts to absorb radiation; therefore, external irradiation is typically more important for sediment dwelling organisms.**

Provide quantification of exposure pathway (0=no pathway, 1=unlikely pathway, 2=minor pathway, 3=major pathway):

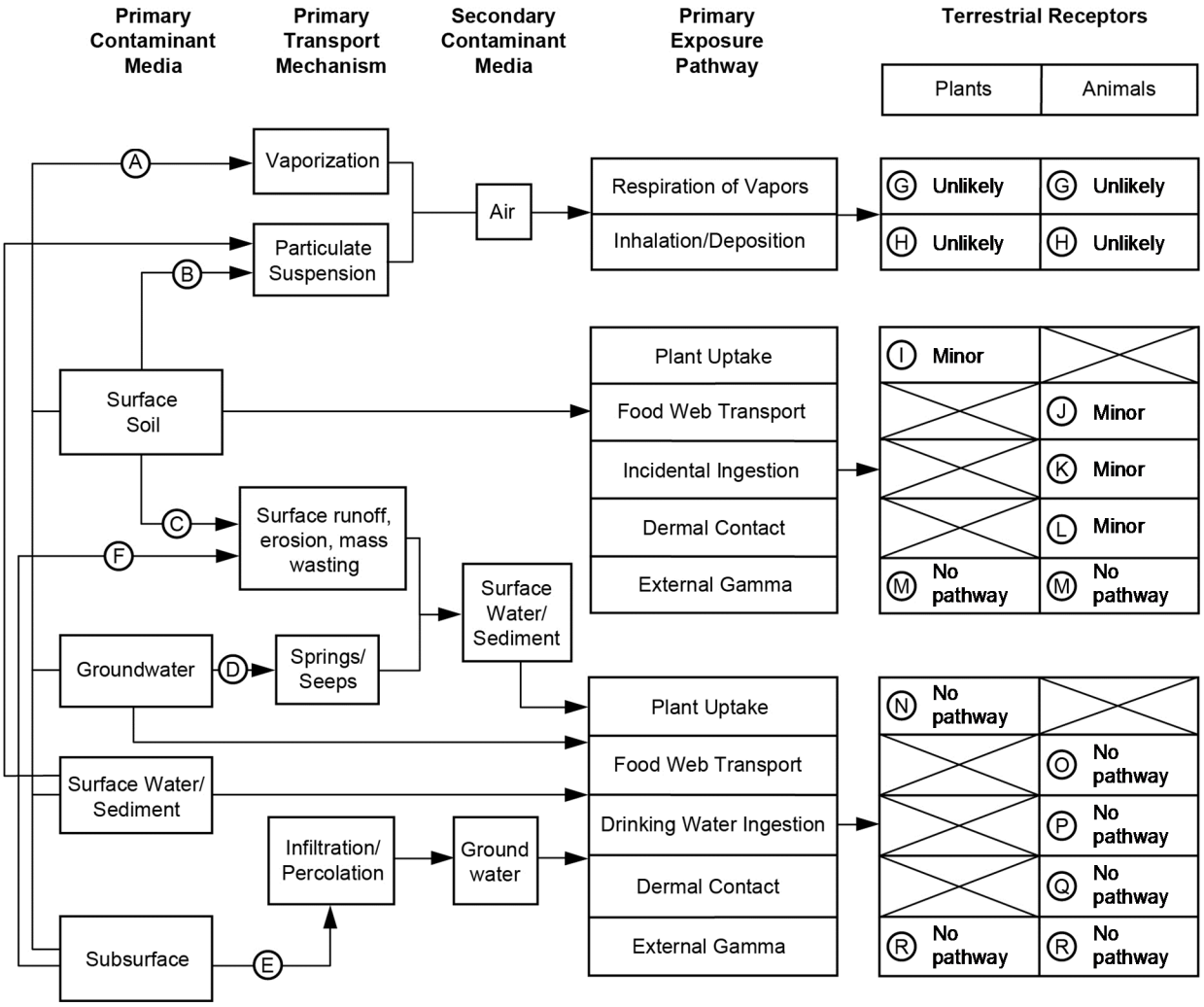
Aquatic Plants: 0 No Pathway

Aquatic Animals: 0 No Pathway

Provide explanation: There are no aquatic environments on-site.

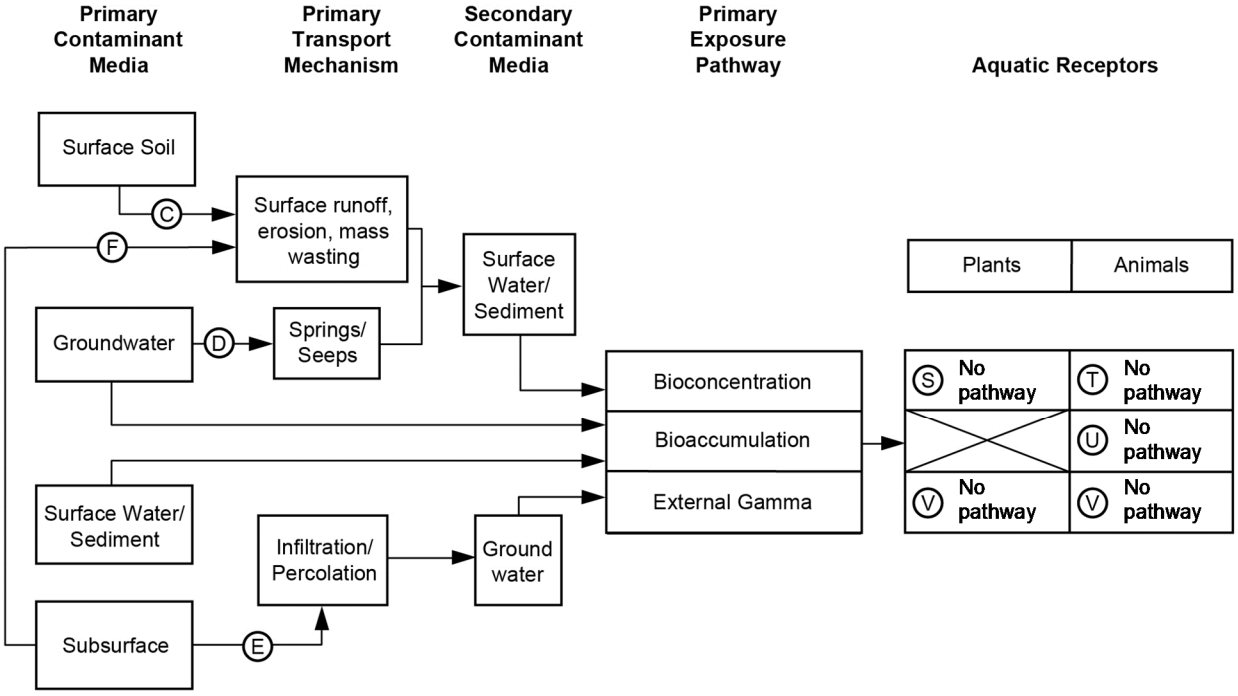
Ecological Scoping Checklist
Terrestrial Receptors
Ecological Pathways Conceptual Exposure Model

NOTE:
Letters in circles refer to questions on the scoping checklist.



Ecological Scoping Checklist
Aquatic Receptors
Ecological Pathways Conceptual Exposure Model

NOTE:
Letters in circles refer to questions on the scoping checklist.



SIGNATURES AND CERTIFICATION

Checklist completed by:

Name (printed): Richard Mirenda
Name (signature): Richard Mirenda
Organization: ET-ER
Date completed: 2/4/2014

Checklist reviewed by:

Name (printed): Tracy McFarland
Name (signature): Tracy McFarland
Organization: MOF-CM-STR
Date reviewed: 3/19/14