EXECUTIVE SUMMARY

This document describes results of the Phase III Resource Conservation and Recovery Act (RCRA) facility investigation (RFI) that was conducted at consolidated Solid Waste Management Unit (SWMU) 16-021(c)-99, which is located at Technical Area 16 (TA-16) within the Los Alamos National Laboratory (the Laboratory or LANL). This SWMU is associated with an outfall situated behind a high explosives (HE) processing building (Building 260). The outfall is also known as the TA-16-260 outfall, or the 260 outfall (see Figure 1.2-3). The Phase III RFI, which was conducted from 1999 to 2002, is an integral part of the corrective measures study (CMS) plan and the CMS plan addendum. Sampling was conducted according to the sampling and analysis plan (SAP) included in the CMS plan for SWMU 16-021(c)-99. The plan was approved by the New Mexico Environment Department (NMED) in September 1999. The regulatory status of SWMU 16-021(c)-99 is shown in Table ES-1.

The CMS plan divides the evaluation of transport pathways and the selection of remedial alternatives into an alluvial groundwater CMS and a regional groundwater CMS. The alluvial groundwater CMS is focusing on the Cañon de Valle source area, alluvial groundwater system, and the subsurface tuff and saturated system, including canyon springs. The regional groundwater CMS for SWMU 16-021(c)-99 is a separate investigation into the extent of contamination in the deep perched zone and the regional aquifer. One important goal of the Phase III RFI was to investigate, and incorporate into the conceptual model, the hydrogeologic and contaminant transport dynamics of the Cañon de Valle and Martin Spring Canyon alluvial and subsurface groundwater systems. The Phase III RFI data have reduced data uncertainties such as contaminant concentration and distribution for the CMS process.

The following Phase III RFI activities were conducted in support of the alluvial groundwater CMS:

- characterizing the subsurface and alluvial groundwater through the installation of seven piezometers in Cañon de Valle and three alluvial groundwater wells in Martin Spring Canyon;
- determining contaminant dynamics and contamination distribution by sampling alluvial groundwater, surface water, and springs in Cañon de Valle and Martin Spring Canyon;
- determining contaminant inventory and distribution in sediment through geomorphic-based sediment sampling in both Cañon de Valle and Martin Spring Canyon;
- characterizing hydraulic interconnectivity and the residence time of water in the subsurface through a continuing bromide tracer study which was initiated in 1997 and through a stable isotope study;
- characterizing the nature and extent of contamination in the mesa vadose zone through the sampling and analysis of the intermediate-depth perched aquifer;
- identifying potential subsurface contaminant migration pathways using geophysical studies; and
- performing baseline human health risk assessments for the Cañon de Valle and Martin Spring Canyon and a baseline ecological risk assessment for Cañon de Valle.

SWMU 16-021(c)-99 Source Area

The SWMU 16-021(c)-99 source area is comprised of a settling pond and an upper and lower drainage channel that extends from the 260 outfall downgradient to the confluence of the drainage and Cañon de Valle. The source area was excavated during an interim measure (IM) conducted from winter 2000 through summer of 2001. The IM removed more than 1300 yd^3 of contaminated soil, sediment, and tuff containing approximately 90% of the HE compounds that existed in the source area. HE compounds and barium COPCs still remain in the SWMU 16-021(c)-99 source area in isolated locations throughout the drainage channel. Remaining sources of contamination are associated with either historic HE releases elsewhere in TA-16 or secondary sources such as sediment.

Cañon de Valle Alluvial System Investigation

The primary COPCs for Cañon de Valle surface water are RDX (cyclotrimethylene-trinitramine) and barium, both of which were detected in surface water samples at the confluence of Cañon de Valle and Water Canyon (approximately 3 mi downstream from the source area). This indicates that the entire Cañon de Valle alluvial system contains RDX and barium. RDX concentrations in the surface water of Cañon de Valle are highest near the 260 outfall area. The highest mass flow rate of RDX in surface water occurred during wet periods. In addition, Americium-241 and Ruthenium-106 were included as radionuclides of concern for risk analysis based on pre-1998 limited detections in surface water and sediment.

The primary COPCs for Cañon de Valle alluvial groundwater are RDX, barium, and manganese. There is a positive correlation between saturated thickness in Cañon de Valle alluvial wells and RDX concentration, indicating that RDX residing within the vadose zone constitutes an important secondary source which is released to the alluvial groundwater during high surface water flow events with the corresponding increased saturated thickness in the alluvium. Barium concentration trends in alluvial groundwater over time are stable to slightly decreasing, with spikes associated with pulses of barium into the system, possibly due to sediment flushing.

The primary COPCs for Cañon de Valle sediment are RDX, HMX (cyclotetramethylene-tetranitramine), amino-2,6-dinitrotoluene[4-], amino-4,6-dinitrotoluene[2-], TNT (trinitrotoluene[2,4,6-]), antimony, barium, cobalt, copper, lead, nickel, and silver. The active channel sediment resampling in 2002 (conducted after the Cerro Grande fire in 2000) showed a reduction in RDX and barium in the upper canyon since the 1996 sampling, indicating a contaminant inventory shift. This was probably a result of increased post-fire surface water runoff.

Martin Spring Canyon Alluvial System Investigation

The COPCs for Martin Spring Canyon surface water are RDX, barium, boron, and manganese. The COPCs for alluvial groundwater include RDX, arsenic, barium, beryllium, boron, cadmium, lead, and manganese. The COPCs in Martin Spring Canyon alluvium, sediment, and tuff include amino-2,6-dinitrotoluene[4-], amino-4-6-dinitrotoluene[2-], RDX, TNT, arsenic, barium, cadmium, chromium, copper, lead, mercury, selenium, and silver. Both barium and RDX are present in Martin Spring Canyon sediment, but at much lower concentrations and with much smaller inventories than in Cañon de Valle.

Subsurface Systems—Intermediate-Depth Perched Aquifer and Springs Investigation

The subsurface system investigations included physical and chemical characterization of SWSC, Burning Ground, and Martin Springs; the 90s Line Pond; and samples collected from five intermediate-depth perched aquifer wells. The springs are a manifestation of the intermediate-depth perched groundwater, present primarily in tuff discontinuities such as fractures and surge beds that underlie the northwestern portion of TA-16. The 90s Line Pond, located on the mesa top, was included because it may be a groundwater recharge source. The springs investigation included quarterly sampling of the three springs and additional flow-integrated samples. Analytical data from these sampling campaigns indicate all three springs contain RDX and TNT as primary COPCs. Intermediate-depth perched groundwater is ephemeral in most of the well locations. Analysis of the intermediate-depth groundwater indicates low levels of contamination. Groundwater wells are frequently dry but, when wet, contaminant levels are detected for several constituents, including HE compounds. Concentrations exceed contaminant-screening limits for RDX and metals including aluminum, antimony, arsenic, barium, beryllium, boron, cadmium, chromium, cobalt, copper, lead, manganese, nickel, selenium, silver, thallium, and zinc.

Conceptual Model

In general, the conceptual model that was presented in the Phase II RFI still applies on a site-wide basis. The Phase III RFI conceptual model changes have largely been refinements that have reduced data uncertainties for the CMS process.

The key components of the conceptual site model include:

- the source area;
- a mesa vadose zone, consisting of nonfractured and fractured tuff and intermediate-depth ephemeral perched groundwater;
- canyon alluvial sediment;
- canyon springs;
- canyon surface water;
- canyon alluvial groundwater;
- a deep vadose zone, consisting of nonfractured and fractured tuff that extends from the canyon bottom to the top of the regional aquifer; and
- the regional aquifer, as defined by the installation of Regional Aquifer Well R-25. While the regional aquifer is not included in the scope of this Phase III RFI, key results from the installation and sampling of Regional Aquifer Well R-25 are important for a general understanding of the conceptual model.

Isotopic differences in composition between mesa vadose zone groundwater and Cañon de Valle alluvial groundwater indicate mesa groundwater probably comes from local precipitation and snowmelt on the mesa top, whereas Cañon de Valle groundwater is at least partially derived from spring flow recharged at higher elevations. Borehole sampling in the mesa vadose zone indicates no contamination in the unsaturated depth intervals in any boreholes except in the immediate vicinity of the former settling pond. These results indicate mesa vadose zone contamination is concentrated beneath source area SWMUs such as the former and current ponds and drainages (90s Line Pond, V-Site Pond, 30s Line Pond) on the mesa top. However, ephemeral groundwater in mesa vadose zone wells not located in the vicinity of the former settling pond have shown contamination, indicating lateral movement (possibly through surge beds) of water and contaminants in the mesa subsurface. In addition, based on the oxygen and deuterium stable isotope results, mesa vadose zone groundwater from Well 16-02665 (Martin Spring Canyon) and Well 16-02669 (90s Line Pond) and surface water from the 90s Line Pond all show evaporative signatures, but spring water does not. These results reinforce the presence of a mesa vadose zone groundwater flow regime that is dominated by fractures and surge beds and, in general, the importance of hydrologic heterogeneity at TA-16.

Human Health Risk—Cañon de Valle Source Area

The baseline risk assessment for the Cañon de Valle source area used the list of identified COPCs and evaluated potential exposures to an on-site environmental worker, a trail user, and a construction worker. The on-site environmental worker is assumed to be involved in environmental monitoring such as field sampling efforts. The trail user is a worker using the trails for recreation or exercise such as walking or jogging. The construction worker is assumed to be involved in intrusive work activities such as excavation. Thus, the frequency and duration of exposure differs, though the exposure pathways for all these human receptors are assumed to be the same.

The cumulative excess cancer risk to all human receptors from potential exposures to all COPCs in soil and tuff was slightly above, or less than, the 1×10^{-5} target risk specified by NMED under both central tendency estimate (CTE) and reasonable maximum exposure (RME) assumptions (cancer risk ranges from 4×10^{-7} to 3×10^{-5}). Noncancer hazards are below, or slightly above, a hazard index (HI) of 1.0 for CTE and RME assumptions (HIs range from 0.03 to 2.0).

Human Health Risk—Cañon de Valle Alluvial Area

For the Cañon de Valle alluvial area, a trail-user scenario was assessed. Cumulative excess cancer risk to the trail user from potential exposures to all COPCs in sediment and surface water is below the 1×10^{-5} target risk specified by NMED for CTE and RME assumptions. Noncancer hazards are below an HI of 1.0 for both exposure assumptions.

The potential dose from radionuclides of concern (Americium-241 and Ruthenium-106) in surface water was calculated using the residual radioactive material (RESRAD) version 6.21 computer code, as developed by Argonne National Laboratory for the U.S. Department of Energy. The default RESRAD exposure parameters were used assuming surface water was the primary drinking water source (pathways evaluated include ingestion, inhalation, and external gamma exposure). The resulting total dose was 0.000003 millirem per year (mrem/yr). These doses are minimal, and well below the dose of 15 mrem/yr U.S. Department of Energy-Albuquerque Office guideline (DOE-AL 2000, 67153).

Human Health Risk—Martin Spring Canyon

For the Martin Spring Canyon baseline risk assessment, a trail-user scenario was assessed. Cumulative excess cancer risk to the trail user from potential exposures to all COPCs in sediment and surface water is below the 1×10^{-5} target risk specified by NMED for CTE and RME assumptions. Noncancer hazards are below an HI of 1.0 for both exposure assumptions.

Ecological Risk—Cañon de Valle

For the ecological risk assessment, the process followed US Environmental Protection Agency and NMED guidance. The ecological risk assessment for the terrestrial system in Cañon de Valle found elevated metals concentrations in small mammals but not at levels that are likely to cause adverse effects for the Mexican spotted owl. The numbers of species, population densities, and reproductive classes for those species indicated that the Cañon de Valle small mammal community is not being adversely affected by contaminants.

The ecological assessment of the aquatic system in the canyon found some differences between benthic macro-invertebrates in Cañon de Valle and reference canyons, though these results were not replicated in a subsequent toxicity test, indicating high variability in the contaminant signatures for this sediment. The toxicity testing for Cañon de Valle shows potential impacts relative to the reference site in Starmer's Gulch, although the sediment is heterogeneous with regard to potential toxic effects. In Cañon de Valle, a viable benthic macro-invertebrate community is present, which is a meaningful indicator that site contaminants cause negligible ecological effects.

Conclusions

- Although the volume of the residual soil within the former outfall source area is less than 100 yd^3 (based on field observations), the soil contains elevated concentrations of HE and barium that could be mobilized by stormwater runoff.
- The potential risk for residual contamination in the former outfall source area soil is marginally above NMED's target risk levels for RME for the environmental worker (cancer risk) and the construction worker (noncancer hazard) and may be within EPA's target risk range; potential risks for CTE exposures and other RMEs for the receptors were below these NMED target levels.
- Sediments in Cañon de Valle and Martin Spring Canyon represent a widely dispersed secondary source for HE and barium that is potentially mobilized by surface water and alluvial groundwater. Moreover, the perennial reach of Cañon de Valle alluvial groundwater provides a high potential for subsequent infiltration of mobilized contaminants.
- The drought has influenced the hydrogeology of the area by reducing mesa vadose zone groundwater recharge, reducing canyon alluvium saturated thickness, and causing SWSC and Martin Spring to dry up.
- Contaminant transport in the mesa vadose zone is dominated by a fracture or surge bed flow regime, of which contaminated springs are a known manifestation. With the IM source removal, a substantial source for this contamination is gone, though reductions in spring contaminant concentrations are not yet evident. More wells are planned in both the mesa vadose zone groundwater and the regional aquifer to further assess the importance of these pathways.
- Cañon de Valle and Martin Spring Canyon surface water, groundwater, springs, and sediment do not pose a potential unacceptable human health risk to the trail user (i.e., potential risks and hazards are below 10^{-5} and HI of 1.0 for all exposures).
- The ecological risk assessment conducted in Cañon de Valle found that COPCs have no adverse effects on terrestrial receptors and have negligible adverse effects on aquatic receptors.

Table ES-1
Summary of Proposed Actions

SWMU Number	SWMU Description	HSWA	Radionuclide Component	Proposed Action	Rationale for Recommendation
16-021(c)	Outfall and drainage channel	Yes	No	CMS/CMS report	RCRA contamination within acceptable human health risk and ecological risk ranges; isolated areas of contamination exceed acceptable ranges and will be addressed in CMS

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1.0 INTRODUCTION

Los Alamos National Laboratory (LANL or the Laboratory) is a multi-disciplinary research facility owned by the US Department of Energy (DOE) and managed by the University of California. 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 approximately 40 mi^2 of the Pajarito Plateau, which consists of a series of fingerlike mesas separated by deep canyons that contain ephemeral and intermittent streams that run from west to east. Mesa tops range in elevation from approximately 6200 ft to 7800 ft. The eastern portion of the plateau stands 300 to 900 ft above the Rio Grande.

The Laboratory's Risk Reduction and Environmental Stewardship–Remediation Services (RRES-RS) project is involved in a national effort by the DOE to clean up facilities that were formerly involved in weapons production. The goal of the RRES-RS project is to ensure that the DOE's past operations do not threaten human or environmental health and safety in and around Los Alamos County, New Mexico.

This document describes the results of a Phase III RCRA facility investigation (RFI) which was conducted at consolidated Solid Waste Management Unit (SWMU) 16-021(c)-99 from 1999 through 2002. This consolidated SWMU, located within Technical Area 16 (TA-16), includes the TA-16-260 outfall and associated drainage. The Phase III investigation is an integral part of the corrective measures study (CMS) plan (LANL 1998, 62413.3) and the CMS plan addendum and its revision (LANL 1999, 64873.3; LANL 2003, 75986.2).

The CMS plan separates the evaluation of transport pathways and the selection of remedial alternatives into an alluvial CMS and regional groundwater CMS.

The alluvial CMS is focused on the Cañon de Valle source area and alluvial system and on the subsurface tuff and saturated system (for example, perched water, SWSC Spring and Burning Ground Spring in Cañon de Valle, and Martin Spring in Martin Spring Canyon). The Phase III investigation was designed to evaluate interactions among these hydrogeologic systems, to characterize contamination transport through the mesa, and to help define the boundaries of the existing plume(s). Results are presented for the TA-16-260 outfall area as well as the associated hydrogeologic systems potentially impacted by its releases.

This report describes the sampling conducted during the Phase III RFI, examines the analytical results collected for this site, describes and revises the physical and contaminant transport conceptual model developed for the site, and presents human health and ecological risk assessments. Sampling was conducted according to the approach described in the sampling and analysis plan (SAP) which was included in "CMS Plan for Potential Release Site 16-021(c)" (LANL1998, 62413.3). The plan, and its associated Phase III SAP, was approved by NMED in September 1999.

The regional groundwater CMS for SWMU 16-021(c)-99 investigates the extent of contamination in the deep perched zone and the regional aquifer. In addition to Regional Aquifer Well R-25, two additional deep wells have been installed: CdV-R-15-3 and CdV-R-37-2. Three intermediate-depth wells are planned for Cañon de Valle in FY 2004. These wells will help meet the objectives of the Phase III RFI and CMS, although they are not part of this Phase III RFI.

1.1 Purpose and Regulatory Context

The Phase III RFI, including its sampling and analyses, was conducted under the requirements of RCRA and NMHWA. The investigation of SWMU 16-021(c)-99 was performed in accordance with the Hazardous and Solid Waste Amendments (HSWA) of 1984, and it followed the requirements found in Module VIII of the Laboratory's Hazardous Waste Facility Permit (EPA 1990, 01585). Module VIII was issued to the Laboratory by the US Environmental Protection Agency (EPA) on May 23, 1990, and was approved on May 4, 1994 (DOE 1994, 35328).

The RCRA corrective action program at SWMU 16-021(c)-99 is being implemented in phases. Table 1.1-1 lists the RCRA corrective action program phases and the RCRA-driven actions that have been, or will be, implemented at SWMU 16-021(c)-99.

The purposes of the Phase III RFI are to (1) collect sufficient data to further define the nature and extent of site contamination, and (2) refine the site conceptual model. Specifically, Phase III sampling is designed to assess the interconnectivity between the source area and springs at TA-16, and between the canyon bottom systems and deeper groundwater systems. Phase III sampling was also designed to evaluate the interactions among the springs, surface water, and alluvial groundwater, and the responses of those components of the site hydrogeologic system to precipitation events and flow conditions. Finally, Phase III sampling was designed to assess contaminant storage and redistribution in canyon sediment. Collectively, these lines of investigation were designed to establish the relationships between contaminant concentration variability and migration and the site hydrogeologic system behavior.

The Phase III data also augment data from previous investigations to support the performance of site-specific risk assessments and to support the CMS. The objective of the risk assessments is to quantify the potential risks, if any, to human and ecological receptors from exposure to site-related contaminants. The CMS provides a preliminary evaluation of technologies used to remediate contamination at the site, remedial alternatives, characterization of contaminant transport (as detailed in the Phase III SAP), and remedial action designs. Remedial actions are then implemented to mitigate any threat to human health and the environment by removing, containing, or treating contaminated media until established target levels are attained.

Table 1.1-1
Chronology of RRES-RS Activities at SWMU 16-021(c)-99

Date	Activity (Reference)	Synopsis of Activity
1990	RCRA facility assessment (RFA) (LANL SWMU Report 1990, 07512)	RFA initial site assessment is completed. Prior studies are summarized, and document extensive contamination in TA-16-260 sump water.
July 1993	Phase I RFI work plan—site characterization plan (LANL 1993, 20948)	"RFI Work Plan for Operable Unit 1082" is issued. Plan addresses Phase I sampling at SWMU 16-021(c).
May 1994	First addendum to Phase I RFI work plan (LANL 1994, 52910)	"RFI Work Plan for Operable Unit 1082, Addendum 1" is issued. Plan is approved by NMED in January 1995.
April 1995–November 1995	Phase I RFI site characterization	Phase I RFI is implemented, including Phase I investigation of SWMU 16-021(c)-99.
1995–1996	Interim action (IA)—best management practices (BMPs) (LANL 1996, 53838)	Sandbag dam and diversion pipe are installed upgradient from the former high explosives (HE) pond; sandbag dam is located east of the parking lot behind TA-16-260; geotextile fabric matting is placed in former HE pond area; eight hay bale check dams are placed within the SWMU drainage between the rock dam and the 15-ft-high cliff.

Table 1.1-1 (continued)

Date	Activity (Reference)	Synopsis of Activity
September 1996	Phase I RFI report (LANL 1996, 55077)	Phase I RFI report is issued. Data show widespread HE contamination at SWMU 16-021(c)-99, extending from the 260 outfall discharge point down to the sediment and waters of Cañon de Valle. Report is approved by NMED in March 1998.
September 1996	Phase II RFI work plan (part of LANL 1996, 55077)	Phase II RFI work plan is included in Phase I RFI report. Report is approved by NMED in March 1998.
November 1, 1996–December 23, 1996; May 1997–November 9, 1997	Phase II RFI site characterization	Phase II RFI is implemented at SWMU 16-021(c)-99.
September 1998	Phase II RFI report (LANL 1998, 59891)	Phase II RFI report is issued. Data confirm widespread HE contamination extending from the 260 outfall discharge point down to the sediment and waters of Cañon de Valle and show deeper subsurface contamination. Up to 1% total HE is detected in surge bed at a depth of 17 ft. Report documents risk to human health and the environment. Report is approved by NMED in September 1999.
September 30, 1998	CMS plan (LANL 1998, 62413.3)	CMS plan is issued. Alternatives are evaluated. Report includes Phase III RFI sampling plan and describes ongoing hydrogeologic investigations for the site. Report is approved by NMED in September 1999.
October 1998–present	Phase III RFI site characterization	Continued monitoring and sampling are used to characterize the temporal and spatial variability of site contamination; components of the site hydrogeologic system are undergoing continued evaluation.
October 1998–present	CMS—ongoing evaluation of alternatives	CMS is initiated. Series of soil and water corrective measures technologies are evaluated. Investigation of components of the site hydrogeologic system continues.
September 30, 1999	Addendum to CMS plan (LANL 1999, 64873.3)	Addendum to CMS plan is issued. Addendum expands investigations to include deeper perched and regional groundwater potentially impacted by releases from SWMU 16-021(c)-99.
November 1999	Interim measure (IM) plan—abatement of potential risks at the source area (LANL 2000, 64355.4)	IM plan is issued. Plan specifies removal of the highly contaminated soil and tuff identified in the 260 outfall drainage channel. Plan is approved by NMED in April 2002.
November 12, 1999–November 18, 2000	Abatement of ongoing risks is initiated	TA-16-260 IM begins. Activities are interrupted by Cerro Grande fire. Initial stage of project is completed in November 2000.
January 7, 2000	Contained-in determination (NMED 2000, 64730)	NMED memo of contained-in determination is sent to the Laboratory (J. Brown) and DOE-ER (T. Taylor).
April 4, 2000	Designation of area of contamination (NMED 2000, 70649)	NMED designates SWMU 16-021(c)-99 an area of contamination. Purpose of designation is to allow material from entire drainage area to be excavated, processed, and segregated without invoking RCRA land disposal restrictions. Excavated material considered potentially hazardous waste is staged in covered piles within area-of-contamination boundary.

Table 1.1-1 (continued)

Date	Activity (Reference)	Synopsis of Activity
June 5, 2000	In situ blending authorization (NMED 2000, 67094)	NMED authorizes in situ blending in memo sent to the Laboratory and DOE. To ensure worker health and safety during the IM and after, settling pond soil is robotically blended in situ with clean or low HE concentration material to reduce maximum concentration of settling pond sediment to below-reactive limit.
August 4, 2001–October 13, 2001	Abatement of ongoing risks is completed	Remobilization and removal of isolated areas containing more than 100 mg/kg of RDX (cyclotrimethylenetrinitramine) is completed. Waste disposal stage of project is completed.
July 2002	260 outfall IM report (LANL 2002, 73706)	IM results are presented in IM report. Report is approved by NMED in January 2003.
March 2003	Revision 1 to CMS plan addendum—evaluation of alternatives (LANL 2003, 75986.2)	Addendum to CMS plan is updated. Investigation into deeper perched and regional groundwater and deeper vadose zone potentially impacted by releases from SWMU 16-021(c)-99 is expanded further. Plan is approved by NMED in March 2003.
September 2003	Phase III RFI report issued (this document)	Report focuses on investigations into the surface water, alluvial groundwater, canyon sediment, and springs in Cañon de Valle and Martin Spring Canyon. Report includes analysis of data generated since Phase II RFI report (post-1998) and baseline risk assessments using a comprehensive database of both pre- and post-1998 data and emphasizes greater understanding of site hydrogeology and contaminant behavior. Report presents human health baseline risk assessments, one for source area, one for a selected reach of Cañon de Valle. In addition, a baseline ecological risk assessment is performed for that reach of Cañon de Valle.
November 2003	CMS report for alluvial system will be issued—corrective measures evaluated/selected	CMS report for SWMU 16-021(c)-99 alluvial system will be issued. Report is a companion document to Phase III RFI report and relies heavily on the understanding of site hydrogeology and contaminant behavior outlined in that document. Report evaluates potential remedial technologies for each media and proposes appropriate technologies.
March 2006	CMS report issued for regional groundwater system—corrective measures evaluated/selected	CMS report for SWMU 16-021(c)-99 deep perched and regional groundwater system will be issued. Data will be used to support risk assessments that include the deep perched saturated zone and the regional aquifers as pathways.
Pending	Corrective measures implementation (CMI)	Final evaluation, selection, and design of selected treatment technology for impacted site media will be presented. CMI will include refinements to long-term monitoring program and criteria for establishing the attainment of media cleanup standards.
Pending	Long-term monitoring	Verification that remedies are/were effective.

1.2 Facility Location and Background

TA-16 is located in the southwest corner of the Laboratory (Figure 1.2-1). It covers 2410 acres, or 3.8 mi^2. The land is a portion of that acquired by the Department of Army for the Manhattan Project in 1943. TA-16 is bordered by the Bandelier National Monument along State Highway 4 to the south, and by the Santa Fe National Forest along State Highway 501 to the west. To the north and east, it is bordered by TA-8, -9, -

11, -14, -15, -37, and -49. TA-16 is fenced and posted along State Highway 4. Water Canyon, a 200-ft-deep ravine with steep walls, separates State Highway 4 from active sites at TA-16. Cañon de Valle forms the northern border of TA-16. Security fences surround the production facilities. A complete discussion of the TA-16 environmental setting is presented in Appendix B to this report.

The administrative boundary for the CMS is shown in Figure 1.2-2. The boundary runs along State Highway 501, which coincides with the Pajarito fault, to the west, and follows the basin divides between Water Canyon and Cañon de Valle to the south, as far as Martin Spring Canyon, Pajarito Canyon, and Cañon de Valle to the north. These basin divides converge at the confluence of Cañon de Valle and Water Canyon. This area will be referred to as the Cañon de Valle basin. The areal extent of the study includes all the surface and subsurface terrain within the boundary except (1) individual SWMUs and associated downgradient areas to the edge of Cañon de Valle, and (2) Fishladder Seep and its sub-basin. These potential contaminant sources are being addressed within the scope of other RRES-RS activities.

The administrative boundary is designed to incorporate contaminant sources and the fate and transport mechanisms of the Cañon de Valle basin. The TA-16-260 outfall is considered the major source of contaminants in the basin. Monitoring and data analysis at the basin scale will support decisions about conducting remedial activities at other potential contaminant source locations as well.

1.2.1 Facility History and Operations

TA-16 was established for the purposes of developing explosive formulations, casting and machining explosive charges, and assembling and testing explosive components for the US nuclear weapons program. Almost all the work has been conducted in support of the development, testing, and production of explosive charges for the implosion method. Present-day use of this site is essentially unchanged, although facilities have been upgraded and expanded as explosive and manufacturing technologies have advanced.

The TA-16-260 facility, in operation since 1951, is an HE machining building that processes large quantities of HE. Machine turnings and HE wash water are routed as waste to 13 sumps associated with the building. Historically, discharge from the sumps was routed to the TA-16-260 outfall (also known as the 260 outfall); at one point, discharge was reportedly as high as several million gal. per year (LANL 1994, 76858).

During the late 1970s, the 260 outfall was permitted to operate by the EPA as EPA Outfall No. 05A056 under the Laboratory's National Pollutant Discharge Elimination System (NPDES) permit (EPA 1990, 12454.2). The last NPDES permitting effort for this TA-16-260 outfall occurred in 1994. The NPDES-permitted TA-16-260 outfall was deactivated in November 1996; it was officially removed from the Laboratory's NPDES permit by the EPA in January 1998. This waste stream is currently managed by pumping the sumps and treating the water at the TA-16 HE wastewater plant.

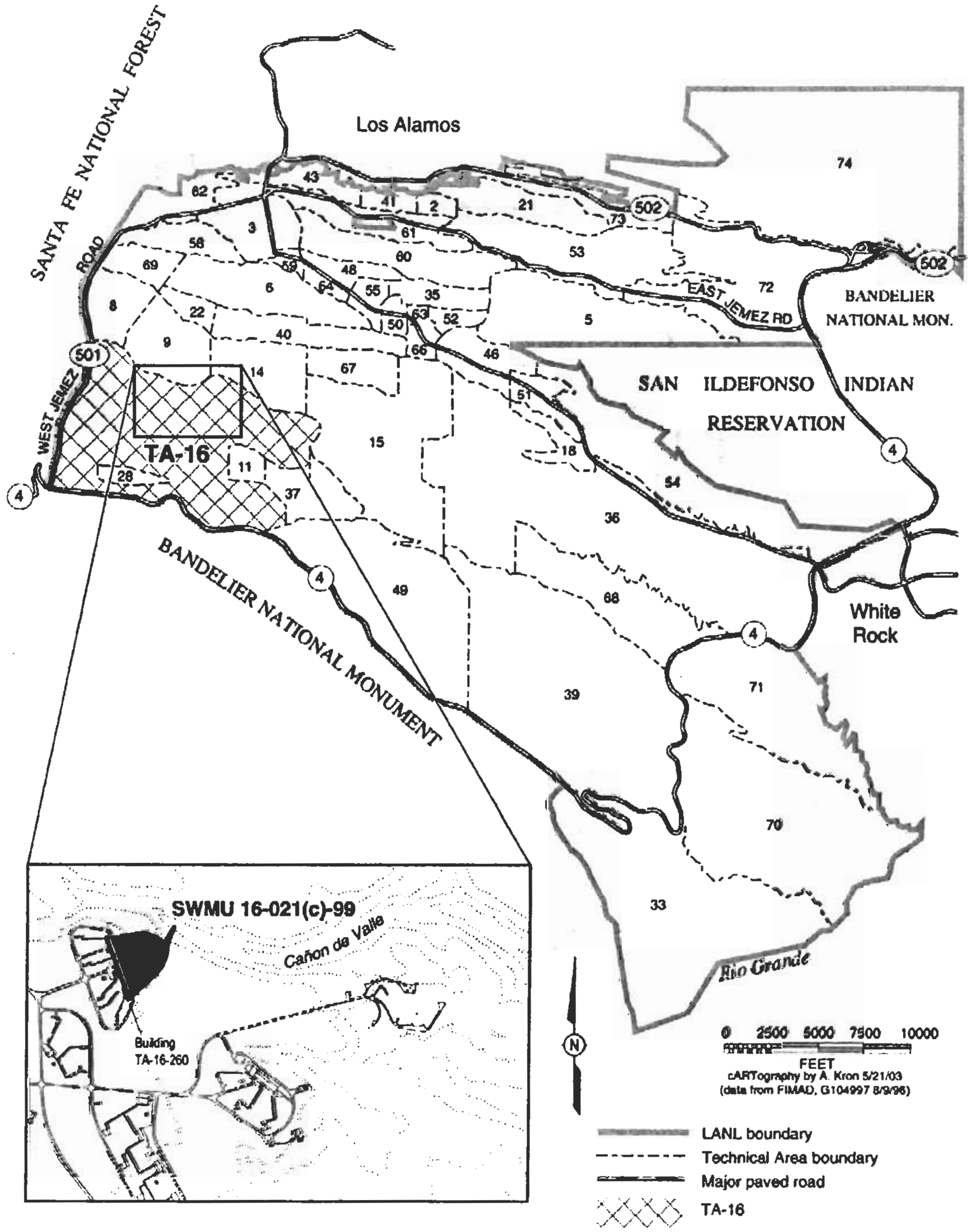


Figure 1.2-1. Location of TA-16 with respect to Laboratory technical areas and surrounding landholdings; Building 260 is also shown

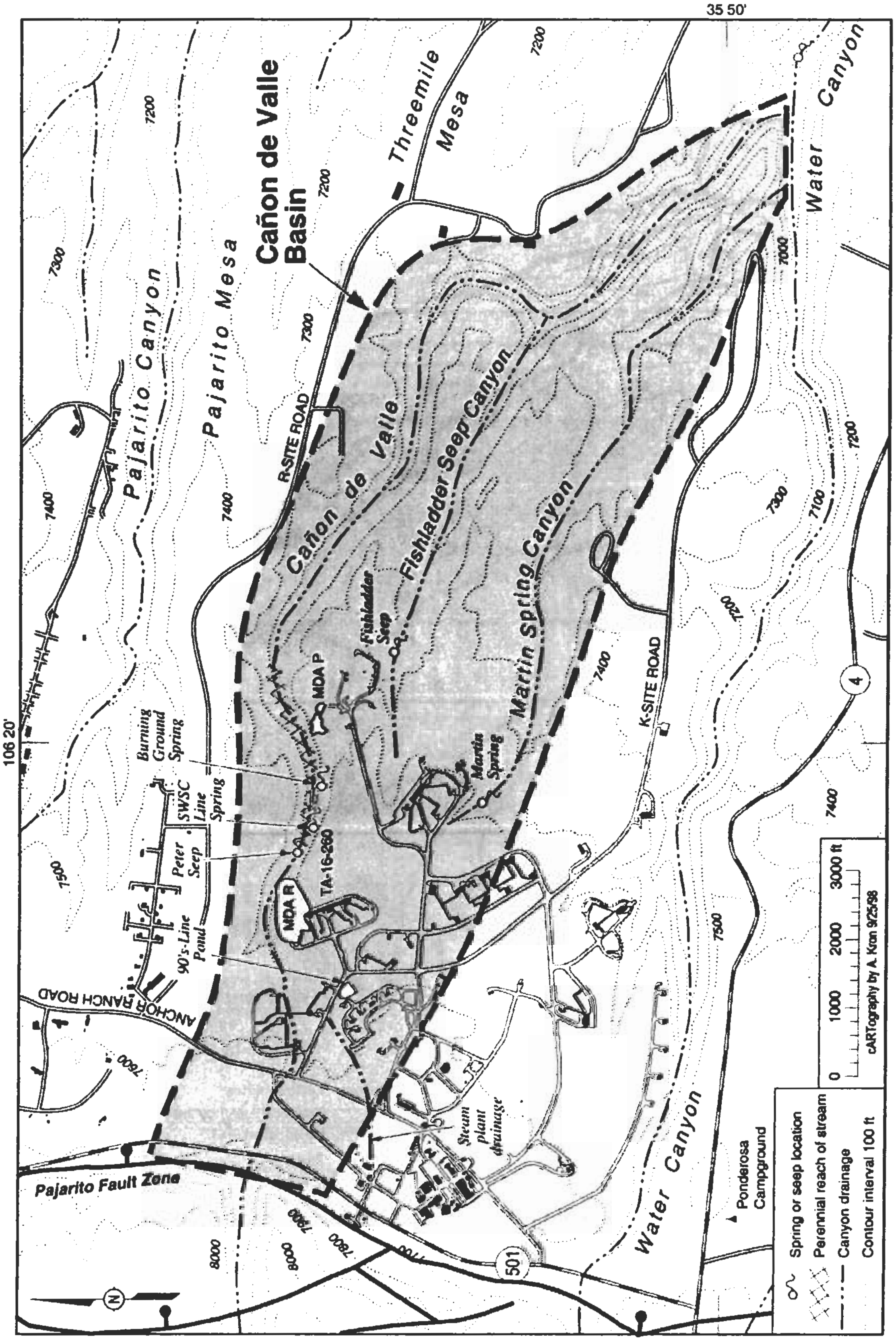


Figure 1.2-2. Administrative boundaries for SWMU 16-021(c)-99 CMS

Both the TA-16-260 outfall and the drainage channel from the TA-16-260 outfall are contaminated with HE and barium. The sumps and drainlines of this facility are designated as SWMU 16-003(k), and the TA-16-260 outfall and drainage are designated as SWMU 16-021(c) in Module VIII of the Laboratory's Hazardous Waste Facility Permit (EPA 1990, 01585). Following LANL's SWMU consolidation effort, the two former SWMUs are now collectively referred to as SWMU 16-021(c)-99. Prior to the Phase I and II RFIs at SWMU 16-003(k) and 16-021(c), known contaminants included barium, RDX, TNT (trinitrotoluene), and HMX (cyclotetramethylenetetranitramine). Suspected contaminants included other HE compounds, additional inorganic chemicals, volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), and uranium.

1.2.2 SWMU Descriptions

SWMU 16-021(c)-99 is a Laboratory consolidation of two designated SWMUs: 16-003(k) and 16-021(c).

SWMU 16-003(k) comprises 13 sumps and approximately 1200 ft of associated drainlines or troughs that lead from the HE machining building (TA-16-260) to the TA-16-260 outfall. HE-contaminated water flowed from the sumps into the concrete drainlines and ultimately to the 260 outfall, located approximately 200 ft east of Building 260. Building 260 is located on the north side of TA-16 (Figure 1.2-3). The structure was originally built in 1951; minor modifications were made to the structure at a later date.

SWMU 16-021(c) is comprised of a well-defined upper drainage channel fed directly by the 260 outfall, a former settling pond, and a lower drainage channel leading to Cañon de Valle. The former settling pond, which was removed during the 2000 IM, was approximately 50 ft long, 20 ft wide, and located within the upper drainage channel, approximately 45 ft below the 260 outfall. The upper drainage channel runs approximately 600 ft northeast from the 260 outfall to the bottom of Cañon de Valle. A 15-ft near-vertical cliff is located approximately 400 ft from the 260 outfall and marks the break between the upper and lower drainage channels.

A small settling pond approximately 55 ft long was originally part of SWMU 16-021(c)-99. HE-contaminated water from the 260 outfall entered the settling pond about 40 ft from the outfall. The settling pond and 260 outfall drainage channel are significant sources of the contamination identified in downgradient components of the SWMU 16-021(c)-99 hydrogeologic system. An IM was conducted during 2000 and 2001, and more than 1300 yd^3 of contaminated soil were excavated from the settling pond and channel. Approximately 90% of the HE that existed in the SWMU 16-021(c)-99 source area was removed during the IM (LANL 2002, 73706). The residual contamination in the source area is addressed in this report and through the ongoing CMS.

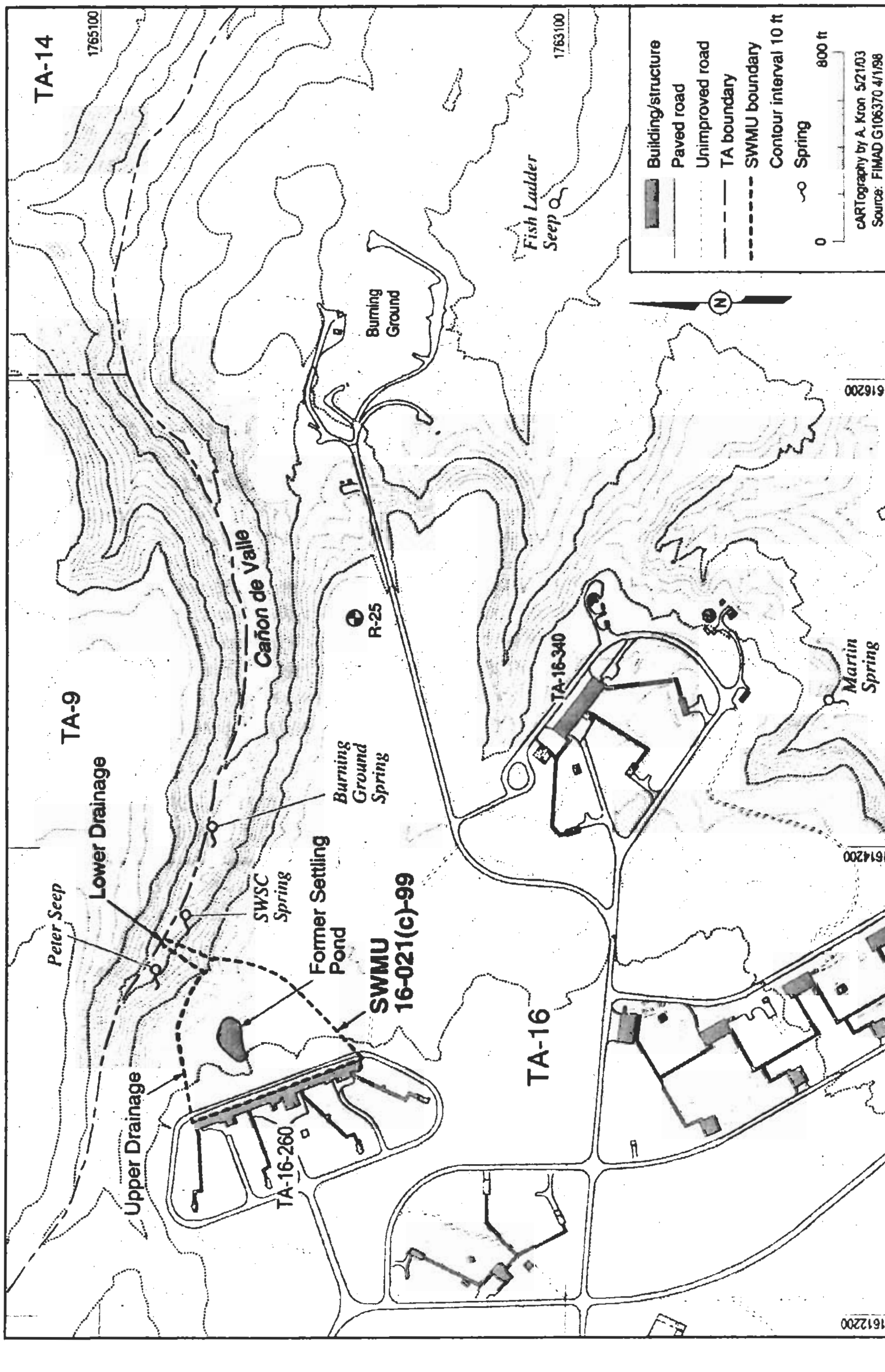


Figure 1.2-3. Location of SWMU 16-02(c)-99 and associated physical features

1.2.3 Adjacent Land Use

The land adjacent to the 260 outfall site is dedicated to continued Laboratory operations. Other SWMUs located in the vicinity of the 260 outfall are shown in Figure 1.2-4. The SWMUs with the greatest potential influence on the SWMU 16-021(c)-99 investigation are described below.

- Material Disposal Area (MDA) R (SWMU 16-019)—This MDA is located north of the 260 outfall area. MDA R was constructed in the mid-1940s and used as a burning ground and disposal area for waste explosives and possibly other debris. Potential contaminants at this MDA include HE, HE byproducts, and metals (particularly barium). Use of the site was discontinued in the early 1950s. Soil removal and site investigations were conducted at MDA R following the Cerro Grande fire (LANL 2001, 69971.2).

- The burning ground SWMUs [16-010(b,c,d,e,f), 16-010(h)-99, 16-028(a), and 16-016(c)-99]—These SWMUs are located on a level portion of the mesa in the northeast corner of TA-16. The burning ground was constructed in 1951 for HE waste treatment and disposal. Over the years, hundreds of thousands of pounds of HE and HE-contaminated waste material have been burned at this location. The remaining noncombustible material was subsequently either placed in MDA P, north of the burning ground (through 1984), or taken to TA-54 for disposal (1984 to present). A barium nitrate pile was located at the TA-16 burning ground for many years. Site investigations were conducted at several of these SWMUs in 1995 and later (LANL 2003, 76876). Information was also obtained from investigations conducted between 1997 and 2002 at Flash Pad 387 and the consolidated SWMU 16-016(c)-99. Flash Pad 387 underwent clean closure and the sites representing consolidated SWMU 16-016(c)-99 underwent voluntary corrective action (VCA) concurrently with the MDA P clean closure.

- MDA P (SWMU 16-018)—This MDA contained wastes from the synthesis, processing, and testing of HE; residues from the burning of HE-contaminated equipment; and construction debris. HE waste-disposal activities at this site started in the early 1950s and ceased in 1984. The site is located on the south slope of Cañon de Valle. MDA P recently underwent a cleanup under RCRA in which approximately 55,000 yd^3 of soil and debris were removed (LANL 2003, 76876).

- The 90s Line Pond portion of consolidated SWMU 16-008(a)-99 [former SWMU 16-008(a)]—The 90s Line Pond is an inactive unlined settling pond located a few hundred feet west of Building 260. The pond may have received HE, barium, uranium, and organic chemicals from machining operations discharge from TA-16-89, -90, -91, -92, and -93. As recently as 2002, HE solids were observed at the pond area.

All these SWMUs contain (or did contain, prior to closure, as in the case of MDA P) contaminants similar to those found in SWMU 16-021(c)-99, and all drain into Cañon de Valle. Furthermore, the 90s Line Pond contained standing water that may have created a persistent increase in hydraulic head and could have caused the migration of contaminants and contributed to the effects observed in the Cañon de Valle and Martin Spring Canyon alluvial systems.

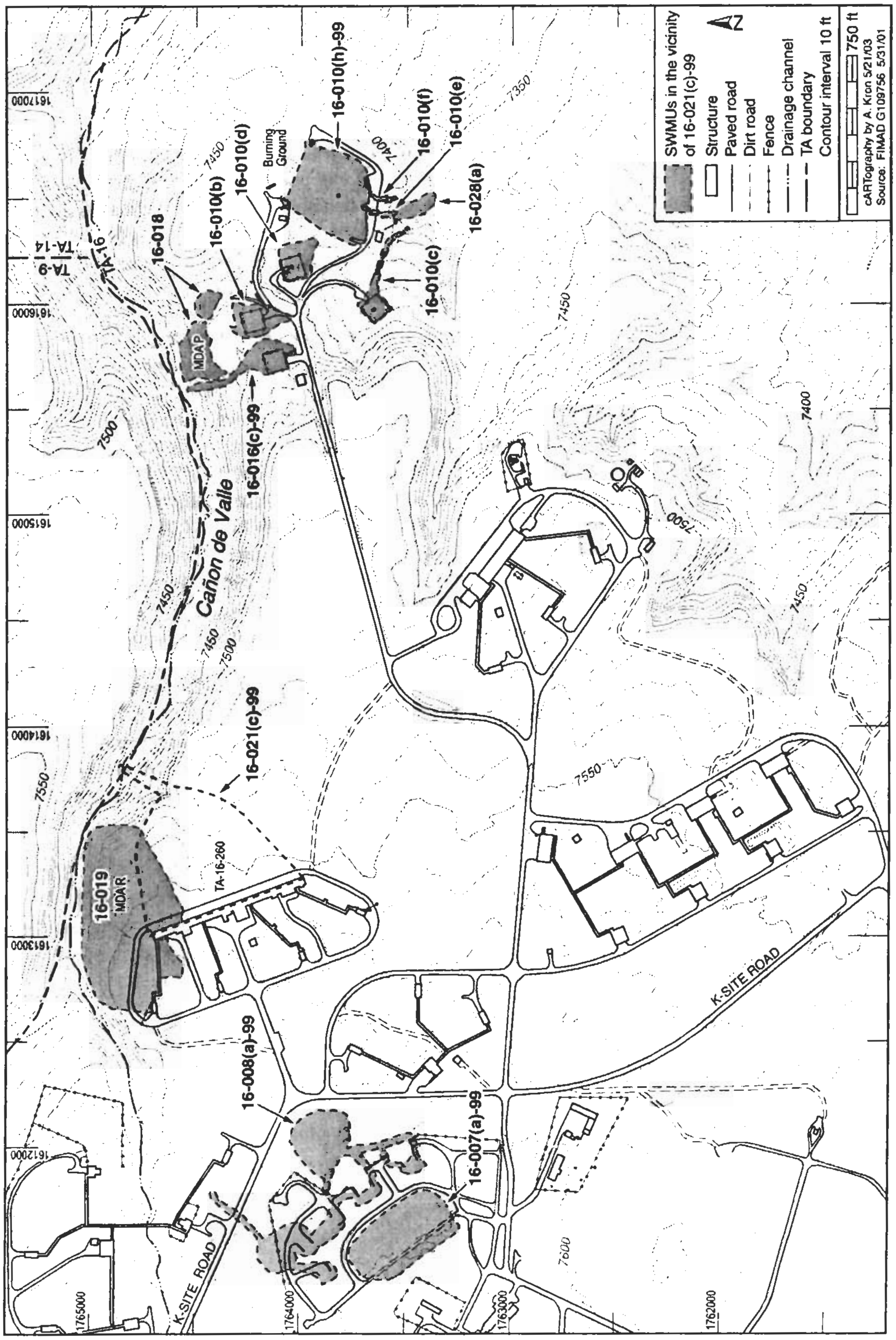


Figure 1.2-4. Significant SWMUs in the vicinity of SWMU 16-021(c)-99

According to the Laboratory's comprehensive site plan of 2000 and its 2001 update (LANL 2000, 76100; LANL 2001, 70210), future land use at TA-16 is designated as HE research and development and HE testing. Most areas within TA-16 are active sites for the Engineering Science and Application (ESA) Division of the Laboratory, and construction of new buildings and other facilities in the area is possible.

1.3 Previous Investigations

Data have been collected for the 260 outfall [SWMU 16-021(c)] since the early 1970s and have indicated substantially elevated HE contamination in the sediment, outfall, and sump water. Levels up to 27 wt % (270,000 ppm) of HMX and RDX had been documented in the area of the former pond. The data showed HE contamination extending from the discharge point to Cañon de Valle (Baytos 1971, 05913; Baytos 1976, 05920). The historical data have been summarized in the Phase I and II RFI reports for SWMUs 16-003(k) and 16-021(c) (LANL 1996, 55077; LANL 1998, 59891).

This section provides a summary of data from the Phase I and II RFIs and the IM. All available data for the site are used in this Phase III RFI report to build a physical site model that supports risk-assessment and CMS activities. Specific issues regarding the use of the different data sets are addressed in the data sections of this report.

1.3.1 Source Area Investigation

The Phase I RFI primarily consisted of surface sampling within the drainage area. The Phase II RFI included sampling surface and near-surface material within the drainage and sampling 13 boreholes (BHs) drilled to depths between 17 and 115 ft in and near the drainage. The Phase II RFI also included extensive field-screening using immunoassay methods for RDX and TNT as well as laboratory sampling for HE and other chemicals.

Elevated concentrations of HE and barium were reported within the drainage from the surface down to the soil/tuff interface. Soil depths were about 5.5 ft below the ground surface (bgs) in the former settling pond area and drainage (about 40 to 95 ft downstream from the outfall); soil depths were only about 1 ft bgs close to the mesa (300 to 400 ft downstream from the outfall).

Phase I and II surface sampling showed surface contamination did not extend laterally beyond the reasonably well-defined drainage. Concentrations of the major contaminants (barium and HMX, RDX, and TNT) were downgradient within the drainage and decreased rapidly beyond the settling pond, although substantial levels of HMX and barium were present at the base of the colluvial slope in Cañon de Valle.

Subsurface sampling indicated concentrations also decreased rapidly below the soil/tuff interface. However, up to 1000 mg/kg of HE was found in tuff, within the uppermost tuff unit (Unit 4 of the Tshirege Member of the Bandelier Tuff, Qbt 4), beneath the upper part of the drainage and including the former settling pond area. Almost 1 wt% (10,000 ppm) HE was reported in a saturated sample from BH 16-2700 encountered at a depth of about 17 ft beneath the former settling pond (LANL 1998, 59891). The sample was collected from a surge bed within Unit 4 of the Tshirege Member of the Bandelier Tuff. Below the level of this surge bed, HE was observed only sporadically and at much lower concentrations (less than 5 mg/kg). However, thin surge bed deposits were reported in BH 16-06370, drilled into the center of the former settling pond during the IM (see section 4.3.4.2, Table 4.3-6 of the IM report), at depths of 40 ft and 46 ft bgs, indicating multiple potential transmissive zones at depth (LANL 2002, 73706).

HE and barium were the principal contaminants found at the 260 outfall, although several other metals, including cadmium, chromium, copper, lead, nickel, vanadium, and zinc, were consistently observed above background levels in the drainage. Other organic compounds (SVOCs, VOCs, and PCBs) were also detected in one to four samples each. Details and results from the Phase I and II RFIs are presented in two RFI reports (LANL 1996, 55077; LANL 1998, 59891).

1.3.2 Alluvial System Investigation

Sampling in the Cañon de Valle alluvial system included collection of surface and subsurface sediment, three pairs of overbank sediment samples, filtered and unfiltered surface water, and one quarterly round of filtered and unfiltered alluvial groundwater. These samples were collected during three different investigations which took place in 1994, 1996, and 1997/1998, respectively.

Barium was the most abundant inorganic contaminant in sediment. For the surface samples, barium ranged from 6.3 mg/kg to 40,300 mg/kg. Other inorganic chemicals consistently above the background levels included cadmium, chromium, copper, lead, nickel, vanadium, and zinc. Several types of HE were detected: the amino-dinitrotoluenes (A-DNTs), HMX, nitrobenzene, 3-nitrotoluene, RDX, 1,3,5-trinitrobenzene (TNB), and trinitrotoluene (TNT). The two HE compounds highest in abundance and concentration were HMX and RDX. Their maxima were 170 mg/kg and 42 mg/kg, respectively.

Surface water samples and alluvial groundwater samples from the five alluvial wells and Peter Seep were collected in Cañon de Valle. Filtered/unfiltered sample pairs were collected during 1994 and 1997/98; primarily unfiltered samples were collected in 1996. The differences in concentration between the filtered and unfiltered samples are small. The inorganic chemicals identified as chemicals of potential concern (COPCs) in all water were antimony, barium, chromium, lead, manganese, mercury, nickel, vanadium, and zinc. Barium is the most abundant, with concentrations ranging from 99 µg/L to 16,000 µg/L. As in the sediment, HE appears to be the other major COPC in Cañon de Valle surface water and alluvial groundwater. The HE COPCs identified were A-DNTs, HMX, nitrobenzene, 2-nitrotoluene, RDX, TNB, and TNT. RDX is the HE highest in concentration, with a maximum concentration of 818 µg/L in surface water. All contaminants decrease downgradient from Peter Seep to the confluence with Water Canyon (LANL 1998, 59891).

1.3.3 Subsurface System Investigation

The intermediate-depth perched aquifer investigation included drilling five wells (91 to 207 ft) at locations likely to intersect the saturated zones at TA-16. The local trend of subunit-subunit contacts is to the north and east. Three of these wells intersected ephemeral perched water. In each case, the water dissipated in less than 1 month. Analysis of this perched water indicated low concentrations (generally ppb) of contamination.

The springs investigation included quarterly sampling of SWSC, Burning Ground, and Martin Springs. Results indicate all three springs are contaminated with RDX and other HE. Several major cations and anions, including calcium, magnesium, sodium, and boron, were detected. Boron is particularly elevated (1800 µg/L) in Martin Spring. Aluminum, iron, barium, phosphate, and nitrate were also elevated. Although low levels (ppb) of VOCs have been detected in all three springs, detections were sporadic and occurred primarily during the quarterly sampling round of June 1997.

Time-series analysis of the springs data indicates extreme variability in the concentration of constituents (up to a factor of 20 in RDX concentration at Martin Spring). Similarities in element variability and flow rate changes over time indicate that SWSC Spring and Burning Ground Spring are hydrogeologically related, but that Martin Spring probably represents a different hydrogeological system.

A potassium bromide tracer was deployed at SWMU 16-021(c) during April 1997. A breakthrough of bromide ions was observed in SWSC Spring during August 1997. Bromide breakthrough may also have occurred at Burning Ground Spring during August 1997, but the effects were more subtle, due to partial masking by variability in all the anions (LANL 1998, 59891). This indicates that the springs are hydrologically connected to the SWMU 16-021(c) source area.

1.3.4 IM at the 260 Outfall

An IM was conducted from the winter of 2000 through the summer of 2001 to remove contaminated material from the 260 outfall drainage area. It successfully removed the bulk of contamination from the outfall drainage channel. More than 1300 yd^3 of contaminated soil were excavated and disposed of at off-site facilities. Of this amount, more than 200 yd^3 of characteristic hazardous waste for reactivity (D003), which contained HE in concentrations of approximately 2 wt% (20,000 ppm), were treated by the selected disposal facility prior to final disposition. An IM report for SWMU 16-021(c)-99, which was completed in 2002, details the activities and results (LANL 2002, 73706).

1.4 Conceptual Understanding and Approach

TA-16 is a complex site in terms of geohydrologic behavior and contaminant fate and transport, and there are many uncertainties associated with the conceptual model. The most thorough conceptual model going into the Phase III RFI was detailed in the Phase II RFI report (LANL 1998, 59891) and is summarized below.

- Saturated flow systems occur in different forms. These include the alluvial surface water and groundwater in Cañon de Valle; the SWSC, Burning Ground, and Martin Springs; and the 90s Line Pond.
- The saturated systems that feed the springs are hypothesized to be flow through localized fracture zones or surge beds.
- Recharge of the saturated zones may occur via various sources and processes, including the Pajarito fault zone, the steam plant drainage, and the 90s Line Pond.
- Recharge may also occur via transient saturated flow or via matrix or porous media flow.
- The 260 outfall was a primary source of contamination for SWSC Spring and possibly Burning Ground Spring. Contaminants in Martin Spring may have come from a source other than the 260 outfall. Martin Spring chemistry and flow behavior is substantially different from those of the Cañon de Valle springs.

Although the hydrogeological system is better understood and the conceptual model is more clearly defined following the Phase III investigation, many of the same questions that were asked after the Phase II RFI remain.

These questions may be translated into specific data needs. The approach to Phase III data collection was focused on answering these questions and on improving the understanding of the conceptual model. The data collection objectives are summarized in Table 1.4-1 and the sampling plan is detailed in the CMS plan (LANL 1998, 62413.3).

Overall, the approach to the RFI/CMS at the 260 outfall has been tailored to focus on source identification together with the delineation of soil and sediment contamination and confirmation of groundwater and surface water contamination. During this process, the data have been continually evaluated to determine if contamination is present, if it presents a potential risk to human health or the environment, if it has been sufficiently delineated, and what further action(s) is needed.

Based on current understanding of the site, the conceptual model for the 260 outfall includes a complex set of contaminant transport pathways and hydrogeologic features. Contaminant transport pathways are structurally controlled in the underlying Bandelier Tuff by fractures and other preferential pathways such as surge beds between tuff units. Major uncertainties in the conceptual model result from this complexity, particularly regarding the location of saturated zones in the subsurface and associated contaminant transport pathways at the site. The presence of the saturated zones may also be seasonal or episodic. Further study of the site is warranted to understand the dynamics of contaminant transport and to determine the effects of post-remedial actions. Even as more data are collected at the site, substantial uncertainties may remain in the conceptual model. It is not necessary or feasible to determine the exact extent of contamination at the site in a detailed and spatially explicit manner. Extent can only be described in an overall sense based on current understanding and on monitoring data as they are obtained. Sufficient understanding of the site will be obtained for the purposes of selecting and implementing corrective measures that will mitigate potential risk to human and ecological receptors.

Table 1.4-1
Data Objectives for the Phase III RFI as Defined in the SAP

Technical Category	Investigative Questions	RFI Sampling Program	Location in Phase III RFI Report
Hydraulic connectivity	1. How is the 260 outfall connected to TA-16 springs and seeps?	Potassium bromide tracer inventory—continued sampling of springs and seeps to detect tracer	Section 2.2.2
	2. Are there other transport pathways that connect directly to perched groundwater or regional groundwater?	Perched groundwater intermediate borehole drilling (5 BHs)	Section 4.4.2.2
		Regional groundwater drilling (not covered in this report)	Not applicable
Residence times	1. How long does it take water to travel from a recharge point(s) to the TA-16 springs and seeps?	Precipitation sampling and stable isotope analysis	Section 3.4.2.1.4, Appendix B
		Spring/seep sampling for isotopic analysis	Section 4.4.2.2.9, Appendix B
Alluvial water dynamics	1. What is the overall water balance in Cañon de Valle? Does the perennial reach have unidentified losing stretches?	Monitoring surface and subsurface discharge profiles in perennial reach (6 alluvial wells, 15 stream profile locations)	Section 3.4.2.1.4, Appendix H
		Precipitation measurement and sampling	Section 3.4.2.1.4, Appendix B
		Geophysical surveys	Section 3.4.2.1.4, Appendix D
		Calculating overall water balance	Section 5.2.5, Appendix N
	2. What is the nature of the Martin Spring Canyon alluvial water dynamics?	Water sampling and analysis; installed 3 alluvial wells	Section 3.4.2.3 and 3.4.2.4

Table 1.4-1 (continued)

Technical Category	Investigative Questions	RFI Sampling Program	Location in Phase III RFI Report
Alluvial sediment dynamics	1. What are the contaminant inventories in the active channel and overbank deposits in Cañon de Valle and Martin Spring Canyon?	Geomorphic mapping/sampling and analysis of deposits	Section 3.4.2.5, Appendix E
		Resampling and analysis of channel deposits	Section 3.4.2.5
	2. Are these channel and overbank deposits a secondary source of contamination to alluvial water?	Sampling and analysis of geomorphic units	Section 3.4.2.5, Appendix E
	3. How is contaminated sediment being transported and redeposited (redistribution) in the alluvial system?	Geomorphic mapping	Appendix E
	4. How will this redistribution of contaminated sediment affect future concentrations and inventories in areas both within the TA-16 CMS administrative boundaries and downstream of the administrative boundaries?	Geomorphic mapping	Section 3.4.2.5, Appendix E
Spring and seep dynamics	1. How do contaminant concentrations change with discharge, season, runoff, and precipitation?	Discharge measurements at springs and collection of flow-integrated water samples	Section 4.4.2.1, Appendix H, Appendix I-3
	2. At TA-16, do contaminants at the springs and seeps have the same sources or different subsets of sources?	Isotopic data	Section 4.4.2.2.9
	3. What is the extent of Peter Seep?	Measurement of head/foot location	Section 3.4.2.1.4
		Water sampling and analysis	Section 3.4.2.1.4

Source: LANL 1998, 62413.3.

To complete the RFI/CMS at this site, activities will continue to be performed in compliance with the following documents:

- A CMS plan (issued in September 1998 [LANL 1998, 59891])—the CMS plan includes a preliminary evaluation of technologies that can be applied to the source area contaminated soil, alluvial sediment, spring water, and surface water; a process and criteria for evaluating remedial alternatives; a Phase III SAP for characterizing contaminant transport through the mesa, to the springs, and to the alluvial system; and a design strategy for long-term monitoring to assess trends in contaminant concentrations and fluxes over time.

- An IM plan (issued in November 1999 [LANL 1999, 64355.4])—this plan details the source removal effort needed to accomplish the IM and considers practical engineering approaches. The plan includes a SAP that characterizes the extent of contamination remaining in the environment following source removal.

- An IM report (issued in September 2002 [LANL 2002, 73706])—the IM was conducted from winter 2000 through summer 2001. The report documents the results of removing contamination from the 260 outfall source area. It details post-remediation characterization and bromide inventory sampling.
- A Phase III RFI report (this report)—this report documents the results of the Phase III data collection, the conceptual model refinement, and the post-IM characterization. The report includes human health as well as ecological site-specific risk assessments, both of which will be used during the CMS.
- An alluvial CMS report (issued in November 2003)—this report will focus on the contaminants remaining in the unsaturated subsurface and the alluvial system in Cañon de Valle. The intermediate and regional groundwater CMS report (scheduled to be issued in March 2006) will focus on the extent of contaminants in the deep perched zone and the regional aquifer. Remedial alternatives and long-term monitoring requirements will be addressed in both reports.

Throughout the completion of the CMS at this site, the technical team will continue to work closely with the Groundwater Protection Program and the Canyons Investigations Team to complete data collection activities using compatible and consistent approaches. Following the completion of the CMS for the 260 outfall, the Groundwater Investigations Team and the Canyons Investigations Team will conduct further evaluations of the Cañon de Valle groundwater system.

1.5 COPC Screening Methodology for Human Health Risk

In order to identify which chemicals are COPCs for SWMU 16-021(c)-99, all chemicals detected in either solid media (soil, sediment, or tuff, hereinafter collectively referred to as sediment) or water are subjected to a screening methodology. The screening methodologies for sediment and water are depicted in Figures 1.5-1 and 1.5-2, respectively, and described in this section. The SWMU 16-021(c)-99 screening methodology evaluates COPCs based on the following criteria: (1) detect status, frequency of detection, and comparison of the detection limit to the screening level (for infrequently detected chemicals); (2) comparison to Laboratory-wide BVs (LANL, 1998, 09730) for solid media; (3) comparison to EPA's Region 6 (or Region 9) human health screening levels for residential tap water (or New Mexico Water Quality Control Commission (NMWQCC) regulations numeric standards for water if no EPA screening level exists); and (4) screening action levels (SALs) for sediment, soil, and tuff. Steps 1 through 3 are conducted within sections 3.0 and 4.0 of this report. Step 4 is conducted in the risk assessments provided in Appendix K. Chemicals that fail screening are retained as COPCs and are evaluated in one or more subsequent analyses: (1) a statistical analysis for background concentrations (soil, sediment, and tuff), provided in Appendix I-1; (2) an uncertainty analysis, provided in Appendix K; and (3) risk assessments, provided in Appendix K. This prioritized screening process is consistent with the COPC evaluation methods presented in EPA's Risk Assessment Guidance for Superfund (RAGS) (EPA 1989, 08021).

General chemistry cations/anions and related parameters that are not relevant to human health risk assessment have been eliminated from the screening methodology and are not presented in the frequency-of-detected-chemicals tables or screening tables. Specifically, the eliminated cations/anions and related parameters include alkalinity, ammonia, bromide, chlorate, hardness, iodide, oxalate, phosphorus, orthophosphate (expressed as PO_4), silicon dioxide, total organic carbon, and total phosphorus. Additionally, calcium, sodium, magnesium, and potassium are essential nutrients and are eliminated from human health risk assessment.

Because an IM was conducted for the SWMU 16-021(c)-99 source area, two separate data screenings are required for Cañon de Valle: (1) a soil and tuff screening of the 260 outfall source area data to identify any post-IM COPCs that might contribute to potential risk, and (2) a baseline sediment and water screening for Cañon de Valle area data in support of a baseline human health risk assessment for the Cañon de Valle canyon bottom. In addition, data screening was conducted for Martin Spring Canyon sediment and water to support a risk assessment.

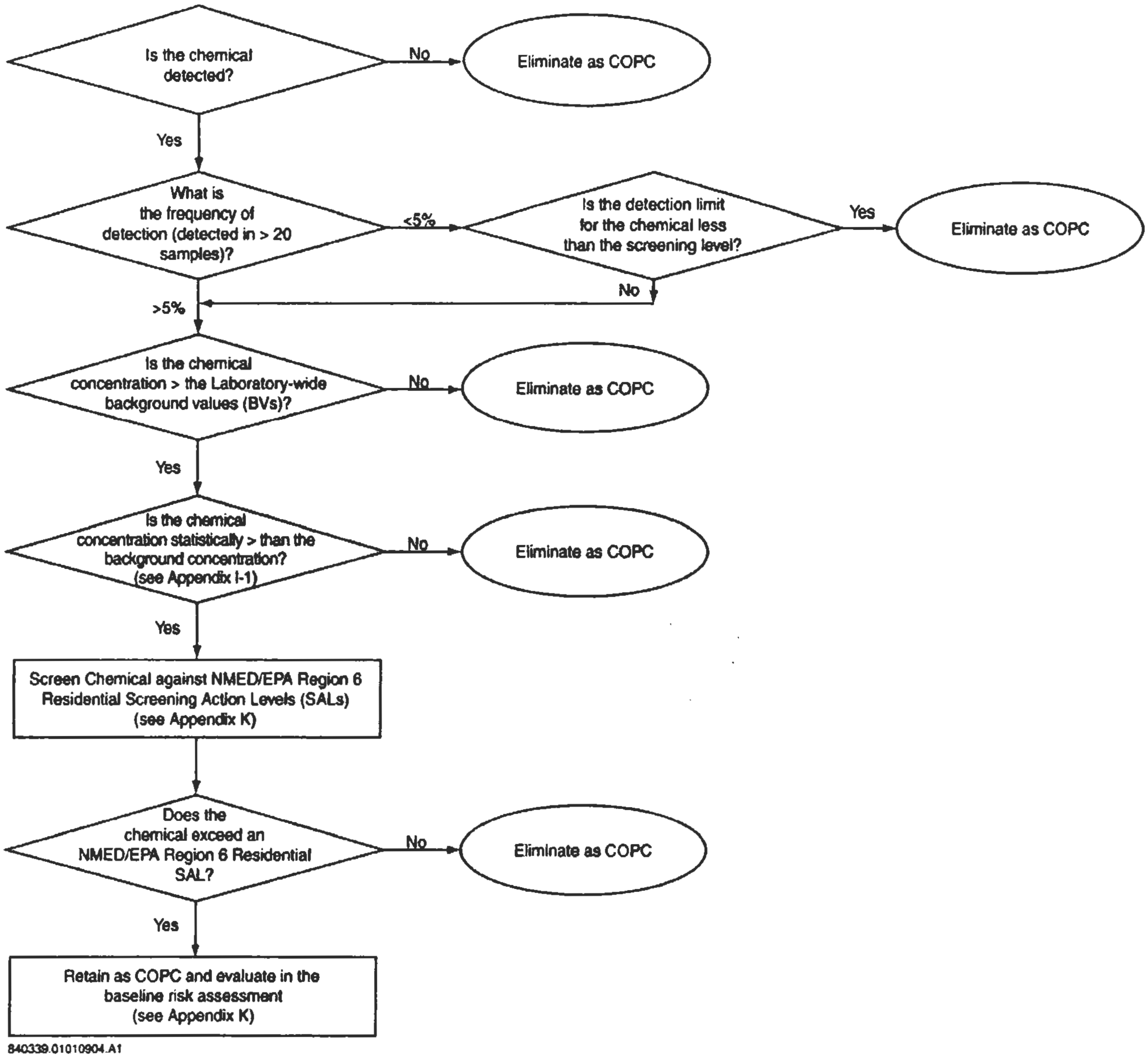
The frequency of detection and background screening for sediment in the 260 outfall source area was conducted as part of the IM. No new soil and tuff data have been collected in the source area since the IM; hence, no additional screening is required. A summary of the IM screening results is provided in section 2.0 (Table 2.3-1 and Table 2.3-2). However, sediment and water sampling in the Cañon de Valle and Martin Spring Canyon has continued since the Phase II RFI, thus a full screening of post-1998 data is presented in section 3.0, section 4.0, Appendix I-1, and Appendix K. All available data (pre- and post-1998) for sediment and water are evaluated in the risk analyses for Cañon de Valle and Martin Spring Canyon presented in Appendix K.

1.5.1 Frequency of Detection

Both sediment and water data for SWMU 16-021(c)-99 have been initially evaluated based on how frequently a chemical is detected in a particular medium at a site. Evaluating chemicals based on their frequency of detection is important because infrequently detected chemicals may be artifacts in the data due to sampling, analytical, or other problems, and therefore may not be representative of true site conditions or operations (EPA 1989, 08021). Moreover, chemicals that are not detected in any of the samples taken for a particular medium are commonly eliminated from further analysis because there is no indication that the chemicals are present at the site (EPA 1989, 08021).

For SWMU 16-021(c)-99, all chemicals that reported 0% detection in a particular medium (i.e., a medium for which only U- or UJ-qualified data are reported for that chemical) are eliminated as COPCs with no further evaluation. Without detection, there is no indication that these chemicals are of potential concern for human health and/or the environment at SWMU 16-021(c)-99.

In addition, most chemicals that were analyzed for a particular medium in more than 20 samples, but reported or detected in less than 5% of the samples, are also eliminated. Based on RAGS guidance, these chemicals may be considered data sampling artifacts that do not represent the site's true conditions (EPA 1989, 08021). However, it is important to note that not all chemicals reporting less than 5% detection for a particular medium are eliminated: the decision to eliminate infrequently detected chemicals from further COPC evaluation depends on whether adequate detection limits are reported for the chemicals in question. Laboratory analytical methods such as dilution and matrix effects can cause detection limits to become elevated which then introduces a level of uncertainty into the data (see Appendix F). For SWMU 16-021(c)-99 data, the evaluation of adequate detection limits is based on whether they are below a chemical's designated benchmark concentration (e.g., a screening level) or regulatory standard. In samples for which the detection limit exceeds the defined benchmark concentration, the chemical is retained for further evaluation.



LEGEND	
BV =	Background Value
COPC =	Chemical of Potential Concern
EPA Region 6 SAL =	U.S. Environmental Protection Agency Region 6 Screening Action Level

Figure 1.5-1. COPC screening methodology for soil, sediment, and tuff

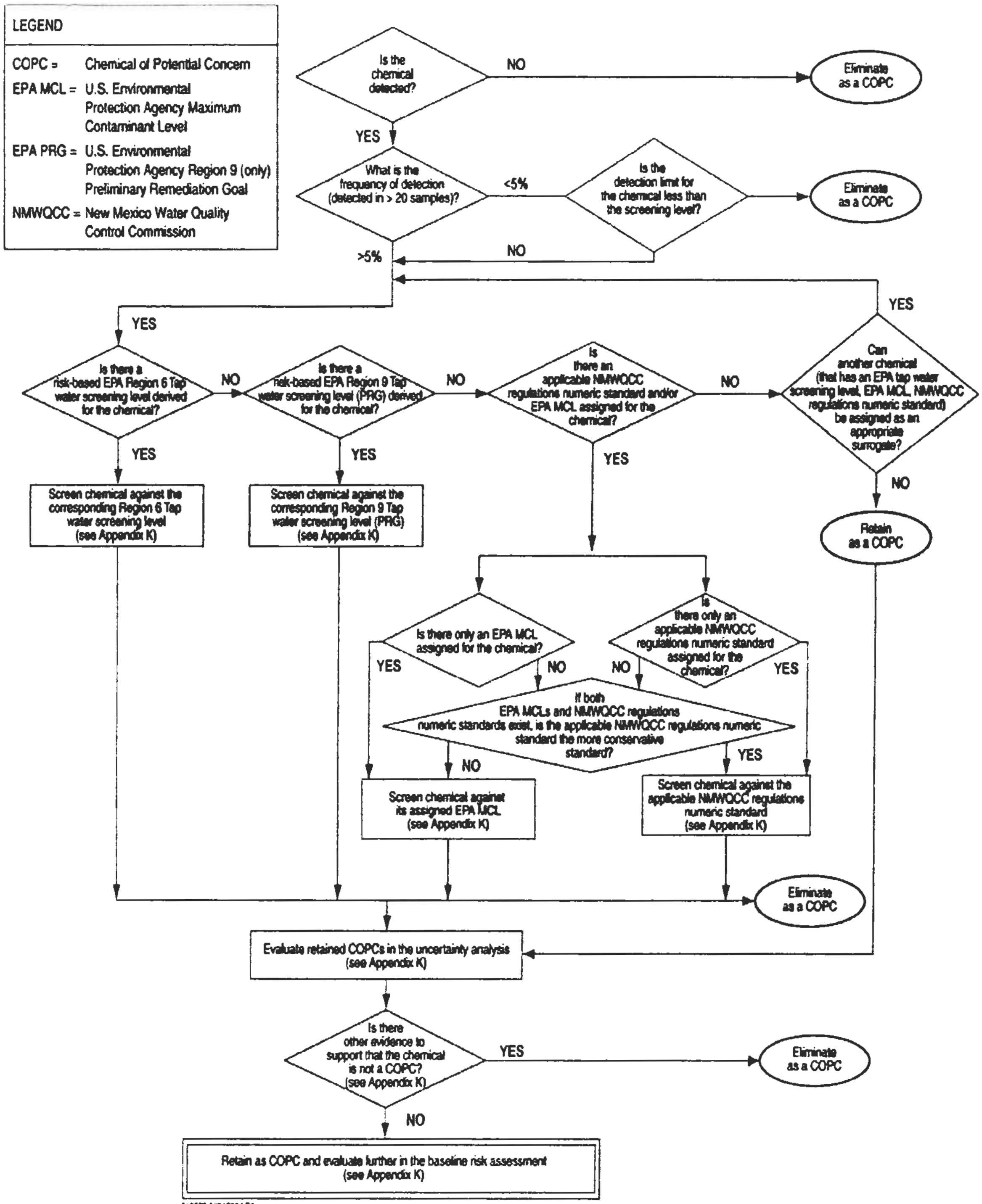


Figure 1.5-2. COPC screening methodology for water

1.5.2 Comparison to Laboratory-Wide BVs (Soil, Sediment, and Tuff)

All detected inorganic chemicals (including radionuclides) in SWMU 16-021(c)-99 solid media are screened against the corresponding Laboratory-wide BVs for soil, sediment, and Bandelier Tuff (LANL 1998, 59730). For each chemical, the maximum reported detected value, as well as the maximum reported detection limit, is compared to the corresponding LANL 95% upper tolerance limit (UTL) or BV. Chemicals reporting all data below the 95% BV UTL are eliminated as COPCs. Chemicals reporting either a detected or an undetected concentration exceeding the BV were retained as COPCs and evaluated further. For SWMU 16-021(c)-99, all detected organic chemicals are retained as COPCs and evaluated further.

1.5.3 Comparison to Regulatory Standards (Water Only)

The Laboratory has not established BVs for chemicals in water; therefore, all detected chemicals in SWMU 16-021(c)-99 water are screened against EPA's Region 6 (or Region 9) human health screening levels for residential tap water or NMWQCC regulations numeric standards for water if no EPA screening level exists.

The following New Mexico Water Quality Control Commission (NMWQCC) regulations numeric standards (20.6.2 and 20.6.4 New Mexico Administrative Code [NMAC]) are utilized to identify COPCs found at SWMU 16-021(c)-99:

- NMWQCC surface water (SW) human health standards (20.6.4.900 NMAC)
- NMWQCC surface water (SW) livestock watering standards (20.6.4.900 NMAC)
- NMWQCC SW aquatic life (acute) standards (20.6.4.900 NMAC)
- NMWQCC groundwater (GW) human health standards (20.6.2.3103 NMAC)
- NMWQCC GW standards for irrigation use (20.6.2.3103 NMAC)
- NMWQCC GW standards for domestic water supply use (20.6.2.3103 NMAC)

If a NMWQCC regulations numeric standard does not exist, or if the EPA MCL is a more conservative screening level than the NMWQCC regulations numeric standard, then the detected chemicals are subsequently screened against the EPA maximum contaminant levels (MCLs) 40 CFR Parts 141 and 143 (EPA 2002, 76871).

Chemicals for which there is neither an EPA Region 6 (or Region 9) medium-specific human health screening level, a NMWQCC regulations numeric standard, or an EPA MCL are retained as COPCs and subsequently evaluated in the human health and ecological risk assessments or, if one is available and appropriate, a surrogate chemical is assigned. Using surrogate chemicals provides a more complete screening process. The following criteria are used to select appropriate surrogate chemicals for SWMU 16-021(c)-99 data: structural similarity, isometric form, and impurity and metabolite characteristics. These criteria are outlined in the Laboratory document, "Human Health Risk-Based Screening Methodology" (LANL 2002, 72639). Attachment A to that document provides a short list of chemicals for which LANL has already identified surrogates: these surrogates were adopted and used at SWMU 16-021(c)-99, where applicable. For the additional chemicals found at SWMU 16-021(c)-99 that are not listed in Attachment A, surrogates were selected using the same criteria listed above.

For the screening, either the maximum detected concentration and/or the maximum detection limit for a chemical are evaluated against the screening level. Those chemicals whose maximum detected concentrations exceed the screening standards are retained for further evaluation. Those chemicals for which only the maximum detection limit exceeds the screening level are also retained for further evaluation. Those chemicals for which neither the maximum detected concentration nor the maximum detection limit exceeds the screening level are eliminated as COPCs.

1.6 Report Organization

This report is organized identically to the Phase II RFI report. The report consists of eight sections and fourteen appendixes. To simplify presentation of such a large volume of complex environmental data, a three-compartment approach—as negotiated between the NMED Hazardous Waste Bureau (HWB) and LANL personnel—has been used for this report. Each of the three compartments represents a major investigation within the Phase III data collection activities: (1) the source area investigation, (2) the alluvial system investigation, and (3) the subsurface system investigation.

The source area investigation and its results are presented in section 2.0. Section 3.0 contains the alluvial system investigation and its results. Section 4.0 presents the subsurface investigation and its results. Section 5 discusses the updated understanding of the site conceptual model. Section 6 summarizes the human health risk assessments for the source area and canyon bottom of the Cañon de Valle as well as the ecological risk assessment for Cañon de Valle. In addition, Section 6 summarizes the human health risk assessment for Martin Spring Canyon. (The entire human health and ecological risk assessments are presented in Appendixes K and L, respectively.) Section 7 presents the report conclusions. Section 8 is a reference list that includes all of the documents cited in the body and the appendixes of this report. The parenthetical information following each in-text reference provides the author, publication date, and ER ID number. This information can be used to locate cited documents as follows.

The ER ID number is assigned by RRES-RS to track material associated with RRES-RS activities. All cited documents are assigned ER ID numbers. An ER ID number can be used to help the reader locate a copy of the actual document at the Records Processing Facility (RPF) and, where applicable, within the RRES-RS Reference Library. Copies of this reference library are housed at NMED-HWB, DOE, and the RRES-RS Project Office. This library is a living document that was developed to ensure that NMED has all of the necessary material to review the decisions and actions proposed in documents submitted by RRES-RS. The library will be updated to include appropriate documents cited in this report.

The fourteen appendixes to this report provide additional information about the Phase III RFI and are listed in Table 1.6-1.

Table 1.6-1
Table of Appendixes

Appendix Letter	Appendix Title
Appendix A	List of Acronyms and Glossary
Appendix B	Operational and Environmental Setting
Appendix C	Borehole Logs and Well Completion Diagrams
Appendix D	Geophysical Reports
Appendix E	Evaluation of Sediment Contamination in Cañon de Valle and Martin Spring Canyon
Appendix F	Results of Quality Assurance/Quality Control Activities
Appendix G	Analytical Suites and Results

Table 1.6-1 (continued)

Appendix Letter	Appendix Title
Appendix H	Water and Sediment Screening Results: Charts, Tables, and Data Files
Appendix I	Evaluation of Chemical and Physical Data from the SWMU 16-021(c)-99 Source Area, Cañon de Valle, and Martin Spring Canyon
Appendix J	Evaluating the Hydrogeochemical Response of Springs Using Singular Spectrum Analysis and Phase-Plane Plots
Appendix K	Human Health Baseline Risk Assessments for Cañon de Valle and Martin Spring Canyon
Appendix L	Ecological Risk Assessment for Cañon de Valle
Appendix M	Relevant Documents (includes the response to the request for supplemental information for the Phase II RFI report, scheduled for inclusion with the next relevant submittal)
Appendix N	Water Balance Calculation for Cañon de Valle

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