VOLUNTARY CORRECTIVE ACTION (VCA) COMPLETION REPORT APPROVAL/DISAPPROVAL FORM

PRS(s) 12-001(a)

The undersigned have reviewed the VCA Completion Report and believe that the intent and goals of the VCA plan have been met.

FPL ____________ Date 9/20/96

FPC Everett Trollinger Date 9/26/96

....

I, Theodore J. Taylor, DOE-LAAO, **APPROVE** ✓, **DISAPPROVE** ________ the accompanying Voluntary Correction Action Report for PRS(s) 12-001(a), TA- 12.

The following reasons reflect the decision for disapproval:

Signed: ____________ Date: 9/26/96

RFI Report for Potential Release Sites in TA-16

16-003(k)
16-021(c)

Field Unit 3

Environmental Restoration Project

September 1996

A Department of Energy
Environmental Cleanup Program

Los Alamos
NATIONAL LABORATORY

LA-UR-96-3191

EXECUTIVE SUMMARY

This Resource Conservation and Recovery Act (RCRA) facility investigation (RFI) report discusses Phase I investigations, results, and recommendations for two potential release sites (PRSs), 16-021(c) and 16-003(k), at Los Alamos National Laboratory (LANL) Technical Area (TA) 16. TA-16 has been the site of high explosives (HE) research and development programs since 1944. PRSs 16-021(c) and 16-003(k) are the HE sumps, drain lines, and outfall associated with TA-16-260, an HE-machining building that has been in operation since 1951. PRS 16-003(k) includes the HE sumps, the vitrified-clay pipe connected to the sumps, the concrete troughs that feed the single outfall, and contaminated soil surrounding those structures. PRS 16-021(c) includes all contaminated soils and tuff downstream from the outfall. These two PRSs are combined in this RFI report because they are both associated with TA-16-260, because they contain similar constituents, and because any cleanup of the two PRSs will be coordinated to save costs and time.

The RFI work plan for Operable Unit (OU) 1082 (LANL 1993, 1094) was approved by the Environmental Protection Agency (EPA) Region 6 in December 1994 (Taylor 1995, 1357). The approval letter required that RFI reports for these two PRSs be completed by September 30, 1996. Only a subset of the sampling prescribed for PRS 16-003(k) was completed due to funding constraints and hazards associated with drilling in HE-contaminated areas. This deviation from the approved work plan was documented in a letter to EPA dated May 24, 1995 (Jansen and Taylor 1995, 15-16-627).

Phase I sampling for PRSs 16-021(c) and 16-003(k) was completed during fiscal year (FY) 1995. Surface and near-surface samples were collected. Analyses were performed for HE, inorganics, volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), and uranium. Existing data suggested that PRS 16-021(c) was highly contaminated with HE and barium, so the objective of the Phase I sampling at that PRS was to determine the lateral extent of contamination in anticipation of a voluntary corrective action (VCA) cleanup. The objective of Phase I sampling at PRS 16-003(k) was to determine whether a release had occurred beneath the HE sumps and troughs that presented a risk to human health and the environment.

The following constituents were found above screening action levels (SALs) at PRS 16-021(c): cyclotrimethylenetrinitramine (RDX), cyclotetramethylene-tetranitamine (HMX), 2,4,6-trinitrotoluene (TNT), 2,4-dinitrotoluene (DNT), 1,3,5-trinitrobenzene (TNB), anthracene, bis(2-ethylhexyl)phthalate, and barium. Some constituents, such as RDX, were present at levels more than four orders of magnitude greater than SALs. Detection limits for HE and other organic constituents were high due to the large amounts of HE in many samples and the resultant large numbers of dilutions required for chemical analyses. Non-RFI surface and groundwater sampling reveal that HE constituents and barium are present at levels greater than maximum contaminant levels (MCLs) in springs and surface waters potentially associated with PRS 16-021(c). Together, these data imply that a corrective measures study (CMS) and corrective measures implementation (CMI) are required for this unit.

The PRSs discussed in this RFI report are listed in Table ES-1. PRS 16-003(k) is recommended for voluntary corrective action (VCA) to be performed in conjunction with CMS/CMI at PRS 16-021(c). Phase I data indicated that minor releases of constituents to the environment have occurred at the sumps, but the identified releases are not at levels greater than SALs. Final soil characterization, drain line and trough removal, and, if necessary, soil cleanup of PRS 16-003(k) will occur in association with the CMI at PRS 16-021(c). Accelerated Phase II sampling is recommended for PRS 16-021(c) in preparation for a CMS. A CMS plan will be completed during fiscal year 1997.

Although radionuclides are regulated by the Department of Energy (DOE) and not under RCRA, it is more efficient and cost-effective to investigate all types of potential contaminants during a single site characterization. Therefore, it is LANL and DOE policy to address radiochemical concerns in this report.

TABLE ES-1

SUMMARY OF PROPOSED ACTIONS

PRS[a] NUMBER.	HSWA[b]	RADIONUCLIDE COMPONENT[c]	PROPOSED ACTION			SECTION NO.
			NFA[d] RITERION	FURTHER ACTION	RATIONALE	
16-003(k)	X		N/A[e]	VCA	Characterize soils, remove fixtures, and cleanup soil with CMI[f] at 16-021(c)	5.1.10
16-021(c)	X	X	N/A	Further Investigation (10/96) CMS[g] (9/97)	Contamination not bounded Highly contaminated soils	5.2.10

[a] PRS = Potential release site.

[b] An X in this column indicates that the site is listed on the Hazardous and Solid Waste Amendments (HSWA) Module (Module VIII) of the Laboratory's RCRA operating permit.

[c] An X in this column indicates that the site has a known radionuclide component.

[d] NFA = No further action.

[e] N/A = Not applicable.

[f] CMI = Corrective Measures Implementation.

[g] CMS = Corrective measures study.

SUMMARY OF PRSs

PRS 16-003(k) consists of 13 HE sumps and drain lines associated with TA-16-260. The sump outlets to the outfall are currently scheduled to be plugged during fall 1996. After the sumps are plugged they will continue to receive large amounts of HE-bearing process water, which will be collected in vacuum trucks and transported to the TA-16 Burning Ground rather than be discharged at the outfall. Barium, chromium, cobalt, copper, lead, nickel, silver, uranium and zinc were found above LANL upper tolerance limits (UTLs). The HE 4-amino-dinitrotoluene (4-ADNT), HMX, TNB, and TNT were found above analytical detection limits. These analytes were found in soils near the sumps and troughs. Small amounts of VOCs and SVOCs were found. No analytes above SALs were found. A multiple constituent evaluation (MCE) suggests that the cumulative risk from both carcinogens and noncarcinogens is small. However, potential releases from this unit have not been fully characterized. Thus, PRS 16-003(k) is recommended for further characterization and VCA in conjunction with CMS/CMI activities at PRS 16-021(c). The drain lines and troughs are currently scheduled to be deactivated during fall 1996. LANL will remove those drain lines and troughs, and complete additional characterization sampling in the locations of these removed structures. The active portions of PRS 16-003(k) beneath the sumps will be characterized as part of the VCA. Details of these activities will be provided in a VCA plan that will be submitted concurrently with the CMS report. VCA activities will occur concurrently with CMI activities.

PRS 16-021(c) is the outfall associated with the 13 HE sumps on the northeast side of TA-16-260. The outfall will no longer receive HE-bearing wastewater following plugging of the sumps. Barium, chromium, copper, lead, nickel, silver, uranium, vanadium, and zinc were found in soils above LANL UTLs. Barium was found well above SALs throughout the PRS. The HE 2-amino-dinitrotoluene (2-ADNT), 4-ADNT, DNB, DNT, HMX, nitrobenzene (NB), 3-nitrotoluene (NT), RDX, TNB, and TNT were all found at this PRS. DNT, HMX, RDX, TNB, and TNT were all found at levels in soils well above SALs for a distance of 600 ft from the outfall. SVOCs and VOCs were detected above analytical detection limits - including anthracene and bis(2-ethylhexyl)phthalate at levels greater than SALs. Although no formal risk assessment was performed, risks are estimated to be in the range of 10^{-2} to 10^{-3} for carcinogens and a hazard index greater than 1 based under comparison with EPA Region IX calculations made under a generic industrial exposure scenario. In addition, HE levels in the PRS represent an acute (explosive) hazard due to HE levels greater than five weight percent. Nearby springs and surface waters are contaminated at levels greater than background and MCLs, potentially due to contaminants derived from PRS 16-021(c). Several best-management practices (BMPs), including hay bale dams, sandbag barriers, and geotextile matting in the highly-contaminated zone, have been implemented at this PRS to minimize run-on and runoff.

A Phase II sampling plan is proposed to: 1) determine the extent of contamination requiring remediation, 2) investigate the hydrologic connection between the PRS and contaminated surface waters and groundwaters, and 3) examine the potential for off-site migration of contaminants from the PRS. This Phase II sampling and analysis plan is designed to support the CMS plan for this PRS. The CMS plan is currently scheduled for delivery to the New Mexico Environment Department in September 1997.

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1.0 INTRODUCTION

This report presents the results of the Phase I Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) for two potential release sites (PRSs) associated with Technical Area (TA) 16 at Los Alamos National Laboratory (LANL). The two PRSs are the outfall and sumps from a high explosives (HE) machining building, TA-16-260. This report describes the sampling conducted during Phase I, examines the analytical results, and proposes future action for the PRSs.

1.1 General Site History

TA-16 is located in the southwest corner of the Laboratory (Fig. 1.1-1 and Fig. 1.1-2). It contains 2 410 acres or 3.8 square miles. The land is a portion of that acquired by the Department of Army for the Manhattan Project in 1943. It was used prehistorically by the ancestral Indians of the Pajarito Plateau and prior to World War II for farming and a sawmill operation. TA-16 is bordered by Bandelier National Monument along State Road 4 to the south and the Santa Fe National Forest along State Road 501 to the west. To the north and east, it is bordered by TAs 8, 9, 14, 15, and 49. TA-16 is fenced and posted along State Road 4. Water Canyon, a 200-ft-deep ravine with steep walls, separates State Road 4 from active sites at TA-16. Cañon de Valle forms the northern border of TA-16. Security fences surround the production facilities.

TA-16 was established to develop explosive formulations, cast and machine explosive charges, and assemble and test explosive components for the US nuclear weapons program. Almost all of the work was 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 advanced.

TA-16-260 is located on the north side of TA-16. The structure was originally built in 1951, with minor modifications to the structure made later. It is an HE machining facility that processes large quantities of explosives. Machine turnings and HE washwater are routed to the 13 sumps as waste. The drainage channel from the outfall is contaminated with high-explosive waste and barium. The outfall is currently scheduled to be deactivated; however, it is still permitted as Environmental Protection Agency (EPA) 05A056. The sumps, drain lines, and troughs have been designated PRS 16-003(k) and the outfall as PRS 16-021(c).

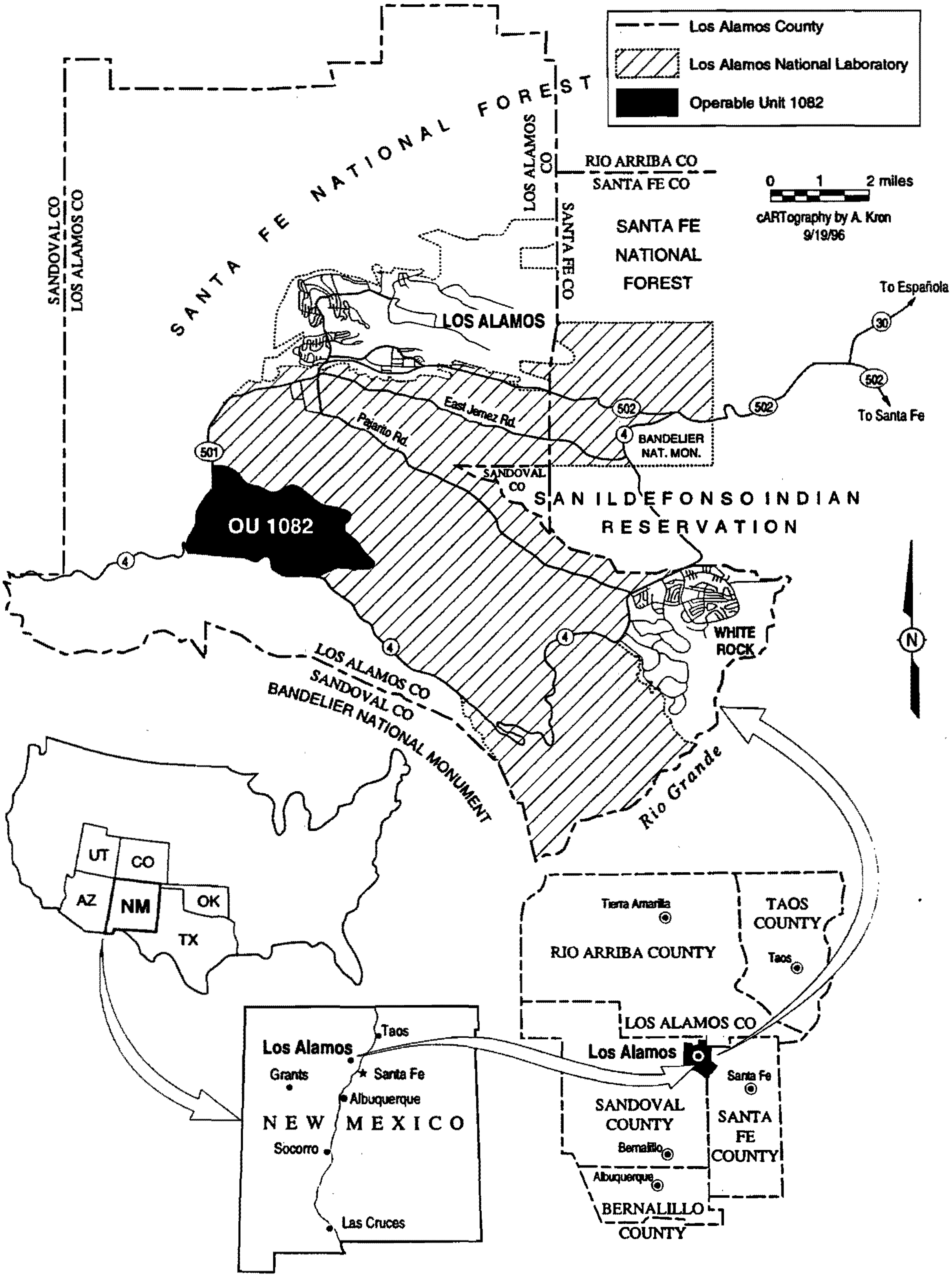


Fig. 1.1-1. Location of Operable Unit 1082.

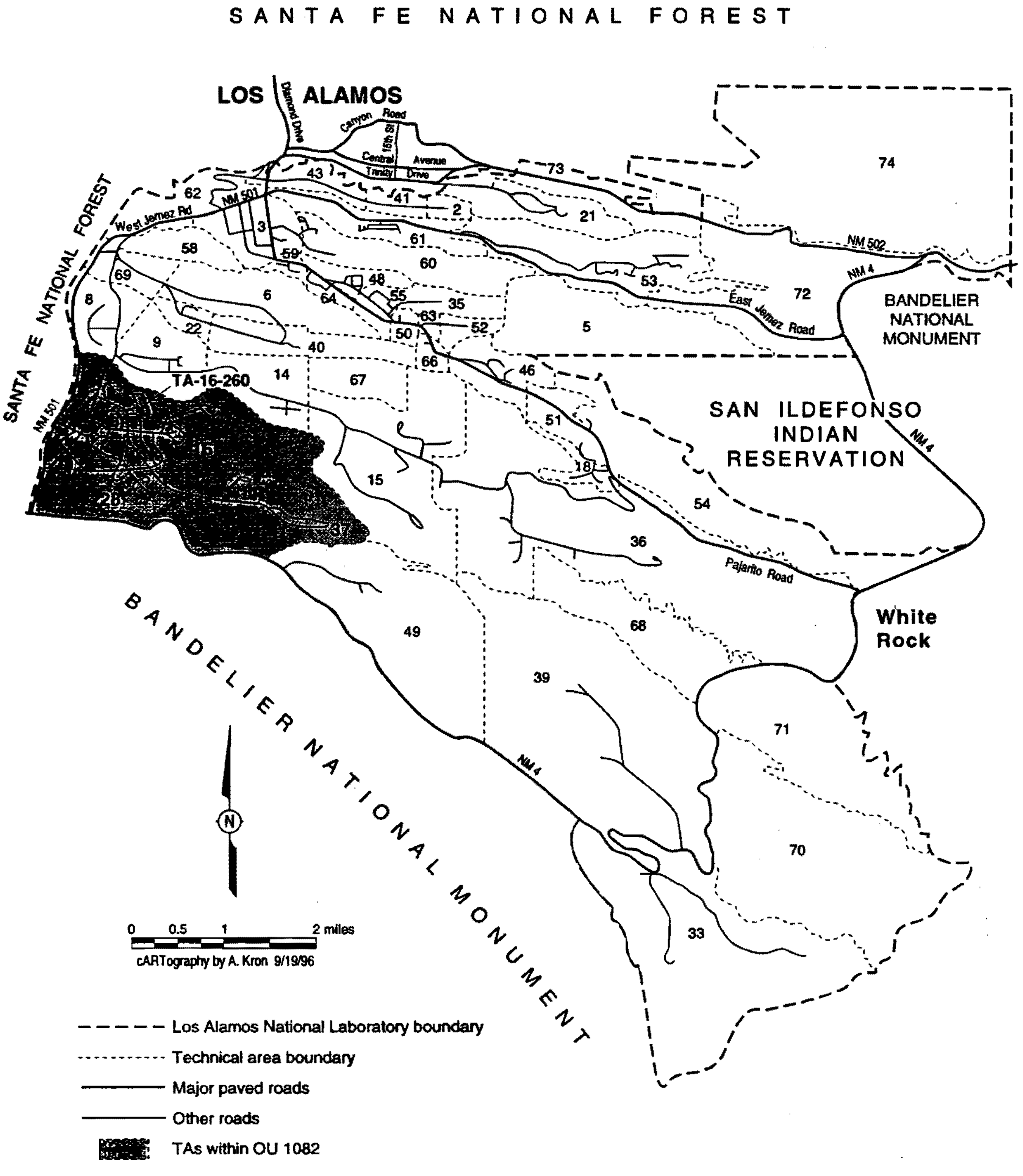


Fig. 1.1-2. Location of Operable Unit 1082 with respect to Laboratory technical areas and surrounding landholdings. Building TA-16-260 within TA-16 is also shown.

Chemicals of potential concern (COPCs) at this site include various types of HE, HE impurities and degradation products, uranium, metals (especially barium), volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), and cyanide.

1.2 RFI Overview

The sampling plans for the PRSs discussed in this document are contained in subsection 5.3 of the RFI Work Plan for Operable Unit (OU) 1082 (LANL 1993 1094). This work plan was submitted to the EPA Region 6 in July 1993. A notice of deficiency (NOD) was received in July 1994. LANL's response was submitted to the Los Alamos Area Office of the Department of Energy (DOE) in August 1994. EPA' s approval of the work plan with modifications was received during December 1994 (Taylor 1995, 1357)

The technical approach of the work plan included phased sampling to locate the sources and types of contamination associated with LANL activities. Contaminants detected during Phase I reconnaissance sampling may be subject to subsequent sampling to ensure that contamination is investigated in compliance with the Hazardous and Solid Waste Amendments (HSWA) Module VIII of the LANL Hazardous Waste facility permit (EPA 1990, 0306).

The conceptual model for this site is referenced in subsection 4.3 of the RFI work plan for Operable Unit 1082 (LANL 1993, 1094). The primary exposure routes for continued industrial operations include ingestion and inhalation, dermal contact, external radiation, and potential HE detonation. Further work at these PRSs includes: 1) Phase II sampling followed by the corrective measures study (CMS)/corrective measures implementation(CMI) process, and 2) further characterization associated with voluntary corrective action (VCA).

1.3 Field Activities

1.3.1 Sample Collection Activities

The fieldwork for the PRSs in this report began in June 1995 and ended in October 1995. Sampling was limited to Fridays due to safety requirements dictated by the operating group. Sampling was completed by ICF Kaiser Engineers. All applicable LANL Environmental Restoration (ER) standard operating procedures (SOPs) were followed, unless otherwise noted in Chapter 5 of this document.

Field screening for HE by spot test, volatiles by photoionization detector (PID), and radionuclides by hand-held sodium-iodide (NaI_2) detector occurred at both PRSs. The purpose of field screening was to bias core samples to locations with the highest contamination at

PRS 16-003(k) and to aid in bounding extent of contamination at PRS 16-021(c). Screening was also needed to ensure compliance with shipping requirements for explosive materials. HE spot test results were particularly important for biasing laboratory sampling locations and to support bounding of the extent of contamination.

PRS 16-003(k) sampling consisted of remote-drilled vertical boreholes adjacent to the sumps and drainage troughs that constitute this PRS. PRS 16-021(c) sampling consisted of surface and near-surface sampling using spade and scoop and hand-auger methods. Each sample was photographed and all sampling data were loaded into a field 4-D database that was later uploaded into the facility for information management and display (FIMAD).

Land surveys were conducted between January and March 1995 and June 1996. All surface samples were taken to an approximate depth of 6 in. within a diameter of 6–8 in. VOC samples were taken from a depth of greater than 6 in. but less than 6 ft. Soil was collected from each sampling location using dedicated nonsparking aluminum sampling implements. Augered samples were collected with a remote drill rig (SIMPCO™) operated from a distance of greater than 30 ft with all operators shielded behind a bullet-proof polycarbonate shield. Wet drilling was required to comply with operational health and safety requirements. These sampling safety precautions are required in areas containing potentially-explosive levels of HE.

1.3.2 Field Quality Assessment Activities

Field quality assessment (QA) samples, in the form of collocated and performance evaluation (PE) samples, were collected as specified and defined in the site-specific quality assurance/ quality control (QA/QC) plan for the fiscal year (FY) 95 TA-16 field campaign (ICF-Kaiser 1995, 15-16-628). Collocated surface samples, designated as field duplicates in the RFI work plan, were established less than 1 ft north of their respective RFI-mandated sample locations. Split subsurface samples were collected from 1–2 ft intervals of core.

The PE samples were collected to check for contamination that may have been introduced from ambient conditions or improper handling procedures, to evaluate matrix effects on analytical laboratory recovery of inorganics and radioactive constituents, and to evaluate the overall process of sample handling and analysis. Because most of the PE samples were submitted to support the entire FY95 TA-16 field campaign, a detailed discussion of these samples is provided in the RFI report for the other 35 PRSs sampled in FY95. This report will be submitted by October 31, 1996. As described in that report, no problems were noted with the PE samples.

1.3.3 Deviations from the RFI Work Plan

Three deviations from the RFI work plan and its NOD occurred:

1) At PRS 16-003(k) two vertical boreholes were collected at each sampled sump rather than the angled borehole proscribed in the work plan NOD. This change was necessitated by HE safety concerns promulgated by the LANL operating group. The operating group requires all drilling in HE areas to be completed wet, and it was deemed impossible to maintain a wet borehole using angled drilling. Two vertical boreholes were estimated to be as effective at determining whether a large plume of HE existed beneath a sump as a single angled borehole. A large plume of HE would likely extend beyond the borders of an HE sump in one or more directions, and not be confined to the soils directly beneath the sump structure.

2) At PRS 16-003(k) only two of the five sumps and two of the five trough locations that were planned to be characterized according the work plan and its NOD were sampled during FY95. It was believed that partial implementation of the sampling plan would adequately determine whether a major release from this unit had occurred. In addition, the full sampling plan could not be completed within the budget for fiscal year 1995. This deviation from the work plan was discussed with representatives of EPA Region 6 during spring 1995, and the decision to complete only this portion of the Phase I RFI sampling was communicated to EPA Region 6 in a letter dated May 24, 1995 (Jansen and Taylor 1995, 15-16-627). Cores were screened on 12-in. intervals rather than 6-in. intervals in order to provide enough material for analysis.

3) Four waste-characterization samples , which were not included in the work plan, from two locations were collected in anticipation of soil removal and treatment. These samples were analyzed for toxicity characteristic leaching procedure (TCLP) metals and organics and for herbicides and pesticides.

2.0 ENVIRONMENTAL SETTING

The environmental setting of the Laboratory is described in Subsection 2.4 of the Installation Work Plan (IWP) for Environmental Restoration (LANL 1995, 1164). A discussion of the environmental setting, including climate, geology, hydrology, and a conceptual hydrogeologic model for the area and surroundings, is presented in Chapter 3 of the work plan for OU 1082 (LANL 1993, 1094). A summary of that and new data collected since 1993 are presented in the following sections.

2.1 Climate

Los Alamos County has a semiarid, temperate, mountain climate. Summers are generally sunny with moderate, warm days and cool nights. High altitude, light winds, clear skies, and dry atmosphere allow mean summer temperatures to range from 60° F to 68° F at TA-16. Winter mean temperatures typically range from 30° F to 37° F. The average annual rainfall in the area of TA-16 is estimated to range from 18 to 20 in. (Bowen 1990, 0333). Of this total, 40% occurs as brief, intense thunderstorms during July and August.

2.2 Geology

2.2.1 Geologic Setting

A detailed discussion of the geology of the entire Los Alamos area can be found in Subsection 2.5.1 of the IWP (LANL 1995, 1164). The geology of TA-16 is described in Subsection 3.4 of the work plan (LANL 1993, 1094). However, significant additional information on the geology of TA-16 has become available during the last three years. These new data are described below.

The operations area at TA-16 is bounded on the south by Water Canyon and on the north by Cañon de Valle. Cañon de Valle is a tributary to Water Canyon; they join at the east end of TA-16 approximately 3 miles downstream from the drainage for PRS 16-021(c), which is located 600 ft south of Cañon de Valle. Water Canyon drains into the Rio Grande approximately 7 miles east of the easternmost boundary of TA-16.

Operational areas at TA-16 are located on the mesa tops, composed of Unit 4 (QBT-4) of the Tshirege Member of the Bandelier Tuff. Unit 3 (QBT-3) of the Tshirege Member of the Bandelier Tuff crops out on the mesa tops at the east end of TA-16 and in the bottoms and walls of Cañon de Valle and Water Canyon. Correlation of recent mapping to the east of PRS 16-021(c) at Material Disposal Area (MDA)-P with the recently-released bedrock geologic map of Rogers (Rogers 1995, 1353) suggests that mesa top portions of PRS 16-021(c) are underlain by approximately 80—110 ft of Unit 4 of the Tshirege Member of the Bandelier Tuff.

At MDA-P, QBT 4 is a lithologically complex unit consisting of in ascending order: 1) a poorly indurated, white to light-gray, nonwelded ignimbrite, 2) an indurated light tan, nonwelded, cliff-forming tuff overlain by a broad bench, 3) a varicolored, nonwelded cliff-forming tuff with devitrified base and a 10-ft thick glassy upper part, 4) a crystal-rich surge bed up to 1 ft thick, and 5) a hard, densely-welded tuff that forms the caprock for the mesa (Broxton et al. 1996, 1305). The latter subunit correlates with Unit QBT$_f$ and the first 3 units correlate with Unit QBT$_e$ of Rogers (Rogers 1995, 1353). The crystal-rich surge bed was mapped by Rogers as the boundary between her units QBT$_e$ and QBT$_f$. This high-permeability sandy parting may represent a possible perched zone - provided it also overlies a low-permeability zone. Examination of this contact in the walls of Cañon de Valle between MDA-P and PRS 16-021(c) suggests that the surge bed is discontinuous. Rogers subunit QBT$_e$ contains a unit characterized by horizontal fractures that also may represent a possible perched-flow pathway.

QBT 3 in Cañon de Valle adjacent to MDA-P consists of two hard, pinkish-brown, partially to moderately welded, cliff-forming ignimbrites that are separated by a soft, pinkish-orange, nonwelded, slope-forming tuff. The uppermost subunit within Unit 3 contains significant horizontal fractures.

Detailed information on the mineralogy, modes, whole-rock chemistry, and outcrop characteristics of Unit 3 and Unit 4 at TA-16 are provided in Broxton et al. (1996, 15-16-1305).

A large, near-vertical fault, the Frijoles segment of the Pajarito fault zone, has been mapped to the west of OU 1082. This fault is the largest segment of the Pajarito fault system in the Los Alamos area, with down-to-the-east displacement ranging up to 400 ft during the last 1.1 million years. Fault zones may provide pathways for water flow.

2.2.2 Soils

A discussion of soils in the Los Alamos area can be found in Subsection 2.5.1.3 of the IWP (LANL 1995, 1164). Soil at TA-16 is described in Subsection 3.4.3.2 of the work plan (LANL 1993, 1094). As described in that subsection, the area surrounding PRS 16-021(c) was mapped as fine typic Eutroboralfs by Nyhan (Nyhan et al. 1978, 0161). Examination of soils at PRSs around TA-16-260 suggests loamy fine soils. A recent study of background soils on the north and south slopes of Cañon de Valle near the TA-16 Burning Ground suggests that: 1) soil horizons ranged from 40 to 237 cm in depth, 2) soils are poorly developed and consist of A-R, A-Bw-R, or A-Bw-C soil profiles, and 3) soils are classified as Lithic Ustorthents, Typic Haplumbredt, Cumulic Haplumbredt, Typic Ustochrept, and Udic Paleoustalf soils (McDonald et al. 1996, 1354). The geomorphic environment of these soils, on the slopes of Cañon de Valle, is probably similar to that in the vicinity of PRS 16-021(c).

2.3 Hydrology

The hydrology of the Pajarito Plateau is summarized in Subsection 2.5.2 of the IWP (LANL 1995, 1164). The shallowest depth to groundwater at TA-16 is unknown. This question will be investigated as part of Phase II sampling for PRS 16-021(c). Shallow perched aquifers at TA-16 are likely quite heterogeneous. Several moderate depth (up to 200 ft) boreholes drilled at the TA-16 Burning Ground near MDA-P did not contain a saturated zone. The depth to the main aquifer at TA-16 is estimated to be greater than 1 000 ft. Four deep groundwater wells to the main aquifer are scheduled in and around TA-16 as part of sitewide hydrogeologic studies scheduled for FY97 to FY01. These wells will be located: 1) in Cañon de Valle near MDA P 2) at the confluence of Cañon de Valle and Water Canyon 3) at New Mexico State Road 501 and Cañon de Valle, and 4) at New Mexico 501 and Water Canyon.

2.3.1 Surface Water

Surface water issues at TA-16 are described in Subsection 3.5.1 of the work plan (LANL 1993, 1094). Additional information on surface waters, collected since 1993, is summarized below.

Perennial and intermittent surface water exist at many locations at TA-16, due both to natural and anthropogenic sources. Cañon de Valle contains what appears to be a perennial reach, the surface water between TA-16-260 outfall and a location beyond MDA-P has flowed continuously since initial investigations in 1992. Several small saturated areas are present in small, tributary, drainages to Cañon de Valle and Water Canyon. Many of these zones are due to the discharge of process waters from TA-16 operations. Figure 2.3.1-1 shows locations of possible wetlands-type vegetation, HE-process outfalls (as of 1994), and other surface water locations.

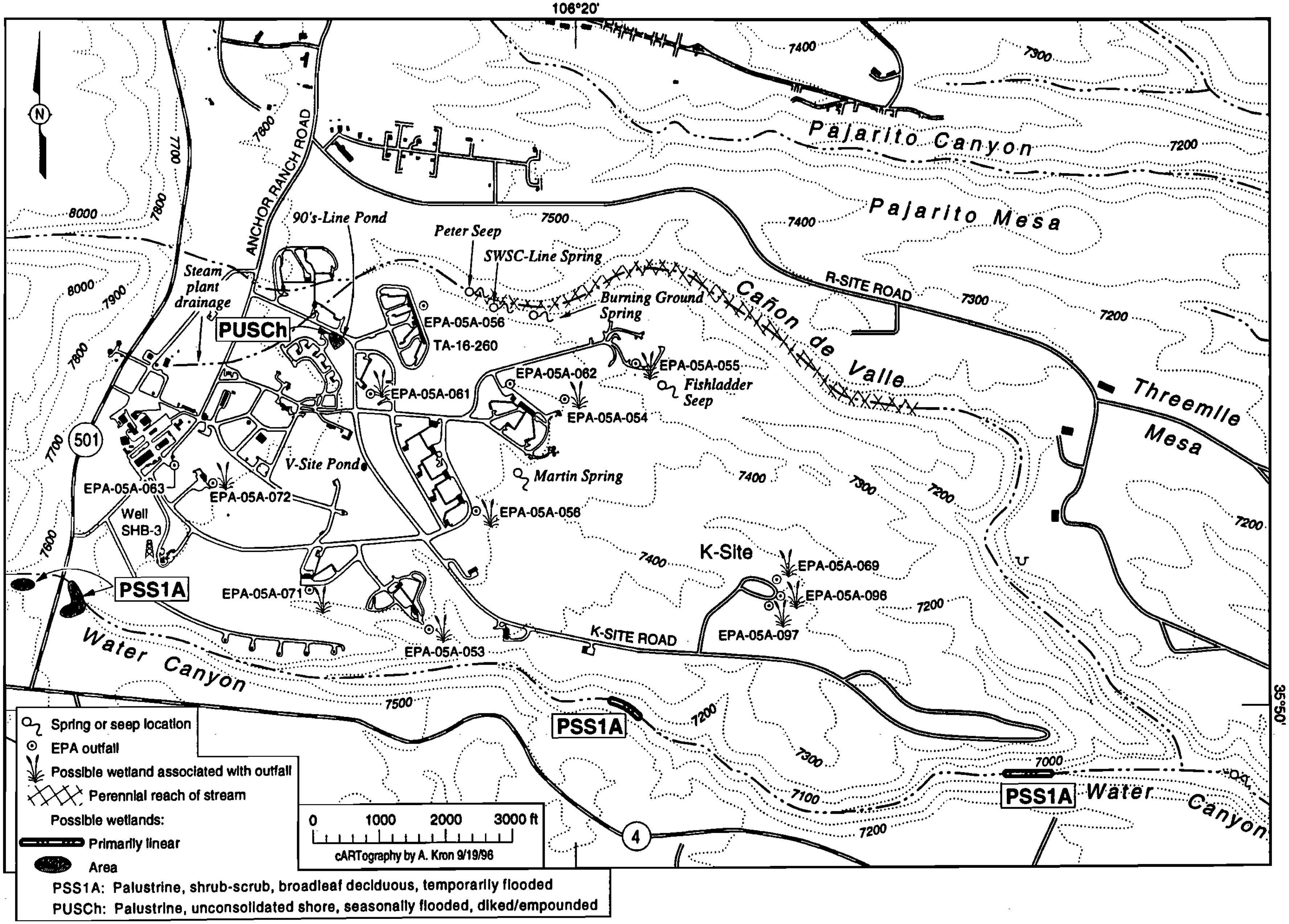


Fig. 2.3.1-1. Topography, springs, seeps, National Wetlands Inventory, and LANL-defined wetlands associated with National Pollution Discharge Elimination System (NPDES) HE outfalls (active and inactive) at TA-16.

Surface waters in many of these locations have been analyzed as part of Framework Studies surface water characterization activities, by New Mexico Environment Department (NMED) Agreement in Principle (AIP) personnel as part of their surveillance activities, and as part of non-RFI hydrogeologic sampling at TA-16. Complete water analyses, maps showing sampling locations, and more detailed discussions of these data are provided in Appendix C. Information on constituents above background in surface waters is provided in Appendix C and is summarized below.

Certain surface waters in Cañon de Valle are contaminated with several constituents at levels above screening action levels (SALs) and above background. Barium in Cañon de Valle ranges from 2 to 3 ppm, which is above the New Mexico maximum concentration level (MCL) of 1 ppm. The high explosive RDX is also consistently at levels above 100 ppb, which is greater than the New Mexico MCL for that constituent. Several other constituents in Cañon de Valle are at levels above regional spring background. These constituents include HMX, chlorine, sodium, and manganese (see Appendix C).

Other surface waters at TA-16 that have anomalously high levels of constituents include the pond behind the 90s-Line, which contains barium at levels above screening action levels (SALs), and a surface water zone at K-Site, which contains barium and boron above background.

Further analyses of these surface waters will be completed during Phase II sampling activities.

2.3.2 Groundwater

Groundwater issues at TA-16 are described in Subsection 3.5.2 of the work plan. Additional information on groundwaters, collected or reinterpreted since 1993, are summarized below. Information on constituents above background in groundwaters at TA-16 are described in detail in Appendix C.

Borehole SHB-3 (Fig. 2.3.1-1), drilled in November 1991, contained perched groundwater, hypothesized to have been derived from a depth of between 750-350 ft. (Gardner et al. 1993, 0848). This water may represent a perched zone or it could represent the regional aquifer. Water and swab samples were taken from SHB-3 during the summer of 1993. These data show sporadic elevated values of lead, phosphate, rubidium, and ammonium relative to background spring data (Blake et al. 1995, 1355). Static water depth in SHB-3 was roughly 664 ft during 1992 (EPG 1994, 1179)

Several springs and seeps have been identified at TA-16 during the past four years. Locations of these springs are shown on Fig. 2.3.1-1. SWSC Line and Burning Ground spring discharge from within the uppermost, platy, subunit of Tshirege Unit 3. Martin spring apparently discharges from the lower portion of Tshirege Unit 4. All of the springs and seeps are contaminated with constituents (barium, boron, HE, solvents) at levels above background. All of these springs are also contaminated at levels above SALs for RDX (see Appendix C). Martin spring appears to be most highly contaminated.

The presence of these springs suggests the existence of one or more perched zones at a shallow level beneath TA-16. Determination of the depth and nature of the uppermost of these perched zones is one of the goals of the Phase II sampling described in Subsection 5.2.11 of this document.

2.4 Biological and Cultural Surveys

Biological and cultural surveys were performed at TA-16 prior to sampling.

Appendix A to the work plan (LANL 1993, 1094) identifies thirty-three cultural sites eligible for inclusion on the National Register of Historic Places under Criterion D within OU 1082. However, that Appendix also notes that the attributes that make these sites eligible for inclusion on the National Register will not be affected by ER project sampling activities.

Appendix B to the RFI work plan for OU 1082 and Raymer (1996, 15-16-621) describe the results of field surveys for threatened, endangered, and sensitive species (LANL 1993, 1094). Ten plant and animal species of concern were identified in those surveys. These species were: the Jemez Mountain salamander, northern goshawk, peregrine falcon, Mexican spotted owl, broad billed hummingbird, pine marten, meadow jumping mouse, spotted bat, checker lily, and wood lily. Appropriate notifications and mitigation measures for each species were also identified in Appendix B to the work plan. One of these species is known to reside in Cañon de Valle (Dunham 1996, 15-16-622; Raymer 1996 15-16-621).

3.0 APPROACH TO DATA ASSESSMENT AND ANALYSIS

The approach to data assessment used by the ER Project is described in the "Technical Approach to Data Assessment for ER Project Site Characterization Decisions" (Knudsen et al. 1996, 1299). The approaches used in this RFI report included

- sampling and analysis design,
- field investigation and collection of field and quality assurance (QA) samples,

- chemical and radiological analyses of samples and reporting of analytical data,
- routine verification and validation of analytical data,
- organization of field and analytical data into PRS-specific data packages,
- exploratory data analysis,
- comparison of validated analytical results with LANL background data,
- comparison of validated analytical results with SALs,
- assessment of human health risk, and
- formulation of decisions.

The following subsections provide overviews of the methods used to complete these steps for the PRSs discussed in this RFI report.

3.1 Sample Analysis

Samples were collected in accordance with sample design specified in the work plan (LANL 1993, 1094). All samples requiring chemical and radiological analyses and chain-of-custody documentation were submitted to the sample management office (SMO) for analyses. Analytical suites used for samples at these PRSs include VOCs, SVOCs, inorganics, HE, and uranium.

3.1.1 Analytical Methods

All samples were analyzed by contract analytical laboratories using methods specified in ER SMO analytical subcontracts. The allowed methods are EPA SW-846 (EPA 1992, 1207) and contract laboratory program (CLP) methods or equivalent for inorganics including mercury, VOCs, SVOCs, and HE. The subcontracts specify LANL-approved methods for radiochemical analyses. Analytical method selection is described in Appendix II of the ER Project Quality Assurance Project Plan (QAPP) Requirements for Sampling and Analysis (LANL 1996, 1292). For each analyte, a lower, contract-required quantitation limit is specified. These values, estimated detection limits for inorganics and estimated quantitation limits (EQLs) for organics and radionuclides, are listed in Appendix III of the ER Project QAPP. Analytes for each suite are listed in Appendix A.

A few samples, all of those that failed the HE spot test, were analyzed for the non-standard explosive TATB using a LANL in-house analytical method. No effective commercial method exists for this compound due to its insolubility.

3.1.2 Data Verification and Validation

Data verification and baseline validation procedures are used to determine whether analytical data packages have been generated according to specifications and contain the information necessary to determine data sufficiency for decision making. For analytical data used for decisions discussed in this RFI report, routine data validation under the ER protocol was performed as described in Technical Approach to the RFI Report (Knudsen et al. 1996, 1299).

PRS-specific quality assurance/quality control details are presented in Section 4 of this RFI report. Qualifiers resulting from baseline validation are shown in analytical results tables included in Section 5 of this RFI report. Summaries of data quality evaluations for analytical data packages relevant to this RFI report are given in Appendix B.

3.2 Background Comparisons

The purpose of background comparisons is to determine if chemicals that have natural or anthropogenic background distributions should be retained as COPCs or eliminated from further consideration. Background data for decision-making concerning PRSs in this RFI report are from two sources:

- Soil samples collected throughout Los Alamos County for which chemical analyses were performed for certain inorganic (metal) chemicals and naturally occurring radioactive chemicals (Longmire et al. 1995, 1142; 1266).
- Background concentrations of radioactive chemicals associated with global fallout from atmospheric nuclear testing (e.g., plutonium, cesium, strontium, and tritium) reported in LANL Environmental Surveillance reports (i.e., Purtymun et al. 1987, 0211; ESG 1988, 0408; ESG 1989, 0308; EPG 1992, 0740).

Comparisons between site data and background data are initially performed by comparing each observed concentration datum with an upper tolerance limit (UTL) estimated from background data. Details of statistical methods used to generate UTLs from the background data sets and suggestions for statistical methods for comparing site and background concentration distributions are presented in the guidance document, Application of LANL Background Data to ER Project Decision-Making, Part I: Inorganics (Ryti et al. 1996, 1298).

3.3 Detected Organic Constituents

Background data are not available for organic chemicals. Organic chemicals that are reported as detected are carried forward to the screening assessment process in this RFI report. Chemicals reported as not detected in any sample analyses are removed from further consideration.

3.4 Human Health Assessment

3.4.1 Risk Due to Background

Background risks can result from inorganics that are naturally occurring at a site. Calculation of background risks using the same methodology as site risk estimates provides a frame of reference for risk levels calculated at a site. This information provides a basis for determining risk-based remediation goals, which in some circumstances may be set at target risks comparable to background rather than default values, i.e., cancer risk of 1E-6 or hazard index of 1. Background risks can also affect decisions at sites that have constituents for which there is a threshold of toxicity. For some inorganics, background intakes may be near a toxicity threshold so that incremental intakes associated with contamination may be unacceptable.

Background risks calculated here use the same exposure assumptions by which SALs are calculated. SALs are based on health-protective assumptions for a residential scenario (EPA 1995, 1307). For soil exposure, the pathways include incidental soil ingestion, inhalation of resuspended dust, and dermal contact with soil. Because background soil data represent geographically diverse locations, background risks are estimated for both a median concentration and the UTL from the entire background data set to present the range of potential risk associated with different soil constituent concentrations found in and around Los Alamos. The background risks based on the SAL residential exposure model are provided in Table 3.4.1-1.

Risks due to background are presented for both noncarcinogenic and carcinogenic outcomes. The potential for adverse noncarcinogenic health effects is estimated by a hazard quotient. Intakes leading to a hazard quotient up to 1 are not associated with adverse health effects. None of the median background concentrations result in hazard quotients greater than 1. The hazard quotient of the UTL concentration for manganese exceeds 1 (1.9). However, given the unlikely occurrence of this concentration, the conservative assumptions in the exposure assessment, the margin of safety in the reference dose, and the exceedance of less than a factor of two, this intake estimate is not expected to be associated with adverse health effects.

Four of the background inorganics are also carcinogens, although the cancer-risk due to Cr(vi) is not shown, because it is assumed that naturally occurring chromium is in the trivalent state. According to the default exposure assumptions used for SALs, the lifetime cancer risks due to background residential soil exposure are estimated at 1 to 2 in 100 000 for arsenic and beryllium.

These background risk estimates provide a frame of reference for the screening assessment and site decisions. If a site-specific risk assessment is necessary to further evaluate risks, background risks can also be calculated using the site/scenario-specific assumptions to assist in the remedial action decisions for the site.

TABLE 3.4.1-1

RISK DUE TO BACKGROUND CONCENTRATIONS OF SOIL INORGANICS ASSUMING A RESIDENTIAL SCENARIO[a]

SOIL INORGANIC	SOIL CONCENTRATION (mg/kg)		HAZARD QUOTIENT		LIFETIME CANCER RISK	
	MEDIAN	UTL	MEDIAN	UTL	MEDIAN	UTL
Aluminum	10 000	38 700	0.13	0.5	nc[b]	nc
Antimony	0.6	1.0	0.019	0.032	nc	nc
Arsenic	4.0	7.82	0.18	0.36	1.2E-5	2.4E-5
Barium	130	315	0.025	0.059	nc	nc
Beryllium	0.895	1.95	0.0027	0.0059	6.4E-6	1.4E-5
Cadmium[c]	0.20	2.7	0.0053	0.071	1.4E-10	1.9E-9
Chromium[d]	7.2	16.1	0.00009	0.0002	nc	nc
Cobalt	6.0	19.2	0.0013	0.0042	nc	nc
Copper	5.75	30.7	0.0021	0.011	nc	nc
Lead	12	23.3	0.03	0.058	nc	nc
Manganese	320	714	0.84	1.9	nc	nc
Mercury	0.05	0.1	0.0022	0.0043	nc	nc
Nickel	7.0	15.2	0.0047	0.01	nc	nc
Selenium	0.3	1.7	0.00078	0.0045	nc	nc
Thallium	0.2	1.0	0.033	0.16	nc	nc
Uranium	0.9	1.87	0.0039	0.0081	nc	nc
Vanadium	21	41.9	0.039	0.078	nc	nc
Zinc	30.7	50.8	0.0013	0.0022	nc	nc

[a] Risk estimates are based on reference doses, slope factors, and EPA Region IX default exposure assumptions effective in April 1996.

[b] nc= noncarcinogen.

[c] Cancer risks for cadmium are based solely on inhalation of resuspended dust.

[d] Naturally-occurring chromium is assumed to exist in a trivalent state.

3.4.2 Screening Assessment

The purpose of this decision step is to determine if contaminants should be retained as COPCs)or eliminated from further consideration based on comparisons with SALs. This is the last step in the screening assessment process for human health concerns. If COPCs remain after this step, then further action or a risk assessment may be proposed. If no COPCs remain after this step, then no further action (NFA) may be proposed based on the absence of human health concerns. The screening assessment considered the following questions for the PRSs in this RFI report:

- Are reported concentrations or radiological activities due to analytical laboratory/field bias or contamination?
- Are site data greater than background UTLs and fail a multiple chemical evaluation (MCE)?
- Is the maximum site concentration greater than the SAL?
- If a SAL does not exist for a detected chemical, should that chemical be carried forward as a COPC?

SALs are calculated using chemical-specific toxicity information and conservative, default exposure assumptions. Soil and water media have separate SALs for each contaminant. The decision to identify a contaminant as a COPC when a SAL is not available is made on a case-by-case basis, taking into account the availability of process knowledge and toxicological information. A complete description of the methods used to generate SALs is provided in Screening Assessment Methodology (McCann et al. 1996, 1300).

If more than one chemical or radionuclide was present above UTL at the site, an MCE was performed in which the reported concentration for each chemical was divided by its respective SAL. If the sum of the normalized values was less than 1, then the chemicals are removed from further consideration. If the total normalized value is greater than 1, then chemicals having an individual normalized value greater than or equal to 0.1 are retained as COPCs pending further evaluation. For further information on the calculation of MCEs see Screening Assessment Methodology (McCann et al. 1996, 1300).

3.4.3 Risk Assessment

The human health risk assessments follow the policy document Risk-Based Corrective Action Process (Dorries 1996, 1297). The human health risk assessment process consists of the following four steps:

- identification of COPCs,
- exposure assessment,
- toxicity assessment, and
- risk characterization.

No site-specific human health risk assessments were performed for PRSs 16-003(k) or 16-021(c).

3.5 Ecological Assessment

The PRSs in this RFI report are evaluated according to the Ecological Risk Assessment Approach for Los Alamos National Laboratory (Ferenbaugh et al. 1996, 1303). Each PRS is first screened for background concentrations and evaluated for presence of suitable habitat, potential for off-site transport of contaminants, and receptor access to the site or to areas impacted by off-site transport. NFA for ecological concern is recommended when background concentrations are not exceeded, suitable habitat does not exist, and/or if there is no receptor access to the site or to areas impacted by off-site transport.

Because the preliminary ecological screening for the PRS(s) indicates a potential for ecological concern, the PRS(s) will be evaluated as part of the new Ecological Exposure Unit (Ecozone) approach that is being developed by LANL in conjunction with EPA and the NMED. PRS 16-021(c) has clearly impacted environmental receptors. There are significant numbers of dead trees in and around the drainage from the outfall.

4.0 RESULTS OF QUALITY ASSURANCE/QUALITY CONTROL ACTIVITIES

This section reviews the impact on data usability of QC results, reported in Appendix B, together with results from field duplicates. Three field duplicate pairs were collected at PRS 16-021(c).

All laboratory analyses for this report were performed by a single analytical laboratory. All data were subjected to routine data validation. Field results stored in FIMAD have been edited and agree with hard copy results. However, not all QC results reported by the laboratory are either present or correct in FIMAD at this time. Flags assigned by the routine data validators are in FIMAD, but the information in Appendix B is generally more complete.

4.1 Inorganic Analysis

A total of 47 field samples were analyzed for the standard suite of inorganic chemicals. Four samples were submitted for inorganic TCLP analyses. Qualifications placed on these results by routine data validation are summarized in Appendix B, Table B-1.

Relative standard deviations (RSDs) for most inorganic chemicals, as measured by replicate analyses, were generally in the range of 10–30%. RSDs occasionally exceeded 40% for some replicate analyses of the more abundant elements (such as aluminum, iron, manganese, and sodium) and also for one cobalt pair. RSDs were less than 5% for chemicals generally reported below detection level (cadmium, selenium, silver, thorium, antimony, and cyanide). RSDs were below 10% for mercury except for one pair in request #1269, resulting in laboratory qualification of all mercury results for the nine samples in that request. However, none of the mercury results for these samples exceeded 0.1 mg/kg, and as results below 0.1 mg/kg were also obtained uniformly for the remaining 38 samples, the data from this request are likewise accepted as being representative of the very low levels of mercury at these sites.

Comparable RSDs were observed for field duplicate pairs, indicating that local heterogeneity and sample collection and handling procedures did not contribute significantly to variability in the results.

Matrix spike recoveries fell outside the acceptable values for some inorganic chemicals, as noted in Table B-1. For the purposes of this report, the primary purpose being to determine whether inorganic contamination is present, only negative biases are of concern. Negative biases were indicated primarily for selenium and less frequently for arsenic and barium. There is no process information or data to indicate that either selenium or arsenic are COPCs at this site. Barium, a constituent of many high explosives, is both expected and observed to be present at high concentrations. The inorganic data are accepted as qualified in Table B-1.

4.2 Radiochemical Analyses

A total of 46 field samples were analyzed for total uranium. Qualifications placed on these results by routine data validation are summarized in Appendix B, Table B-1.

The RSDs for the three replicated analyses (all at background levels of uranium) were less than 20%. RSDs for two field duplicate pairs were only slightly higher (11% and 29%), indicating that local heterogeneity and sample collection and handling procedures did not significantly increase variability in the results.

Data validation noted no problems with total uranium analyses. The data are considered valid without qualification.

4.3 Organic Analysis

A total of 47 field samples were analyzed for SVOCs and HE. In addition, 18 of the field samples (including all subsurface samples) were analyzed for VOCs. Four surface samples were analyzed for herbicides and four for pesticides. Qualifications placed on these results by routine data validation are summarized in Appendix B, Table B-2.

Volatiles: The RSDs for replicate analyses for the few VOCs detected at low levels (most less than 100 ug/kg) were on the order of 20—50%.

Surrogate recoveries were somewhat low (50—70%) for samples 0316-95-0044, -0045, and -0046 in request number 1173, and ethylene chloride was reported at 21 ug/kg in one QC blank associated with request number 1173. However, data validation indicated that the results associated with these samples, which were reanalyzed, could be accepted (see Table B-2).

Semivolatiles: Only two SVOCs were detected in replicate analyses: anthracene, which was J-qualified, and bis(2-ethylhexyl)phthalate, for which blank contamination was indicated. In both cases, the RSDs were less than 12%. RSDs for anthracene in field duplicate pairs ranged up to 100% in one pair where the J-flagged values were 3.3 mg/kg in 0316-95-0031 and 6.2 mg/kg in 0316-95-2013 (request number 563). Anthracene in samples from this request is, in any case, reported well below the SAL of 19 mg/kg, so the results are accepted as correctly indicating concentrations below levels of concern at this location. (However, anthracene is a COPC at PRS 16-021(c) because it was present at levels above 100 mg/kg in samples collected near the outfall.)

Bis(2-ethylhexyl) phthalate was reported at 4 600 mg/kg in 0316-95-0044 but undetected in its field duplicate 0316-95-2015, collected from the 12—18 in. depth interval at the outfall. It should also be noted that the semivolatile detection levels were very high for this pair, which contained greater than one weight percent levels of HE.

Di-n-butyl-phthalate was identified (J-flagged at 130 ug/kg) in one QC blank associated with request 1102, and bis(2-ethylhexyl)phthalate was reported at 560 ug/kg in a QC blank associated with request 1173. Data validators note additional phthalate contamination (see Table B-2). However, these low levels of possible laboratory contamination are inadequate to explain some very high observations obtained at samples near the PRS 16-021(c) outfall. These high observations are accepted as representing potential phthalate contamination in those areas, despite difficulties with their replication in one field duplicate pair (see above).

Some low surrogate recoveries (less than 40%) were reported for 0316-95-0037 (request number 563). However, there is nothing in nearby samples, including several closer to the outfall, to indicate that SVOC contamination is present below the former pond area at PRS 16-021(c), and the results for this sample are accepted.

High explosives: Many of the HE results were qualified "PM" (i.e., manual review of raw data recommended to determine if data are usable) by the routine data validators. A limited review was performed of four data packages. Most of the problems observed related to the extremely high levels of HE contamination in many of these samples. These required numerous dilutions and, in some cases, special sample preparation techniques, which complicated the interpretation of the high-pressure liquid chromatography (HPLC) chromatograms.

No replicate analyses were performed for HE. Results for the HE compounds detected at high levels in field duplicate pairs (TNT, HMX, RDX) were replicated with RSDs below 40% for these pairs, except for TNT at the outfall pair which was almost twice as high in 0316-95-0044 as in 0316-95-2015. More variability was also observed for some of the DNTs and ADNTs reported close to detection levels for these compounds. Dilution factors of at least 10, and as high as 5 000, were required for all of these samples.

No blank contamination was reported in HE runs.

Surrogate recoveries were sometimes affected by the high concentrations of TNT and RDX (especially in confirmation column results, where the surrogate elutes at almost the same time as RDX). In most cases, however, surrogate recoveries were well within standard limits for the primary runs.

Recovery of seven spiked analytes in the lab control samples (LCSs) was within control limits except as noted in Table B.

Quantitative results for bounding samples with little or no HE are considered valid. Samples with very high concentrations represent areas that will be the subject of further investigation and remediation. These latter results are entirely adequate for the generally qualitative purposes for which they are used in this report, and quantitatively acceptable provided that it is recognized that the very high concentrations of HE may lead to larger than average uncertainties.

5.0 SPECIFIC RESULTS, CONCLUSIONS, AND RECOMMENDATIONS

PRS 16-003(k) is recommended for voluntary corrective action (VCA) in conjunction with corrective measures study (CMS)/corrective measures implemenation (CMI) activities at PRS 16-021(c) (Table 5.0-1). PRS 16-021(c) is recommended for Phase II sampling and analysis to support the development of a CMS plan and CMS/ CMI.

TABLE 5.0-1

SUMMARY OF PRSs IN THIS RFI REPORT

SECTION	PRS ID	DESCRIPTION	COPCs	RECOMMENDATION
5.1	16-003(k)	HE sumps and drain lines	None detected - potential releases not fully characterized.	Voluntary corrective action
5.2	16-021(c)	TA-16-260 drainage	Barium, HE, anthracene, bis(2-ethylmethyl) phthalate	Phase II sampling, corrective measures study/ corrective measures implementation

5.1 PRS 16-003(k)

PRS 16-003(k) consists of 13 HE sumps, their drain lines, and concrete troughs associated with TA-16-260. No contaminants at levels greater than SALs were found in a limited number of core holes adjacent to a few of the sumps and troughs. These data suggest that contaminant levels do not present a current risk to human health and the environment. However, potential releases from this unit have not been fully characterized. Drain line and trough contamination is often localized near leak points and structural flaws, which are best observed during drain line and trough removal. It is anticipated that drain line, trough, and soil contamination may be located during removal of drain lines and concrete troughs at PRS 16-003(k). Thus, the PRS is recommended for VCA. This VCA will accompany CMI at TA-16-260.

5.1.1 History

PRS 16-003(k) is discussed in the RFI Work Plan for OU 1082, Subsection 5.3 (LANL 1993, 1094). TA-16-260 is an HE machining facility, which was constructed in 1951 and continues as an active HE facility. Machine turnings are routed to the sumps as waste. Sumps collect HE wastewater generated during HE machining, then HE particulates are captured in the sumps, which are cleaned periodically. Historically the sumps have discharged to drain lines that discharge into a concrete trough that discharges at an outfall [PRS 16-021(c)]. Currently the sumps are still active, but the drain lines and troughs are currently scheduled to be removed from service during fall 1996. In 1994 roughly 2.5 million gal. of HE wastewater were discharged at TA-16-260 under National Pollution Discharge Elimination System (NPDES) Permit EPA 05A056 (No author 1994, 15-16-629).

In 1966, the 10-ft-wide loading dock on the rear (northeast) of TA-16-260 was removed. All new sumps with water-tight aluminum liners were installed adjacent to the northeast wall of TA-16-260. HE-contaminated soil under the old sumps was removed and replaced with clean, compacted soil.

The discharge points to the HE sumps are currently scheduled to be plugged during fall 1996. The sumps will still receive wastewater; however, this material will be collected periodically with a vacuum truck rather than discharged to the outfall. The vacuum trucks will transport the wastewaters to the TA-16 Burning Ground where they will be treated at the HE-wastewater treatment facility and discharged at NPDES outfall EPA 05A055. Volumes of HE wastewater generated at TA-16-260 have decreased significantly due to waste minimization efforts, particularly the installation of recirculating vacuum pumps. The vitrified-clay pipes and troughs will be considered inactive. The NPDES Permit for the outfall will probably soon be deactivated.

Known and potential contaminants listed in the work plan included HE, inorganics particularly barium, SVOCs, VOCs, and uranium.

5.1.2 Description

PRS 16-003(k) is 13 concrete HE sumps, drain lines and troughs associated with TA-16-260. Sump dimensions are 90 in. long by 36 in. wide by 31 in. deep (1 each) and 176 in. long by 36 in. wide by 31 in. deep (12 each). The HE sumps are connected by vitrified-clay pipe to a 4-ft-deep concrete trough that parallels TA-16-260. This feeder trough discharges into a second concrete trough oriented northeast-southwest that discharges into outfall and drainage PRS 16-021(c). The area surrounding the sumps is a level parking lot, the concrete trough is situated in a fairly level woodland characterized by ponderosa pines.

5.1.3 Previous Investigations

A limited number of analytical data for PRS 16-003(k) exist. In 1972, contaminants in TA-16-260 sump water ranged from 0–3.2 ppm HMX-RDX, 7–18 ppm TNT, and 70–1 587 ppm barium nitrate (Roybal 1972, 15-16-439) (Tables 5.1.3-1 and 5.1.3-2). As part of an NPDES permit application, sump waters from TA-16-260 were analyzed for TNT, yielding values ranging from <0.4–78 ppm (LASL 1977, 15-16-426). A site worker sampled water in the HE sumps in 1988. Water samples from the sumps were analyzed for three HE (HMX, RDX, and TNT) and four VOCs (acetone, methyl ethyl ketone, n-butyl acetate, and toluene). Analytes detected are summarized in Tables 5.1.3-3 and 5.1.3-4. Both HE (HMX, TNT, and RDX) and VOCs (toluene) were present at levels greater than water SALs. EQLS and QA results were not reported for any of these analyses.

TABLE 5.1.3-1

PRS 16-003(k) WATER CONCENTRATIONS FOR HIGH EXPLOSIVES[a]

SAMPLE ID	HE	RESULT (µg/L)	SAL (µg/L)
7/7/72	HMX/RDX	3 200	1 800/0.061[b]
7/14/72	HMX/RDX	3 000	1 800/0.061
7/21/72	HMX/RDX	2 600	1 800/0.061
7/28/72	HMX/RDX	2 100	1 800/0.061
8/4/72	HMX/RDX	2 500	1 800/0.061
8/11/72	HMX/RDX	2 000	1 800/0.061
6/30/72	TNT	13 000	2.2
7/7/72	TNT	10 000	2.2
7/14/72	TNT	10 000	2.2
7/21/72	TNT	18 000	2.2
7/28/72	TNT	13 000	2.2
8/4/72	TNT	8 000	2.2
8/11/72	TNT	7 000	2.2

[a] Roybal, 1972, 15-16-439.

[b] Where two values are shown, these are the SALs for the two constituents listed in the HE column. The analytical method did not differentiate between these two constituents.

TABLE 5.1.3-2

PRS 16-003(k) WATER CONCENTRATIONS FOR BARIUM NITRATE[a]

SAMPLE ID	MEDIA	BARIUM NITRATE (µg/L)
SAL	N/A[b]	1 000[c]
LANL UTL	NA	NA
6/30/72	WATER	1 587 000
7/7/72	WATER	167 000
7/14/72	WATER	196 000
7/21/72	WATER	520 000
7/28/72	WATER	228 000
8/4/72	WATER	371 000
8/11/72	WATER	70 000

[a] Roybal, 1972, 15-16-439.

[b] N/A = Not applicable.

[c] SAL is for total barium in water.

[d] NA = Not available.

TABLE 5.1.3-3

PRS 16-003(k) WATER CONCENTRATION FOR HIGH EXPLOSIVES[a]

SAMPLE ID	HE	RESULT (μg/L)	SAL (μg/L)
1	HMX	1 290	1 800
2	HMX	2 060	1 800
3	HMX	1 960	1 800
4	HMX	1 920	1 800
5	HMX	1 530	1 800
6	HMX	2 700	1 800
7	HMX	1 470	1 800
8	HMX	1 530	1 800
9	HMX	1 610	1 800
10	HMX	2 470	1 800
1	RDX	2 250	0.061
3	RDX	30	0.061
4	RDX	20	0.061
6	RDX	34	0.061
8	RDX	40	0.061
9	RDX	30	0.061
10	RDX	1 190	0.061
1	TNT	60	2.2
4	TNT	20	2.2
6	TNT	40	2.2
9	TNT	10	2.2
10	TNT	190	2.2

[a] Baytos 1988, 15-16-266.

TABLE 5.1.3-2

PRS 16-003(k) WATER CONCENTRATION FOR VOLATILE ORGANIC COMPOUNDS[a]

SAMPLE ID	VOC	RESULT (µg/L)	SAL (µg/L)
6	Acetone	300	610
8	Acetone	100	610
9	Acetone	200	610
10	Acetone	100	610
7	Toluene	7 700	1 000
8	Toluene	100	1 000

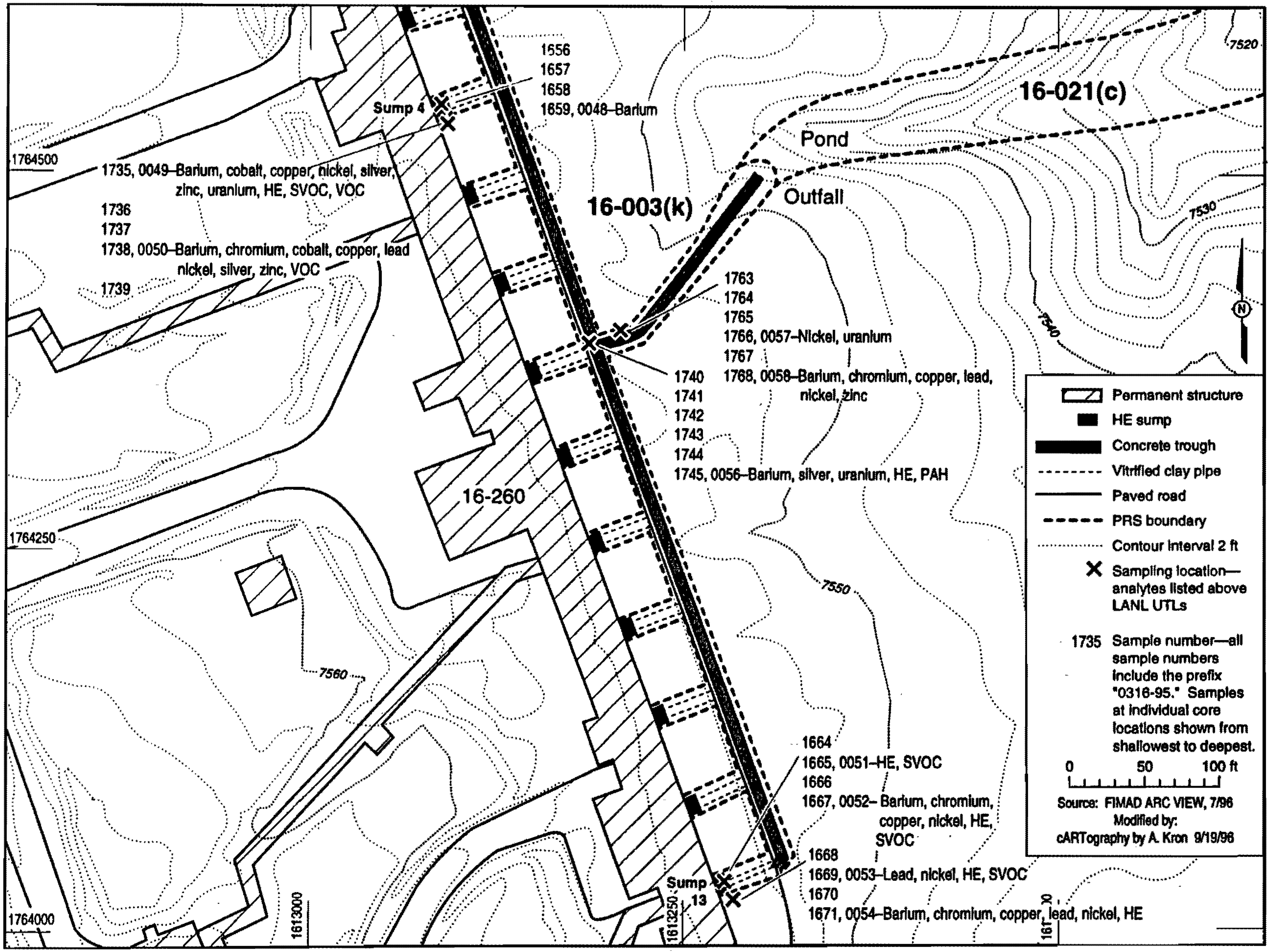
a Baytos 1988, 15-16-266.

5.1.4 Field Investigation

Boreholes were drilled at six locations, two each at the northeast and southeast corners of sumps 4 and 13 and two biased to zones of extensive cracking under the troughs (Fig. 5.1.4-1). Sumps 4 and 13 were identified by the operating group as the two sumps that had received the most HE waste over the past two decades (Hyde 1995, 15-16-584). Drilling was difficult at this PRS and core recovery was poor. In some core holes only a single laboratory sample was taken due to poor recovery. This lack of recovery did not affect the ultimate decision to VCA this PRS. A hollow-stem auger was used to a depth of 2–3 feet, then a coring method using a specially designed carbide tip cutting shoe and split spoon was used to drill to the final depth. Cores were screened on 12-in. intervals, rather than the 6-in. intervals prescribed in the work plan because the 6-in. intervals did not provide enough material for an analytical sample.

Twenty-two subsurface screening samples were taken and analyzed by HE spot test, PID for VOCs, and hand-held Sodium Iodide detector for radionuclides. Screening results above background are reported in Table 5.1.4-1.

The other screening results did not detect constituents or were at or below background. The shallowest and deepest positive screening intervals in any borehole were submitted for laboratory analysis. In some cores, only a single positive interval was found.



Source: FIMAD ARC VIEW, 7/96
Modified by:
cARTography by A. Kron 9/19/96

Fig. 5.1.4-1. PRS 16-003(k), HE sumps and drainlines at TA-16-260.

TABLE 5.1.4-1

FIELD SCREENING RESULTS FOR PRS 16-003(k)

SAMPLE ID	LOCATION ID	SCREENING METHOD/RESULT
0316-95-1656	16-1361	PID: 13 ppm
0316-95-1665	16-1365	PID/ 5 ppm; HE spot test/ positive
0316-95-1667	16-1365	HE spot test/ positive
0316-95-1671	16-1646	HE spot test/ positive
0316-95-1735	16-1645	HE spot test/ positive
0316-95-1738	16-1645	HE spot test/ positive
0316-95-1740	16-1356	PID/ 1 ppm
0316-95-1741	16-1356	PID/ 1 ppm
0316-95-1742	16-1356	PID/ 2 ppm
0316-95-1743	16-1356	PID/ 2 ppm
0316-95-1744	16-1356	PID/ 2 ppm
0316-95-1763	16-1357	PID/ 30 ppm
0316-95-1764	16-1357	PID/ 30 ppm
0316-95-1765	16-1357	PID/ 30 ppm
0316-95-1766	16-1357	PID/ 110 ppm
0316-95-1767	16-1357	PID/ 110 ppm
0316-95-1768	16-1357	PID/ 1 ppm

Ten subsurface laboratory samples were collected for this PRS (Table 5.1.4.2). The work plan and its NOD called for angled drilling a single borehole beneath five sumps and at five locations beneath the drainage troughs. Because of budgetary constraints, only two sumps and only two locations beneath the troughs were drilled. In addition, rather than angled drilling beneath the sumps, two vertical boreholes were drilled at each sump. Vertical boreholes were drilled because the operating group would not agree to angled drilling at PRS 16-003(k). Wet drilling is required at potentially HE-contaminated locations and angled holes are difficult to drill wet. There are potential explosive safety hazards associated with drilling dry core holes at potentially HE-contaminated locations. These deviations from the RFI work plan and its NOD were discussed with EPA representatives and communicated to EPA in a letter dated May 24, 1996 (Jansen and Taylor 1995, 15-16-627).

TABLE 5.1.4-2

SUMMARY OF LABORATORY SAMPLES TAKEN AND REQUEST NUMBERS FOR PRS 16-003(k)

LOCATION ID	SAMPLE ID	DEPTH (ft)	MATRIX	VOCs	SVOCs	HE	INORGs	URANIUM
16-1361	0316-95-0048	3–4	Soil	1102	1102	1102	1106	1108
16-1645	0316-95-0049	0–1	Soil	1203	1203	1203	1204	1205
16-1645	0316-95-0050	3.5–4.5	Soil	1203	1203	1203	1204	1205
16-1365	0316-95-0051	1–2	Soil	1102	1102	1102	1106	1108
16-1365	0316-95-0052	2.5–3.5	Soil	1102	1102	1102	1106	1108
16-1646	0316-95-0053	1.5–2.3	Soil	1102	1102	1102	1106	1108
16-1646	0316-95-0054	3.7–4.25	Soil	1102	1102	1102	1106	1108
16-1356	0316-95-0056	5–6	Soil	1222	1222	1222	1223	1224
16-1357	0316-95-0057	3–4.5	Soil	1222	1222	1222	1223	1224
16-1357	0316-95-0058	5–6	Soil	1222	1222	1222	1223	1224

5.1.5 Background Comparison

Barium, chromium, cobalt, copper, lead, nickel, silver, uranium, and zinc were found above background UTLs but below SALs (Table 5.1.5-1). Barium and lead in samples 0316-95-0056, 0316-95-0057, and 0316-95-0058 (RN 1123) had poor duplicate recoveries. Cobalt, copper, nickel, and zinc in samples 0316-95-0049 and 0316-95-0050 (RN 1204) similarly had poor duplicate recoveries. These data should be considered estimated, but the values are far enough below SALs that the decisions, based on these data, and described below are valid.

TABLE 5.1.5-1

INORGANIC ANALYTES AND URANIUM WITH CONCENTRATIONS GREATER THAN BACKGROUND UTLs FOR PRS 16-003(k)[a]

SAMPLE ID	DEPTH (ft)	SOIL/ ROCK UNIT	BARIUM (mg/kg)	CHROMIUM (mg/kg)	COBALT (mg/kg)	COPPER (mg/kg)	LEAD (mg/kg)	NICKEL (mg/kg)	SILVER (mg/kg)	TOTAL URANIUM (mg/kg)	ZINC (mg/kg)
LANL UTL (all soil)	N/A	N/A[b]	315	19.3	19.2	30.7	23.3	12.2	N/A	1.87	50.8
LANL UTL (Qbt4)	N/A	N/A	42	5.4	25	1.6	4	<2	<1	2.93	47
SAL	N/A	N/A	5 300	210	4 600	2 800	400	1 530	380	29	23 000
0316-95-0048	3.0–4.0	Soil	2 030	10.1	3.8	6.1	10.2	7.9	0.59(U)[c]	1.73	21.7
0316-95-0049	0–1	Soil	805	17	34.6(P)[d]	317(P)	8.5(J+)	70.4 (J+[e]P)	0.63	2.07	200 (J+P)
0316-95-0050	3.5–4.5	Qbt4	352	116	38.5(P)	228(P)	6.5(J+)	103 (J+P)	3.7	1.42	155 (J+P)
0316-95-0052	2.5–3.5	Qbt4	318	6.5	1.1(U)	2.3	3.4	3.2(U)	0.56(U)	1.76	20.4
0316-95-0053	1.3–2.3	Qbt4	24.4	5.5	1(U)	1.6	316	2.7	0.52(U)	2.89	32.1
0316-95-0054	3.67–4.25	Qbt4	311	30	2	6	6.1	6.1	0.6(U)	1.67	27.8
0316-95-0056	5.0–6.0	Soil	557 (J-[f]P)	10.7	3.5	6.7	17.2(P)	8.8	1.7	2.77	37.1
0316-95-0057	3–4.5	Soil	79.1 (J-P)	15.2	6.3	21.7	13.4(P)	15.4	0.61(U)	2.27	49
0316-95-0058	5.0–6.0	Qbt4	125 (J-P)	17.6	8	67.2	11.4(P)	23.7	0.59(U)	2.61	79.7

[a] Analytes greater than UTLs are enclosed in double lines.

[b] Not available.

[c] U = Analyte positively identified in the samples and the associated value is the sample-specific EQL/EDL.

[d] P = Professional judgment should be applied to using this data in decision making.

[e] J+ = The analyte was positively identified and the result is likely to be biased high.

[f] J- = The analyte was positively identified and the result is likely to be biased low.

5.1.6 Evaluation of Organics

HE, SVOCs, and the organic analyte methylene chloride were reported for this PRS (Tables 5.1.6-1, 5.1.6-2, and 5.1.6-3). None of these analytes were present at levels above SALs. Data for several undetected SVOC compounds in sample 031-95-0051 were rejected. These compounds were not detected in the two other samples from the same borehole, so it is unlikely that they were present at high levels in this sample.

TABLE 5.1.6-1

PRS 16-003(k) SOIL CONCENTRATIONS FOR HIGH EXPLOSIVES WITH VALUES GREATER THAN THE REPORTING LIMIT[a]

SAMPLE ID	DEPTH (ft)	4-ADNT (mg/kg)	HMX (mg/kg)	1,3,5-Trinitrobenzene (mg/kg)	2,4,6-Trinitrotoluene (mg/kg)
SAL	N/A[b]	NC[c]	3 300	3.3	15
EQL	N/A	ND[d]	2.2	0.25	0.25
0316-95-0049	0–1	0.092 (U)[e]	0.228	0.085 (U)	0.09 (U)
0316-95-0051	1–2	0.142	0.165 (U)	0.084 (U)	0.225
0316-95-0052	2.5–3.5	0.147	2.3	0.272	0.911
0316-95-0053	1.5–2.3	0.09 (U)	0.304	0.084 (U)	0.089 (U)
0316-95-0054	3.7–4.25	0.091 (U)	3.84	0.085 (U)	0.09 (U)
0316-95-0056	5–6	0.095 (U)	1.15	0.088 (U)	0.093 (U)

[a] Analytes greater than EQLs enclosed in double lines.
[b] N/A = Not applicable.
[c] NC = Not calculated.
[d] ND = Not determined.
[e] U = The analyte was not positively identified in the sample and the associated valued is the sample-specific EQL/EDL.

TABLE 5.1.6-2

PRS 16-003(k) SOIL CONCENTRATIONS FOR SEMIVOLATILE ORGANIC ANALYTES WITH VALUES GREATER THAN THE REPORTING LIMIT[a]

SAMPLE ID	DEPTH (ft)	BENZOIC ACID (mg/kg)	DIETHYLPHTHALATE (mg/kg)	FLUORANTHENE (mg/kg)	2-METHYLNAPHTHALENE (mg/kg)	PYRENE (mg/kg)
SAL	N/A[b]	100 000	52 000	2 600	NC[c]	2 000
EQL	N/A	3.3	0.33	0.33	0.33	0.33
0316-95-0049	0–1	3.8 (U)[d]	0.08 (J)[e]	0.38 (U)	0.38 (U)	0.38 (U)
0316-95-0051	1–2	7.4 (U)	0.74 (U)	0.74 (U)	0.26 (J)	0.74 (U)
0316-95-0052	2.5–3.5	3.7 (U)	0.48	0.37 (U)	0.37 (U)	0.37 (U)
0316-95-0053	1.5–2.3	0.056 (J)	0.35 (U)	0.35 (U)	0.35 (U)	0.35 (U)
0316-95-0056	5–6	3.8 (U)	0.099 (J)	0.046 (J)	0.38 (U)	0.04 (J)

[a] Analytes greater than EQLs enclosed in double lines.

[b] N/A = Not applicable.

[c] NC = Not calculated.

[d] U = The analyte was not positively identified in the sample and the associated valued is the sample specific EQL/EDL.

[e] J = The analyte was positively identified and the associated numerical value is more uncertain than would normally be expected for that analyte.

TABLE 5.1.6-3

PRS 16-003(k) SOIL CONCENTRATIONS FOR VOLATILE ORGANIC ANALYTES WITH VALUES GREATER THAN THE REPORTING LIMIT

SAMPLE ID	DEPTH (ft)	METHYLENE CHLORIDE (mg/kg)
SAL	N/A[a]	11
EQL	N/A	0.05
0316-95-0049	0–1	0.003 (J)[b]
0316-95-0050	3.5–4.5	0.004 (J)

[a] N/A = Not applicable.

[b] J = The analyte was positively identified and the associated numerical value is more uncertain than would normally be expected for that analyte.

5.1.7 Human Health

5.1.7.1 Screening Assessment

No constituents were detected at levels greater than SALs at PRS 16-003(k). No COPCs were identified during this portion of the screening assessment.

Noncarcinogenic contaminants greater than LANL background UTLs were submitted for an MCE for noncarcinogenic effects. Lead is excluded from this grouping because its toxicity is based on the uptake of lead in children as modeled by EPA's Integrated Exposure Uptake Biokinetic (IUBEK) Model (EPA 119, 1178). The sum of the maxima for the noncarcinogenic group is 0.66, which is well below the target value of 1. This indicates a low potential for adverse effects due to exposure to this grouping (Table 5.1.7-1).

TABLE 5.1.7-1

MCE FOR NONCARCINOGENIC EFFECTS AT PRS 16-003(k)

CONTAMINANT	MAXIMUM SOIL CONCENTRATION (mg/kg)	SOIL SAL (mg/kg)	CONCENTRATION NORMALIZED TO SAL
Barium	2 030	5 300	0.38
Cobalt	38.5	4 600	0.008
Copper	317	2 800	0.11
Nickel	103	1 500	0.069
Silver	3.7	383	0.009
Zinc	200	23 000	0.008
HMX	3.84	3 300	0.001
TNB	0.272	3.3	0.08
Benzoic acid	0.056	100 000	0.0000006
Diethylphthalate	0.48	52 000	0.000009
Fluoranthene	0.046	2 600	0.00002
Pyrene	0.04	2 000	0.00002
Total			0.66

Carcinogenic contaminants greater than LANL background UTLs were submitted for an MCE for carcinogenic effects. The sum of the maxima for the carcinogenic group is 0.61, which is below the target value of 1. This result indicates a low potential for adverse effects due to exposure to carcinogens (Table 5.1.7-2).

TABLE 5.1.7-2

MCE FOR CARCINOGENIC EFFECTS AT PRS 16-003(k)

CONTAMINANT	MAXIMUM SOIL CONCENTRATION (mg/kg)	SOIL SAL (mg/kg)	CONCENTRATION NORMALIZED TO SAL
Chromium	116	210	0.55
TNT	0.911	15	0.06
Methylene chloride	0.004	11	0.004
Total			0.61

Only a single radionuclide, uranium, was found at PRS 16-003(k), so no MCE was performed for this constituent.

5.1.7.2 Risk Assessment

No risk assessment was performed at this PRS.

5.1.8 Preliminary Ecological Assessment

In accordance with conversations between LANL ER Project personnel, DOE/Los Alamos Area Office (LAAO), and the regulators, discussion of ecological risk assessment methodology will be deferred until the Ecological Exposure Unit (Ecozone) methodology that is being developed by LANL in conjunction with EPA Region 6 and the NMED has been approved by the regulators.

5.1.9 Extent of Contamination

Although inorganic constituents were identified above UTL values at this PRS, and organic constituents were measured above EQL values, no risk-based COPCs were identified in Subsection 5.1.7.1 above. As described in Subsection 5.1.4, the sampling activities were biased toward areas where residual contamination was expected (highly used sumps and leak points in the troughs).

Although the extent of contamination cannot be defined with certainty based on the data for these sampling locations, additional sampling for this PRS is not proposed at this time. Rather, full characterization of the extent of contamination at this PRS will be performed during the VCA activities that are described below.

5.1.10 Conclusions and Recommendations

PRS 16-003(k) is recommended for VCA associated with CMS/CMI at PRS 16-021(c) (see Subsection 5.2). No large-scale release of constituents to the environment has occurred at PRS 16-003(k) at four locations, two sumps, and two drain line leak points, identified as high probability locations for such a release. No constituents were found above SALs and MCE calculations indicate low probability of impact to receptors due to multiple constituent effects. Full characterization of potential releases within this unit has not occurred because characterization of active sumps, drain lines, and troughs is logistically difficult. The vitrified-clay pipe and troughs can now be characterized because they are currently scheduled to be abandoned as active units during fall 1996. The most cost-effective time to complete such characterization is during VCA accompanying CMI at PRS 16-021(c), when heavy equipment will be deployed. LANL proposes that: 1) the drain lines and troughs be removed as a VCA, 2) soil beneath these structures be further characterized at that time, 3) if characterization data indicate that constituents are present at levels that represent a risk to human health and the environment, the soils be removed and treated concurrently with soils undergoing remediation at PRS 16-021(c), and 4) characterization adequate to support NFA beneath the active sumps occur at that time. Such characterization beneath the sumps will be accomplished using heavy equipment. Characterization via angled drilling is not allowed at TA-16 and characterization using vertical boreholes is not fully effective. A VCA plan describing these activities in detail will be provided along with the CMS report.

5.2 PRS 16-021(c)

PRS 16-021(c) is the outfall area for HE machining building TA-16-260. The outfall receives HE wastewater discharge from the 13 HE sumps that constitute PRS 16-003(k), described in Subsection 5.1 of this report. The outfall is currently active, but is currently scheduled to be deactivated during fall 1996. The outfall is permitted as EPA 05A056. Because the extent of HE contamination is not defined with certainty, the PRS is recommended for Phase II sampling to support the CMS/CMI process. The level of contamination and the presence of HE constituents in surface waters and groundwater, suggest that the CMS/CMI process is appropriate for PRS 16-021(c).

5.2.1 History

PRS 16-021(c) is discussed in work plan, Subsection 5.2 (LANL 1993, 1094). PRS 16-021(c) has received HE wastewater since construction of TA-16-260 in 1951. As described in Subsection 5.1, TA-16-260 is an industrial-scale HE machining building. HE in the drainage area have been recognized as being at potentially dangerous levels since at least 1960 when the first known soil samples from the outfall were analyzed for HE. Known contaminants prior to RFI investigations included barium, RDX, TNT, and HMX. Suspected contaminants were other HE constituents, additional inorganics, VOCs, SVOCs, and uranium.

5.2.2 Description

PRS 16-021(c) is the outfall associated with the 13 HE sumps on the northeast side of TA-16-260. The drainage channel from the outfall flows approximately 600 ft to the bottom of Cañon de Valle over a drop in elevation of 80 ft. The drainage channel from the outfall is well defined, with apparent high-water marks. The water flows over a 15-ft-high cliff approximately 500 ft from the outfall. A small pond approximately 55-ft long was formed by a rock dam located 93 ft from the outfall. HE-contaminated water from the outfall enters the former pond about 40 ft from the outfall. The longitudinal axis of the former pond is oriented east-west with flow in the easterly direction. The dam is about 9-ft thick, but only the first 2 ft of rock are closely packed. At present, there is no water in the former pond, although the soil and sediment are wet sporadically. Rainwater from the roadway on the northeast side of TA-16-260 flowed into the former pond prior to installation of hay bales, sandbags, and diversionary piping as an interim action.

Stressed vegetation is evident within the PRS boundaries between the rock dam and the cliff. Most trees in this area have died. One or two dead trees, possibly associated with TA-16-260 discharge, are present within Cañon de Valle downstream from PRS 16-021(c).

A series of best management practices (BMPs) were instituted at PRS 16-021(c) during FY95 and FY96 as an interim action. These BMPs were implemented when a significant amount of inorganic and HE contamination became evident in nearby springs and surface waters (see Appendix C and Subsection 2.3). The BMPs consist of four engineered controls: 1) a sandbag dam and diversion pipe upgradient from the former HE pond; 2) a sandbag dam located east of the parking lot behind TA-16-260; 3) the application of geotextile fabric matting in the former HE pond area; and 4) eight hay-bale check dams within the PRS drainage between the rock dam and the 15-ft high cliff. The rationale for these BMPs is to minimize infiltration, run-on, and runoff from the contaminated area, thereby decreasing contaminant migration to surface water and groundwaters. These BMPs are inspected regularly (at least quarterly) and will be maintained and upgraded to ensure that run-on and run-off from this site are minimized.

5.2.3 Previous Investigations

Existing data for the TA-16-260 outfall, PRS 16-021(c) collected prior to RFI sampling are extensive and show widespread HE contamination extending from the discharge point to Cañon de Valle (Table 5.2.3-1) (i.e. Baytos 1970, 15-16-278; Turner and Schwartz 1971, 15-16-284; King 1991, 15-16-381; and King 1992, 15-16-380). Values range up to four orders of magnitude greater than SALs for RDX.

Baytos analyzed sediment samples taken from the channel during the period 1970 through 1985 (Table 5.2.3-1). His studies extended several hundred feet from the outfall. The highest concentrations of HMX-RDX and TNT were found in the former pond. Concentrations of total HE in the former pond have remained uniformly high, from a low of 10.8 wt % in 1971 to 27.0 wt % in 1976 (Baytos 1971, 15-16-277; and Baytos 1976, 15-16-271). Baytos cited an unpublished report from 1960 in which the total HE concentration was 9.8 wt % (Baytos 1972, 15-16-275). In 1991, Barr and King found concentrations as high as 34.1 wt % in the former pond (King 1991, 15-16-381; King 1992, 15-16-380). Barr and King also found that HE concentrations were high (4.4 wt %) for a distance of over 200 ft down the drainage. In dry soil, such high concentrations could be considered explosive mixtures under certain conditions (Urizar 1984, 15-16-353).

Baytos' distances from the outfall are approximate (i.e., within 10 ft). Distances that the samples were taken from the centerline of the former pond were not always recorded. Therefore, there may be some inconsistencies in the data.

TABLE 5.2.3-1

HIGH EXPLOSIVES IN THE TA-16-260 DRAINAGE CHANNEL BASED ON EXISTING DATA

SAMPLE ID	HIGH EXPLOSIVE	RESULT (mg/kg)	SAL (mg/kg)	EQL
4/29/70 Outfall	HMX/RDX[a]	70 000	3 300/4[b]	NA[c]
4/29/70 Pond center	HMX/RDX	205 000	3 300/4	NA
4/29/70 1 ft below dam	HMX/RDX	48 000	3 300/4	NA
4/29/70 Between dam and cliff	HMX/RDX	129 000	3 300/4	NA
4/29/70 Cliff	HMX/RDX	39 000	3 300/4	NA
11/18/70 10 ft from outfall	HMX/RDX	32 000	3 300/4	NA
11/18/70 Inlet to pond	HMX/RDX	141 000	3 300/4	NA
11/18/70 10 ft above dam	HMX/RDX	221 000	3 300/4	NA
11/18/70 5 ft below dam	HMX/RDX	145 000	3 300/4	NA
11/5/71 10 ft from outfall	HMX/RDX	29 000	3 300/4	NA
11/5/71 Pond inlet	HMX/RDX	108 000	3 300/4	NA
11/5/71 10 ft above dam	HMX/RDX	257 000	3 300/4	NA
11/5/71 10 ft below dam	HMX/RDX	225 000	3 300/4	NA
8/22/73 10 ft from outfall	HMX/RDX	13 000	3 300/4	NA
11/14/74 Outfall	HMX/RDX	17 000	3 300/4	NA
11/14/74 1 ft above dam	HMX/RDX	171 000	3 300/4	NA
11/14/74 50 ft below dam	HMX/RDX	137 000	3 300/4	NA
12/5/75 10 ft from outfall	HMX/RDX	2 000	3 300/4	NA
12/5/75 1 ft above dam	HMX/RDX	92 000	3 300/4	NA
11/19/76 10 ft from outfall	HMX/RDX	2 000	3 300/4	NA
11/19/76 50 ft from outfall	HMX/RDX	30 000	3 300/4	NA
11/19/76 65 ft from outfall	HMX/RDX	267 000	3 300/4	NA
11/19/76 250 ft from outfall	HMX/RDX	173 000	3 300/4	NA
7/18/84 3 ft from outfall	HMX/RDX	3 000	3 300/4	NA
7/18/84 30 ft from outfall	HMX/RDX	104 000	3 300/4	NA
7/18/84 50 ft from outfall	HMX/RDX	167 000	3 300/4	NA
9/12/85 30 ft from outfall	HMX/RDX	20 000	3 300/4	NA
9/12/85 110 ft from outfall	HMX/RDX	266 000	3 300/4	NA
9/12/85 230 ft from outfall	HMX/RDX	17 000	3 300/4	NA
7/21/91 1 ft from outfall	HMX	26 400	3 300	NA
7/21/91 20 ft from outfall	HMX	4 000	3 300	NA
7/21/91 40 ft from outfall	HMX	1 000	3 300	NA
7/21/91 45 ft from outfall	HMX	29 400	3 300	NA
7/21/91 50 ft from outfall - center pool	HMX	43 800	3 300	NA
7/21/91 60 ft from outfall - center pool	HMX	40 000	3 300	NA

TABLE 5.2.3-1 (CONTINUED)

HIGH EXPLOSIVES IN THE TA-16-260 DRAINAGE CHANNEL BASED ON EXISTING DATA

SAMPLE ID	HIGH EXPLOSIVE	RESULT (mg/kg)	SAL (mg/kg)	EQL
7/21/91 70 ft from outfall	HMX	39 000	3 300	NA
7/21/91 80 ft from outfall	HMX	97 000	3 300	NA
7/21/91 90 ft from outfall	HMX	13 250	3 300	NA
7/21/91 110 ft from outfall	HMX	62 000	3 300	NA
7/21/91 60 ft from outfall, north edge of pond	HMX	5 000	3 300	NA
7/21/91 70 ft from outfall, north edge of pond	HMX	90 000	3 300	NA
7/21/91 90 ft from outfall, north edge of pond	HMX	23 000	3 300	NA
11/15/91 90 ft from outfall, 12 in. from north edge	HMX	56 300	3 300	NA
11/15/91 91 ft from outfall	HMX	29 100	3 300	NA
11/15/91 91 ft from outfall, 2 in. deep	HMX	66 800	3 300	NA
11/15/91 91 ft from outfall, 8 in. deep	HMX	54 100	3 300	NA
11/15/91 91 ft from outfall, 13 in. deep	HMX	96 000	3 300	NA
11/15/91 91 ft from outfall, 8 in. from edge 13 in. deep	HMX	92 400	3 300	NA
11/15/91 91 ft from outfall 12 in. from edge 13 in. deep	HMX	106 300	3 300	NA
11/15/91 135 ft from outfall	HMX	20 900	3 300	NA
11/15/91 210 ft from outfall	HMX	37 300	3 300	NA
3/11/60 Pond center	RDX	85 000	4	NA
3/11/60 Pond center	RDX	35 000	4	NA
3/11/60 20 ft below dam	RDX	43 000	4	NA
3/11/60 30 ft below dam	RDX	33 000	4	NA
3/11/60 100 ft below dam	RDX	27 000	4	NA
3/11/60 150 ft below dam	RDX	5000	4	NA
7/21/91 1 ft from outfall	RDX	8 000	4	100[d]
7/21/91 20 ft from outfall	RDX	14 000	4	100
7/21/91 40 ft from outfall	RDX	100	4	100
7/21/91 45 ft from outfall	RDX	< 100	4	100
7/21/91 50 ft from outfall, center pool	RDX	5 000	4	100
7/21/91 60 ft from outfall, center pool	RDX	24 000	4	100
7/21/91 70 ft from outfall	RDX	51 800	4	100
7/21/91 80 ft from outfall	RDX	126 000	4	100
7/21/91 90 ft from outfall	RDX	134 700	4	100
7/21/91 110 ft from outfall	RDX	14 000	4	100
7/21/91 60 ft from outfall, north edge of pond	RDX	400	4	100

TABLE 5.2.3-1 (CONTINUED)

HIGH EXPLOSIVES IN THE TA-16-260 DRAINAGE CHANNEL BASED ON EXISTING DATA

SAMPLE ID	HIGH EXPLOSIVE	RESULT (mg/kg)	SAL (mg/kg)	EQL
7/21/91 70 ft from outfall, north edge of pond	RDX	100 000	4	100
7/21/91 90 ft from outfall, north edge of pond	RDX	340 000	4	100
11/15/91 90 ft from outfall, 12 in. from north edge	RDX	19 700	4	100
11/15/91 91 ft from outfall	RDX	700	4	100
11/15/91 91 ft from outfall, 2 in. deep	RDX	9 600	4	100
11/15/91 91 ft from outfall, 8 in. deep	RDX	7 100	4	100
11/15/91 91 ft from outfall, 13 in. deep	RDX	38 900	4	100
11/15/91 91 ft from outfall, 8 in. from edge, 13 in. deep	RDX	155 200	4	100
11/15/91 91 ft from outfall, 12 in. from edge, 13 in. deep	RDX	171 800	4	100
11/15/91 135 ft from outfall	RDX	1 900	4	100
11/15/91 210 ft from outfall	RDX	6 300	4	100
3/11/60 Pond center	TNT	13 000	15	NA
3/11/60 Pond center	TNT	13 000	15	NA
3/11/60 20 ft below dam	TNT	17 000	15	NA
3/11/60 30 ft below dam	TNT	7 000	15	NA
3/11/60 100 ft below dam	TNT	400	15	NA
3/11/60 150 ft below dam	TNT	200	15	NA
4/29/70 Outfall	TNT	0	15	NA
4/29/70 Pond center	TNT	37 000	15	NA
4/29/70 1 ft below dam	TNT	700	15	NA
4/29/70 Between dam and cliff	TNT	1 200	15	NA
4/29/70 Cliff	TNT	1 000	15	NA
11/18/70 10 ft from outfall	TNT	0	15	NA
11/18/70 Inlet to pond	TNT	1 000	15	NA
11/18/70 10 ft above dam	TNT	5 000	15	NA
11/18/70 5 ft below dam	TNT	2 000	15	NA
11/5/71 10 ft from outfall	TNT	0	15	NA
11/5/71 Pond inlet	TNT	0	15	NA
11/5/71 10 ft above dam	TNT	0	15	NA
11/5/71 10 ft below dam	TNT	0	15	NA
8/22/73 10 ft from outfall	TNT	0	15	NA
11/14/74 Outfall	TNT	0	15	NA
11/14/74 1 ft above dam	TNT	1 000	15	NA
11/14/74 50 ft below dam	TNT	2 000	15	NA

TABLE 5.2.3-1 (CONTINUED)

HIGH EXPLOSIVES IN THE TA-16-260 DRAINAGE CHANNEL BASED ON EXISTING DATA

SAMPLE ID	HIGH EXPLOSIVE	RESULT (mg/kg)	SAL (mg/kg)	EQL
12/5/75 10 ft from outfall	TNT	0	15	NA
12/5/75 1 ft above dam	TNT	0	15	NA
11/19/76 10 ft from outfall	TNT	0	15	NA
11/19/76 50 ft from outfall	TNT	1 000	15	NA
11/19/76 65 ft from outfall	TNT	3 000	15	NA
11/19/76 250 ft from outfall	TNT	3 000	15	NA
7/18/84 3 ft from outfall	TNT	0	15	NA
7/18/84 30 ft from outfall	TNT	9 000	15	NA
7/18/84 50 ft from outfall	TNT	23 000	15	NA
9/12/85 30 ft from outfall	TNT	1 000	15	NA
9/12/85 110 ft from outfall	TNT	48 000	15	NA
9/12/85 230 ft from outfall	TNT	1 000	15	NA
7/21/91 1 ft from outfall	TNT	700	15	100
7/21/91 20 ft from outfall	TNT	10 000	15	100
7/21/91 40 ft from outfall	TNT	< 100	15	100
7/21/91 45 ft from outfall	TNT	< 100	15	100
7/21/91 50 ft from outfall, center pool	TNT	< 100	15	100
7/21/91 60 ft from outfall, center pool	TNT	< 100	15	100
7/21/91 70 ft from outfall	TNT	6 000	15	100
7/21/91 80 ft from outfall	TNT	30 000	15	100
7/21/91 90 ft from outfall	TNT	20 000	15	100
7/21/91 110 ft from outfall	TNT	3 000	15	100
7/21/91 60 ft from outfall, north edge of pond	TNT	< 1 00	15	100
7/21/91 70 ft from outfall, north edge of pond	TNT	20 000	15	100
7/21/91 90 ft from outfall, north edge of pond	TNT	71 000	15	100
11/15/91 91 ft from outfall	TNT	300	15	100
11/15/91 91 ft from outfall, 2 in. deep	TNT	< 100	15	100
11/15/91 91 ft from outfall, 8 in. deep	TNT	2 200	15	100
11/15/91 91 ft from outfall, 13 in. deep	TNT	4 200	15	100
11/15/91 91 ft from outfall, 8 in. from edge, 13 in. deep	TNT	93 400	15	100
11/15/91 91 ft from outfall, 12 in. from edge, 13 in. deep	TNT	9 700	15	100
11/15/91 135 ft from outfall	TNT	300	15	100
11/15/91 210 ft from outfall	TNT	100	15	100

[a] Early HE determinations were by ultraviolet spectrophotometric methods that did not quantitatively distinguish RDX from HMX.
[b] SALs for HMX/RDX respectively.
[c] NA = Not available.
[d] Estimated from minimum reported values.

All samples are surface (0-6 in.) soil samples taken from drainage centerline unless otherwise indicated. Distances are approximate. Data are from Baytos (1970 to 1985, 15-16-278 to 15-16-268) and King (1991 15-16-381; 1992, 15-16-380).

5.2.4 Field Investigation

Surface laboratory samples were collected at 31 locations and subsurface samples were collected at 3 locations (Table 5.2.4-1 and Fig. 5.2.4-1). Three collocated/split duplicate samples were also collected. All laboratory samples were analyzed for HE, SVOCs, total uranium, and inorganics. Subsurface samples were also analyzed for volatiles. Four samples from two locations within the highly-contaminated zone were analyzed for waste characterization purposes by TCLP and for pesticides/herbicides. Samples in the center of the channel were collected at prescribed locations as delineated in the work plan (LANL 1993, 1094) and its notice of deficiency. Bounding samples were taken at 5 ft intervals along traverses located at 100 ft intervals from the outfall at HE-spot test screening locations that tested negative for HE.

All sampling locations were screened for HE by spot test, volatile organics by PID, and radionuclides by hand-held Sodium Iodide detector. Screening results above background are reported in Table 5.2.4-2. Samples that failed the HE spot test were also screened for TATB content by LANL group DX-2. Only one sample, (0316-95-0038) from PRS 16-021(c) contained measurable TATB. This sample contained 880 mg/kg of TATB. No SAL or toxicological data exists for this compound but due to its low solubility in all reagents, it is likely to be non-toxic. Additional HE positive results were found on the bounding traverses at the outfall, at 100 ft (1 positive), at 300 ft (3 positives), and at 400 ft (3 positives). These bounding locations do not have location or sample IDs, so they are not included in Table 5.2.4-2. The other screening results were nondetects or were within the background range.

A total of 37 laboratory samples, including duplicates, were collected at PRS 16-021(c) (Table 5.2.4-1). The subsurface PID screening did not result in elevated readings. Therefore the subsurface analytical samples were biased to the three areas believed to have the greatest possibility for contamination, at the outfall and at the two surface sample locations in the former HE-pond area. Laboratory duplicates were taken at surface locations 16-1382 and 16-1383 and at subsurface location 16-1379.

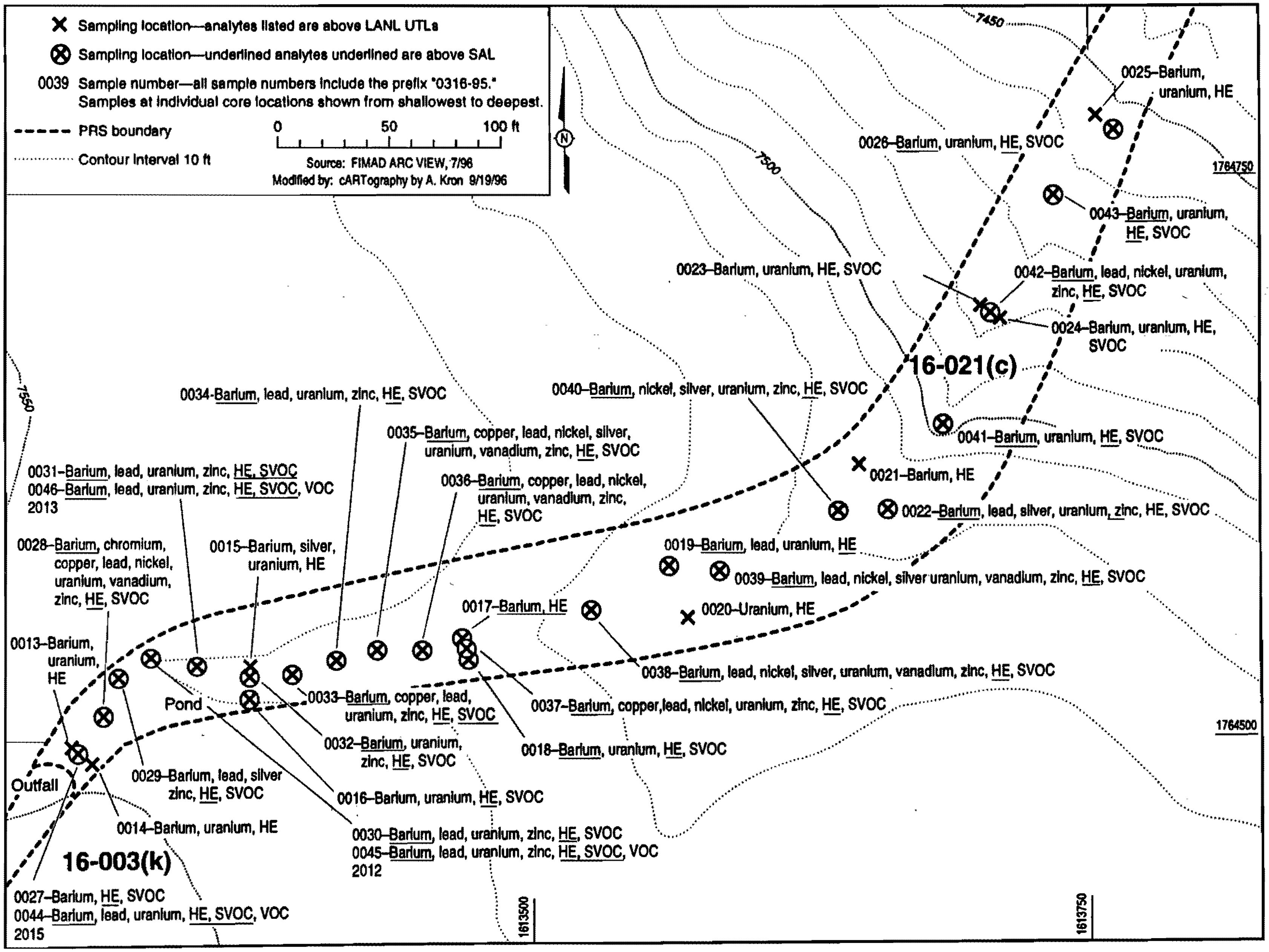


Fig. 5.2.4-1. PRS 16-021(c), HE sump drainage at TA-16-260.

TABLE 5.2.4-1

SUMMARY OF LABORATORY SAMPLES TAKEN AND REQUEST NUMBERS FOR PRS 16-021(c)

SAMPLE ID	LOCATION ID	DEPTH (ft)	MATRIX	HERB/ PEST	TCLP[a]	VOCs	SVOCs	HE	INORGs	URANIUM
0316-95-0013	16-1397	0-0.5	Soil	NA[b]	NA	NA	972	972	978	979
0316-95-0014	16-1396	0-0.5	Soil	NA	NA	NA	972	972	978	979
0316-95-0015	16-1399	0-0.5	Soil	NA	NA	NA	972	972	978	979
0316-95-0016	16-1398	0-0.5	Soil	NA	NA	NA	972	972	978	979
0316-95-0017	16-1401	0-0.5	Soil	NA	NA	NA	972	972	978	979
0316-95-0018	16-1400	0-0.5	Soil	NA	NA	NA	972	972	978	979
0316-95-0019	16-1403	0-0.5	Soil	NA	NA	NA	972	972	978	979
0316-95-0020	16-1402	0-0.5	Soil	NA	NA	NA	972	972	978	979
0316-95-0021	16-1405	0-0.5	Soil	NA	NA	NA	972	972	978	979
0316-95-0022	16-1404	0-0.5	Soil	NA	NA	NA	972	972	978	979
0316-95-0023	16-1407	0-0.5	Soil	NA	NA	NA	1222	1222	1223	1224
0316-95-0024	16-1406	0-0.5	Soil	NA	NA	NA	1222	1222	1223	1224
0316-95-0025	16-1409	0-0.5	Soil	NA	NA	NA	1222	1222	1223	1224
0316-95-0026	16-1408	0-0.5	Soil	NA	NA	NA	1222	1222	1223	1224
0316-95-0027	16-1379	0-0.5	Soil	NA	NA	NA	1268	1268	1269	1270
0316-95-0028	16-1380	0-0.5	Soil	NA	NA	NA	1268	1268	1269	1270
0316-95-0029	16-1381	0-0.5	Soil	NA	NA	NA	563	563	564	565
0316-95-0030	16-1382	0-0.5	Soil	563	563	NA	563	563	564	565
0316-95-0031	16-1383	0-0.5	Soil	563	563	NA	563	563	564	565
0316-95-0032	16-1384	0-0.5	Soil	NA	NA	NA	1268	1268	1269	1270
0316-95-0033	16-1385	0-0.5	Soil	NA	NA	NA	563	563	564	565
0316-95-0034	16-1386	0-0.5	Soil	NA	NA	NA	563	563	564	565
0316-95-0035	16-1387	0-0.5	Soil	NA	NA	NA	563	563	564	565
0316-95-0036	16-1388	0-0.5	Soil	NA	NA	NA	563	563	564	565
0316-95-0037	16-1389	0-0.5	Soil	NA	NA	NA	563	563	564	565
0316-95-0038	16-1390	0-0.5	Soil	NA	NA	NA	1268	1268	1269	1270
0316-95-0039	16-1391	0-0.5	Soil	NA	NA	NA	1268	1268	1269	1270
0316-95-0040	16-1392	0-0.5	Soil	NA	NA	NA	1268	1268	1269	1270
0316-95-0041	16-1393	0-0.5	Soil	NA	NA	NA	1268	1268	1269	1270
0316-95-0042	16-1394	0-0.5	Soil	NA	NA	NA	1268	1268	1269	1270
0316-95-0043	16-1395	0-0.5	Soil	NA	NA	NA	1268	1268	1269	1270
0316-95-0044	16-1379	1-1.5	Soil	NA	NA	1173	1173	1173	1174	1175
0316-95-0045	16-1382	1.5-1.9	Soil	NA	NA	1173	1173	1173	1174	1175
0316-95-0046	16-1383	1.7-2.2	Soil	NA	NA	1173	1173	1173	1174	1175
0316-95-2012	16-1382	0-0.5	Soil	563	563	NA	563	563	564	565
0316-95-2013	16-1383	0-0.5	Soil	563	563	NA	563	563	564	565
0316-95-2015	16-1379	1-1.5	Soil	NA	NA	1173	1173	1173	1174	1175

[a] TCLP = Toxicity characteristic leaching procedure

[b] NA = Not analyzed

TABLE 5.2.4-2

FIELD SCREENING RESULTS FOR PRS 16-021(c)

SAMPLE ID	LOCATION ID	SCREENING METHOD/ RESULT
0316-95-0016	16-1398	PID/ 18 ppm
0316-95-0018	16-1400	PID/ 20 ppm
0316-95-0027	16-1379	HE Spot Test/ positive
0316-95-0028	16-1380	HE Spot Test/ positive
0316-95-0029	16-1381	HE Spot Test/ positive
0316-95-0030	16-1382	HE Spot Test/ positive
0316-95-0031	16-1383	HE Spot Test/ positive
0316-95-0032	16-1384	HE Spot Test/ positive
0316-95-0033	16-1385	HE Spot Test/ positive
0316-95-0034	16-1386	HE Spot Test/ positive
0316-95-0035	16-1387	HE Spot Test/ positive
0316-95-0036	16-1388	HE Spot Test/ positive
0316-95-0037	16-1389	HE Spot Test/ positive
0316-95-0038	16-1390	HE Spot Test/ positive
0316-95-0039	16-1391	HE Spot Test/ positive
0316-95-0040	16-1392	HE Spot Test/ positive
0316-95-0041	16-1393	HE Spot Test/ positive
0316-95-0042	16-1394	HE Spot Test/ positive
0316-95-0043	16-1395	HE Spot Test/ positive
0316-95-0044	16-1379	HE Spot Test/ positive
0316-95-0045	16-1382	HE Spot Test/ positive
0316-95-0046	16-1383	HE Spot Test/ positive

5.2.5 Background Comparison

Barium, chromium, copper, lead, nickel, silver, uranium, vanadium, and zinc were found above background UTLs (Table 5.2.5-1). Barium was found at levels well above SALs. The highest barium values were found between 100 and 400 ft downgradient from the outfall, not in the former HE pond. Scattered high values (greater than 20 000 ppm) are found as far as 600 ft downgradient from the outfall. Barium values do not appear to exhibit systematic increases or decreases in concentration with depth. Other metals (copper, lead, nickel, zinc) and radionuclides (uranium) also appear to be concentrated in the 100–400 ft downgradient interval. Other low-level metals values are widely distributed. Duplicate recovery for several inorganic analytes (i.e barium, copper, chromium, lead, zinc) was consistently outside of the acceptable range, These data are P-qualified in Table 5.2.5-1. These data are acceptable for decision making purposes. Barium is well above SALs in virtually all P-qualified samples, and the other analytes are typically well-below SALs in the P-qualified samples. P-qualified samples are most common within the highly HE-contaminated areas, where sample heterogeneity is a significant problem.

TCLP data for four samples from two locations are presented in Table 5.2.5-2. All metals were below TCLP detection limits except barium and cadmium. Barium results were at a level roughly one-half the level at which the soil would qualify as a RCRA metals waste for barium (D005).

TABLE 5.2.5-1

INORGANIC ANALYTES AND URANIUM WITH CONCENTRATIONS GREATER THAN BACKGROUND UTLS FOR PRS 16-021(c)[a]

SAMPLE ID	DEPTH (ft)	SOIL/ ROCK UNIT	BARIUM (mg/kg)	CHROMIUM (mg/kg)	COPPER (mg/kg)	LEAD (mg/kg)	NICKEL (mg/kg)	SILVER (mg/kg)	TOTAL URANIUM (mg/kg)	VANADIUM (mg/kg)	ZINC (mg/kg)
LANL UTL (all soil)	N/A[b]	N/A	315	19.3	30.7	23.3	15.2	NA[c]	1.87	41.9	50.8
LANL UTL (Qbt4)	N/A	N/A	42	5.4	1.6	4	<2	<1	2.93	9.5	47
SAL	N/A	N/A	5 300	210	2 800	400	1 500	380	29	540	23 000
0316-95-0013	0–0.5	Soil	583 (J+P)[d,e]	14.8	9.4	15.2 (P)	11.5	0.62 (U)[f]	2.39	29.2	32.7
0316-95-0014	0–0.5	Soil	498 (J+P)	6.7	4.2	10.7 (P)	7.5	0.55 (U)	2.51	22.2	16.7
0316-95-0015	0–0.5	Soil	1 170 (J+P)	5	5.3	10.8 (P)	4.7	0.84	1.68	12.3	21.9
0316-95-0016	0–0.5	Soil	693 (J+P)	6.7	6.3	14.4 (P)	6.1	0.62 (U)	2.08	23.1	27
0316-95-0017	0–0.5	Soil	[illegible]	5.8	4.6	8.9 (P)	6	0.59 (U)	1.73	15.6	24.3
0316-95-0018	0–0.5	Soil	[illegible]	6.1	6.1	11.1 (P)	6.8	0.61 (U)	2.16	15.4	24.4
0316-95-0019	0–0.5	Soil	[illegible]	6.1	5.3	30.3 (P)	6.2	0.61 (U)	1.7	15.9	25.7
0316-95-0020	0–0.5	Soil	172 (J+P)	7.9	4.3	11.4 (P)	6.4	0.58 (U)	2.01	25.3	21.6
0316-95-0021	0–0.5	Soil	3 790 (J+P)	5	4.8	9.8 (P)	3.7	0.58 (U)	1.27	13.2	23.3
0316-95-0022	0–0.5	Soil	[illegible]	10	16.1	39.4 (P)	10.2	1.2	3.58	22.8	62.2
0316-95-0023	0–0.5	Soil	619 (J-P)[g]	4.8	7.3	19 (P)	4.3	0.63 (U)	3.62	12.4	21.8
0316-95-0024	0–0.5	Soil	412 (J-P)	3	5.2	14.3 (P)	2.2	0.53 (U)	2.92	7.6	24.1
0316-95-0025	0–0.5	Soil	3 000 (J-P)	4.8	5.1	10.1 (P)	3.9	0.59 (U)	2.48	16.7	23.9
0316-95-0026	0–0.5	Soil	[illegible]	6.8	12.1	16 (P)	8.3	0.85 (U)	3.18	21.2	42.7
0316-95-0027	0–0.5	Soil	5 270	9.5 (P)	9.3	18.7	10.3	0.64 (U)	1.82	26.7	46.3
0316-95-0028	0–0.5	Soil	[illegible]	26.8 (P)	40.5	107	37.3	0.985 (U)	3.17	55.7	226
0316-95-0029	0–0.5	Soil	2 730 (P))	4.5 (P)	10.4 (P)	27.2	2.9	0.59 (U)	2.2	11.4	86.1 (J+P)
0316-95-0030	0–0.5	Soil	[illegible]	9.5 (P)	19.9 (P)	36.7	11.2	0.66 (U)	3.25	24.3	104 (J+P)
0316-95-0031	0–0.5	Soil	[illegible]	11.7 (P)	25.2 (P)	43.1	10.9	0.73 (U)	5.77	33.7	116 (J+P)
0316-95-0032	0–0.5	Soil	[illegible]	9.1 (P)	12.5	19	6.3	0.61 (U)	3.11	28.5	85.2
0316-95-0033	0–0.5	Soil	[illegible]	16.8 (P)	35.9 (P)	58	12.8	0.75 (U)	5.07	40.1	150 (J+P)
0316-95-0034	0–0.5	Soil	[illegible]	9.6 (P)	17.5 (P)	35.5	13.3	0.67 (U)	6.98	24.8	76.8 (J+P)
0316-95-0035	0–0.5	Soil	[illegible]	16.4 (P)	31.8 (P)	57.8	51.9	1.1	6.39	48.8	152 (J+P)
0316-95-0036	0–0.5	Soil	[illegible]	18.9 (P)	38.5 (P)	47.3	16.3	0.75 (U)	6.43	42.5	151 (J+P)
0316-95-0037	0–0.5	Soil	[illegible]	15.1 (P)	31.3 (P)	46.5	30.1	1.6	8.71	40.7	133 (J+P)
0316-95-0038	0–0.5	Soil	[illegible]	18.3 (P)	26.8	46.3	25.9	4.1	4.84	48	139
0316-95-0039	0–0.5	Soil	[illegible]	11 (P)	9.5	38.8	31.9	1.31	2.94	42	68.2
0316-95-0040	0–0.5	Soil	[illegible]	13 (P)	17.5	22.4	21.3	0.95	6.69	37	76
0316-95-0041	0–0.5	Soil	[illegible]	4 (P)	4.8	14.2	6.5	0.57 (U)	2.58	21.8	44.8
0316-95-0042	0–0.5	Soil	[illegible]	10.5 (P)	14.4	33.8	20.1	0.63 (U)	4.08	29.9	62.6
0316-95-0043	0–0.5	Soil	[illegible]	6.2 (P)	5.6	22.5	5.1	0.62 (U)	2.73	25.8	42.3
0316-95-0044	1–1.5	Soil	[illegible]	9.7 (P)	11.8	46.2	11.8	0.67 (U)	4.08	31.7	46 (P)
0316-95-0045	1.5–2	Soil	[illegible]	7.1 (P)	8.8	46.5	10.8	0.70 (U)	2.53	27.3	53.7 (P)
0316-95-0046	1.7–2.2	Soil	[illegible]	12.2 (P)	22.4	48.5	8.9	0.75 (U)	4.21	30.5	97.9 (P)
0316-95-2012	0–0.5	Soil	[illegible]	10.5 (P)	17.8 (P)	38.6	9.9	0.64 (U)	4.3	28.2	100 (J+P)
0316-95-2013	0–0.5	Soil	[illegible]	11.2 (P)	20.1 (P)	41.2	9.4	0.71 (U)	4.32	32	112(J+P)
0316-95-2015	1–1.5	Soil	[illegible]	8.4 (P)	10.4	42.7	11.5	0.70 (U)	3.66	29.1	40.1 (P)

[a] Analytes within double-lines are greater than UTLs. Analytes with shaded background are at levels greater than SALs.

[b] N/A = Not applicable.

[c] NA = Not available.

[d] J+ = Analyte was positively identified and the result is likely to be biased high.

[e] P = Professional judgment needed prior to use of data in decision making.

[f] U = The analyte was not positively identified in the sample and the associated value is the sample-specific EQL/EDL.

[g] J = Analyte was positively identified but the associated numerical value is more uncertain than would normally be expected for the analysis.

[h] J- = Analyte was positively identified and the result is likely to be biased low.

TABLE 5.2.5-2

TCLP RESULTS AT PRS 16-021(C)

SAMPLE ID	DEPTH (ft)	SOIL/ ROCK UNIT	BARIUM (µg/L)	CADMIUM (µg/L)
TCLP LIMIT	NA[a]	NA	100 000	1 000
0316-95-0030	0–0.5	Soil	49 800	6.5
0316-95-0031	0–0.5	Soil	52 400	7.1
0316-95-2012	0–0.5	Soil	63 600	7.1
0316-95-2013	0–0.5	Soil	57 100	6.8

[a] Not applicable.

5.2.6 Evaluation of Organics

HE, SVOCs, and VOCs were all reported for this PRS (Table 5.2.6-1, 5.2.6-2, and 5.2.6-3). The HE DNT, HMX, RDX, TNB, and TNT were all present at levels above SALs. HMX, RDX, and TNT were all found at levels well above SALs in most samples collected along the centerline of the drainage. The SVOCs trichlorophenol, anthracene, benzoic acid, bis(2-ethylhexyl)phthalate, di-n-butylphthalate, phenanthrene, and pyrene were all detected. Anthracene and bis(2-ethylhexyl)phthalate were found at levels greater than SALs. As noted in Subsection 4, bis-(2ethylhexyl)phthalate was also found in the blanks for some SVOC analyses. Low-levels of several VOCs (acetone, dichlorobenzene, p-isopropyltoluene, sec-butlybenzene, trichloroethane, and trimethylbenzene) were also reported. Many of these constituents do not have adequate toxicological criteria to calculate SALs.

HMX levels are highest (greater than 100 000 ppm) in surface samples, particularly between 80 and 200 ft down drainage from the outfall. RDX levels are highest (greater than 50 000 ppm) in subsurface samples that were taken in the 0 to 100 ft interval. TNT is also at the highest levels (>30 000 ppm) in these subsurface samples. This increase in TNT and RDX concentration with depth may reflect either differing transport properties of TNT/RDX compared with HMX. Or, it may reflect that HMX has been used more heavily recently, whereas TNT/RDX were used more heavily during the 1950s and 1960s. Because of the chemical similarities between HMX and RDX, the latter explanation is more likely.

The SVOCs found at levels greater than SALs were also concentrated in the subsurface samples. The SVOCs, particularly anthracene, are most common in samples collected within 200 ft of the outfall in the center of the drainage channel. An exception in benzoic acid, which is found most commonly in bounding samples.

The sample-specific detection limits are high for many organic constituents in the highly-HE-contaminated samples. Low-levels of non-detected HE and SVOC analytes may be present in these samples at levels greater than SALs. The decision to identify virtually all HE constituents as COPCs in the main drainage at PRS 16-021(c) will not be affected by this analytical difficulty. SVOCs may be incorrectly identified as non-detected in samples where they occur. However, sufficient samples with low detection limits exist within the drainage that it is unlikely that a significant SVOC COPC was missed by the sampling. The sample-specific detection limits for bounding samples are at typical levels, so the decision whether an analyte is bounded in the drainage is probably correct.

TABLE 5.2.6-1

PRS 16-021(c) SOIL CONCENTRATIONS FOR HIGH EXPLOSIVES WITH VALUES GREATER THAN THE REPORTING LIMIT[a]

SAMPLE ID	DEPTH (ft)	2- ADNT (mg/kg)	4- ADNT (mg/kg)	1,3-DINITROBENZENE (mg/kg)	2,4-DINITROTOLUENE (mg/kg)	2,6-DINITROTOLUENE (mg/kg)	HMX (mg/kg)	NITROBENZENE (mg/kg)	3-NITROTOLUENE (mg/kg)	RDX (mg/kg)	1,3,5-TRINITROBENZENE (mg/kg)	2,4,6-TRINITROTOLUENE (mg/kg)
SAL	N/A[b]	NC[c]	NC	6.5	0.65	0.65	3300	33	NC	4	3.3	15
EQL	N/A	0.26	ND[d]	0.25	0.25	0.26	2.2	0.28	0.25	1	0.25	0.25
0316-95-0013	0–0.5	0.288	0.093 (U)[e]	0.07 (U)	0.058 (U)	0.081 (U)	22.4	0.092 (U)	0.157 (U)	1.38	0.086 (U)	0.091 (U)
0316-95-0014	0–0.5	0.077 (U)	0.092 (U)	0.069 (U)	0.057 (U)	0.08 (U)	0.822	0.091 (U)	0.155 (U)	0.175 (U)	0.085 (U)	0.09 (U)
0316-95-0015	0–0.5	0.274	0.091 (U)	0.068 (U)	0.057 (U)	0.08 (U)	6.26	0.09 (U)	0.154 (U)	0.541 (U)	0.084 (U)	0.09 (U)
0316-95-0016	0–0.5	0.265	0.093 (U)	0.07 (U)	0.058 (U)	0.081 (U)	16.5	0.092 (U)	0.157 (U)	[illegible]	0.086 (U)	0.091 (U)
0316-95-0017	0–0.5	25.4	20.1	0.069 (U)	0.446	0.08 (U)	2 590	0.091 (U)	0.155 (U)	[illegible]	0.199	[illegible]
0316-95-0018	0–0.5	42.2	21.6	0.07 (U)	[illegible]	0.081 (U)	172	0.092 (U)	2.12	[illegible]	0.086 (U)	5.45
0316-95-0019	0–0.5	2.82	1.63	0.069 (U)	0.305	0.081 (U)	38.3	0.091 (U)	0.156 (U)	[illegible]	0.085 (U)	0.091 (U)
0316-95-0020	0–0.5	0.077 (U)	0.091 (U)	0.069 (U)	0.057 (U)	0.08 (U)	4.02	0.091 (U)	0.155 (U)	0.175 (U)	0.085 (U)	0.09 (U)
0316-95-0021	0–0.5	6.38	2.49	0.069 (U)	0.407	0.08 (U)	1.89	0.091 (U)	0.155 (U)	0.348	0.085 (U)	0.09 (U)
0316-95-0022	0–0.5	27.7	17.9	0.072 (U)	[illegible]	0.084 (U)	367	1.2	0.162 (U)	2.44	0.089 (U)	0.094 (U)
0316-95-0023	0–0.5	0.078 (U)	0.093 (U)	0.07 (U)	0.058 (U)	0.081 (U)	0.969	0.092 (U)	0.157 (U)	0.178 (U)	0.086 (U)	0.091 (U)
0316-95-0024	0–0.5	0.079 (U)	0.094 (U)	0.071 (U)	0.059 (U)	0.082 (U)	0.404	0.093 (U)	0.159 (U)	0.18 (U)	0.087 (U)	0.092 (U)
0316-95-0025	0–0.5	2.8	1.69	0.07 (U)	0.144	0.081 (U)	108	0.092 (U)	0.157 (U)	1.21	0.086 (U)	0.091 (U)
0316-95-0026	0–0.5	82.7	64.1	0.072 (U)	[illegible]	0.084 (U)	378	0.095 (U)	0.162 (U)	[illegible]	0.129	[illegible]
0316-95-0027	0–0.5	6.55	6.85	0.09 (U)	0.122	0.105 (U)	1 360	0.119 (U)	0.203 (U)	[illegible]	0.111 (U)	[illegible]
0316-95-0028	0–0.5	5.26	0.237 (U)	0.094 (U)	[illegible]	0.208 (U)	[illegible]	0.235 (U)	0.401 (U)	[illegible]	0.488	[illegible]
0316-95-0029	0–0.5	2.29 (U)	5.31	0.204 (U)	0.239	0.238 (U)	[illegible]	0.269 (U)	0.46 (U)	5.2 (U)	0.251 (U)	[illegible]
0316-95-0030	0–0.5	14	3.11 (U)	2.34 (U)	1.94 (U)	2.73 (U)	[illegible]	3.09 (U)	5.27 (U)	[illegible]	2.88 (U)	[illegible]
0316-95-0031	0–0.5	40.2	22.8 (U)	17.1 (U)	14.2 (U)	20 (U)	[illegible]	22.8 (U)	38.5 (U)	[illegible]	21.1 (U)	[illegible]
0316-95-0032	0–0.5	41.4	0.566 (U)	0.425 (U)	[illegible]	0.498 (U)	[illegible]	0.561 (U)	0.958 (U)	[illegible]	0.524 (U)	[illegible]
0316-95-0033	0–0.5	28	6.18 (U)	6.15 (U)	5.1 (U)	7.17 (U)	[illegible]	6.11 (U)	13.8 (U)	[illegible]	7.57 (U)	[illegible]
0316-95-0034	0–0.5	27.8	17 (U)	2.52 (U)	2.09 (U)	2.94 (U)	[illegible]	3.33 (U)	5.68 (U)	[illegible]	3.11 (U)	[illegible]
0316-95-0035	0–0.5	25.6	3.51 (U)	2.64 (U)	2.19 (U)	3.08 (U)	[illegible]	3.48 (U)	5.94 (U)	[illegible]	3.25 (U)	[illegible]
0316-95-0036	0–0.5	59.6	36 (U)	27.1 (U)	22.5 (U)	31.6 (U)	[illegible]	35.7 (U)	61 (U)	[illegible]	33.4 (U)	[illegible]
0316-95-0037	0–0.5	35.9	3.27 (U)	2.46 (U)	2.04 (U)	2.87 (U)	[illegible]	3.24 (U)	5.54 (U)	[illegible]	3.03 (U)	[illegible]
0316-95-0038	0–0.5	38.3	34.7	0.501 (U)	[illegible]	0.584 (U)	[illegible]	0.66 (U)	1.13 (U)	[illegible]	0.617 (U)	[illegible]
0316-95-0039	0–0.5	11.5	10.1	0.085 (U)	0.308	0.144	2 750	0.112 (U)	0.191 (U)	[illegible]	0.278	[illegible]
0316-95-0040	0–0.5	64.4	60.8	0.876 (U)	[illegible]	0.786 (U)	[illegible]	0.891 (U)	1.52 (U)	[illegible]	0.833 (U)	[illegible]
0316-95-0041	0–0.5	13.2	10.5	0.405 (U)	[illegible]	0.472 (U)	[illegible]	0.534 (U)	0.912 (U)	[illegible]	0.499 (U)	[illegible]
0316-95-0042	0–0.5	38.2	33	0.446 (U)	[illegible]	0.537	[illegible]	0.588 (U)	1 (U)	[illegible]	0.735	[illegible]
0316-95-0043	0–0.5	33.1	27.3	0.435 (U)	[illegible]	0.507 (U)	[illegible]	0.573 (U)	0.979 (U)	[illegible]	0.535 (U)	14.3
0316-95-0044	1–1.5	0.782 (U)	0.928 (U)	0.898 (U)	[illegible]	0.814 (U)	[illegible]	0.92 (U)	1.57 (U)	[illegible]	1.66	[illegible]
0316-95-0045	1.5–2	0.392 (U)	0.465 (U)	2.04	[illegible]	0.408 (U)	[illegible]	0.461 (U)	0.787 (U)	[illegible]	[illegible]	[illegible]
0316-95-0046	1.7–2.2	1.97 (U)	2.34 (U)	1.76 (U)	[illegible]	2.05 (U)	[illegible]	2.32 (U)	3.96 (U)	116000 (U)	[illegible]	[illegible]
0316-95-2012	0–0.5	17.2	8.4 (U)	6.32 (U)	5.24 (U)	7.37 (U)	[illegible]	8.33 (U)	14.2 (U)	[illegible]	7.78 (U)	[illegible]
0316-95-2013	0–0.5	32.5 (U)	38.6 (U)	29 (U)	24.1 (U)	33.9 (U)	[illegible]	38.3 (U)	65.4 (U)	[illegible]	35.8 (U)	[illegible]
0316-95-2015	1–1.5	1.96 (U)	2.32 (U)	1.75 (U)	1.45 (U)	2.04 (U)	[illegible]	2.3 (U)	3.93 (U)	[illegible]	2.15 (U)	[illegible]

[a] Analytes within double-lines are greater than EQLs. Analytes with shaded background are at levels greater than SALs.

[b] N/A = Not applicable.

[c] NC = Not calculated.

[d] ND = Not determined.

[e] U = Analyte not positively identified in sample and the associated numerical value is the sample-specific EQL/EDL.

TABLE 5.2.6-2

PRS 16-021(c) SOIL CONCENTRATIONS FOR SEMI-VOLATILE ORGANIC ANALYTES WITH VALUES GREATER THAN THE REPORTING LIMIT[a]

SAMPLE ID	DEPTH (ft)	2,4,6-Trichlorophenol (mg/kg)	2,4-Dinitrotoluene (mg/kg)	2,6-Dinitrotoluene (mg/kg)	Anthracene (mg/kg)	Benzoic Acid (mg/kg)	Bis(2-Ethylhexyl)Phthalate (mg/kg)	Di-N-Butylphthalate (mg/kg)	Phenanthrene (mg/kg)	Pyrene (mg/kg)
SAL	N/A[b]	40	0.65	0.65	19	100 000	32	6 500	NC[c]	2 000
EQL	N/A	0.33	0.33	0.33	0.33	3.3	0.33	0.33	0.33	0.33
0316-95-0016	0–0.5	0.41 (U)[d]	0.41 (U)	0.41 (U)	0.41 (U)	0.08 (J)[e]	0.41 (U)	0.41 (U)	0.41 (U)	0.41 (U)
0316-95-0017	0–0.5	0.39 (U)	0.1 (J)	0.39 (U)	0.39 (U)	3.9 (U)	0.39 (U)	0.39 (U)	0.39 (U)	0.39 (U)
0316-95-0018	0–0.5	0.82 (U)	0.31 (J)	0.82 (U)	0.82 (U)	0.13 (J)	0.82 (U)	0.82 (U)	0.82 (U)	0.82 (U)
0316-95-0021	0–0.5	0.39 (U)	0.5	0.39 (U)	0.39 (U)	3.9 (U)	0.39 (U)	0.39 (U)	0.39 (U)	0.39 (U)
0316-95-0022	0–0.5	0.53 (U)	[illegible]	0.53 (U)	0.53 (U)	0.43 (J)	1.9 (U)	0.53 (U)	0.53 (U)	0.53 (U)
0316-95-0023	0–0.5	0.43 (U)	0.43 (U)	0.43 (U)	0.43 (U)	0.12 (J)	0.43 (U)	0.43 (U)	0.43 (U)	0.43 (U)
0316-95-0024	0–0.5	0.33 (U)	0.33 (U)	0.33 (U)	0.33 (U)	0.07 (J)	0.16 (J)	0.33 (U)	0.33 (U)	0.33 (U)
0316-95-0025	0–0.5	0.39 (U)	0.094 (J)	0.39 (U)	0.39 (U)	3.9 (U)	0.39 (U)	0.39 (U)	0.39 (U)	0.39 (U)
0316-95-0026	0–0.5	0.58 (U)	0.5 (J)	0.084 (J)	0.58 (U)	0.12 (J)	0.58 (U)	0.58 (U)	0.58 (U)	0.58 (U)
0316-95-0027	0–0.5	0.048 (J)	0.048 (J)	0.44 (U)	0.44 (U)	4.4 (U)	0.41 (J)	0.44 (U)	0.44 (U)	0.44 (U)
0316-95-0028	0–0.5	13 (U)	13 (U)	13 (U)	13 (U)	130 (U)	4 (J)	13 (U)	13 (U)	13 (U)
0316-95-0029	0–0.5	0.4 (U)	0.09 (J)	0.4 (U)	0.4 (U)	4 (U)	2.1 (B)[f]	0.054 (J)	0.4 (U)	0.4 (U)
0316-95-0030	0–0.5	2.3 (U)	0.39 (J)	0.44 (J)	2.3 (U)	23 (U)	9.3 (B)	2.3 (U)	0.44 (J)	2.3 (U)
0316-95-0031	0–0.5	9.6 (U)	9.6 (U)	9.6 (U)	3.3 (J,PM)[g]	96 (U)	[illegible]	9.6 (U)	9.6 (U)	9.6 (U)
0316-95-0032	0–0.5	2 (U)	0.61 (J)	2 (U)	2 (U)	20 (U)	16	2 (U)	4.6	2 (U)
0316-95-0033	0–0.5	10 (U)	10 (U)	10 (U)	6.1 (J)	100 (U)	[illegible]	10 (U)	10 (U)	10 (U)
0316-95-0034	0–0.5	9.2 (U)	9.2 (U)	9.2 (U)	0.95 (J,PM)	92 (U)	23 (U)	9.2 (U)	9.2 (U)	9.2 (U)
0316-95-0035	0–0.5	10 (U)	10 (U)	10 (U)	1.1 (J,PM)	100 (U)	15 (U)	10 (U)	10 (U)	10 (U)
0316-95-0037	0–0.5	4.8 (U)	[illegible]	4.8 (U)	0.67 (J)	46 (U)	12 (U)	4.8 (U)	4.8 (U)	4.8 (U)
0316-95-0038	0–0.5	0.45 (U)	0.79	0.34 (J)	0.45 (U)	4.5 (U)	4.8	0.45 (U)	0.23 (J)	0.071 (J)
0316-95-0039	0–0.5	0.81 (U)	0.2 (J)	0.81 (U)	0.81 (U)	8.1 (U)	0.59 (J)	0.81 (U)	0.81 (U)	0.81 (U)
0316-95-0040	0–0.5	0.51 (U)	0.5 (J)	0.2 (J)	0.51 (U)	5.1 (U)	1.4	0.51 (U)	0.51 (U)	0.51 (U)
0316-95-0041	0–0.5	0.39 (U)	0.28 (J)	0.089 (J)	0.39 (U)	3.9 (U)	0.77	0.39 (U)	0.052 (J)	0.39 (U)
0316-95-0042	0–0.5	0.44 (U)	0.33 (J)	0.1 (J)	0.44 (U)	4.4 (U)	0.86	0.44 (U)	0.44 (U)	0.44 (U)
0316-95-0043	0–0.5	0.43 (U)	0.28 (J)	0.053 (J)	0.43 (U)	4.3 (U)	0.45	0.43 (U)	0.43 (U)	0.43 (U)
0316-95-0044	1–1.5	110 (U)	110 (U)	110 (U)	110 (U)	1 100 (U)	[illegible]	110 (U)	110 (U)	110 (U)
0316-95-0045	1.5–1.9	120 (U)	120 (U)	120 (U)	[illegible]	1 200 (U)	120 (U)	120 (U)	120 (U)	120 (U)
0316-95-0046	1.7–2.2	130 (U)	130 (U)	130 (U)	[illegible]	1 300 (U)	[illegible]	130 (U)	130 (U)	130 (U)
0316-95-2012	0–0.5	8.7 (U)	8.7 (U)	8.7 (U)	1.9 (J)	87 (U)	26 (U)	8.7 (U)	8.7 (U)	8.7 (U)
0316-95-2013	0–0.5	9 (U)	[illegible]	9 (U)	6.2 (J)	90 (U)	[illegible]	9 (U)	9 (U)	9 (U)

[a] Analytes within double-lines are greater than EQLs. Analytes with black background are at levels greater than SALs.

[b] N/A = Not applicable.

[c] NC = Not calculated

[d] U = Analyte not positively identified in sample and the associated numerical value is the sample-specific EQL/EDL.

[e] J = Analyte positively identified and associated numerical value is more uncertain than would normally be expected for the analysis.

[f] PM =Professional judgment should be used in applying the data to decision making, manual review of data suggested.

[g] B = Found in blank.

TABLE 5.2.6-3

PRS 16-021(c) SOIL CONCENTRATIONS FOR VOLATILE ORGANIC ANALYTES WITH VALUES GREATER THAN THE REPORTING LIMIT[a]

SAMPLE ID	DEPTH (ft)	Acetone (mg/kg)	1,2-dichlorobenzene (mg/kg)	p-isopropyltoluene (mg/kg)	sec-butylbenzene (mg/kg)	1,1,1-trichloroethane (mg/kg)	1,2,4-trimethylbenzene (mg/kg)
SAL	N/A[b]	2 000	2 300	NC[c]	NC	3 000	8
EQL	N/A	0.2	0.05	0.05	0.05	0.05	0.05
0316-95-0044	1–1.5	0.06 (J)[d]	0.007 (UJ)[e]	0.022 (J)	0.007 (UJ)	0.007 (UJ)	0.007 (UJ)
0316-95-0045	1.5–1.9	0.016 (J)	0.007 (UJ)	0.051 (J)	0.007 (UJ)	0.007 (U)	0.052 (J)
0316-95-0046	1.7–2.2	0.031 (UJ)	0.005 (J)	0.008 (UJ)	0.008 (UJ)	0.014 (J)	0.008 (J)
0316-95-2015	1–1.5	0.014 (J)	0.007 (U)	0.007 (U)	0.007 (U)	0.007 (U)	0.007 (U)

[a] Analytes within double-lines are greater than EQLs.

[b] N/A = Not applicable.

[c] NC = Not calculated.

[d] J = Analyte positively identified and associated numerical value is more uncertain than would normally be expected for the analysis.

[e] U = Analyte not positively identified in sample and the associated numerical value is the sample-specific EQL/EDL.

TCLP organic results showed no constituents above analytical detection limits.

5.2.7 Human Health Assessment

5.2.7.1 Screening Assessment

The noncarcinogens barium, HMX, TNB, and anthracene were found at levels greater than SALs (Table 5.2.5-1, 5-2.6-1 and 5.2.6-2). The carcinogens DNT, RDX, TNT, and bis(2-ethylhexyl)phthalate were also found at levels greater than SALs (Table 5.2.6-1, 5.2.6-2). All of these constituents will be carried through the RFI/CMS process as COPCs. No radionuclides were found at levels greater than SALs.

MCEs were performed for both carcinogens and non-carcinogens that were not already identified as COPCs.

Noncarcinogenic contaminants identified to be greater than LANL background UTLs but below SALS were submitted for an MCE for noncarcinogenic effects. Lead is excluded from this grouping because its toxicity is based on the uptake of lead in children as modeled by EPA's IUBEK Model (EPA 1994, 1178). The sum of the maxima for the noncarcinogenic group is 0.51, which is well below the target value of 1, indicating a low potential for adverse effects due to exposure to this grouping (Table 5.2.7.1-1).

Carcinogenic contaminants with levels greater than LANL background UTLs but below SALs were submitted for an MCE for carcinogenic effects. The sum of the maxima for the carcinogenic group is 0.13, well below the target value of 1. This indicates a low potential for adverse effects due to exposure to carcinogens other than those already identified as COPCs because these carcinogens are at levels above SALs (Table 5.2.7.1-2).

Only a single radionuclide, uranium, was identified at levels above background, so no MCE was performed for the radionuclides.

TABLE 5.2.7.1-1

MCE FOR NONCARCINOGENIC EFFECTS AT PRS 16-021(c)

CONTAMINANT	MAXIMUM SOIL CONCENTRATION (mg/kg)	SOIL SAL (mg/kg)	CONCENTRATION NORMALIZED TO SAL
Copper	40.5	2 800	0.014
Nickel	37.3	1 500	0.025
Silver	4.1	383	0.011
Vanadium	55.7	540	0.10
Zinc	226	23 000	0.003
1,3-Dinitrobenzene	2.04	6.5	0.31
Nitrobenzene	1.2	33	0.036
3-Nitrotoluene	2.12	650	0.0033
Benzoic acid	0.43	100 000	0.000004
Di-n-butylphthalate	0.054	6 500	0.000008
Pyrene	0.071	2 000	0.00004
Acetone	0.067	2 000	0.00003
1,2 Dichlorobenzene	0.007	2 300	0.000003
1,2,4-Trimethylbenzene	0.052	8	0.0065
1,1,1-Trichloroethane	0.014	3 000	0.000005
Total			0.51

TABLE 5.2.7.1-2

MCE FOR CARCINOGENIC EFFECTS AT PRS 16-021(c)

CONTAMINANT	MAXIMUM SOIL CONCENTRATION (mg/kg)	SOIL SAL (mg/kg)	CONCENTRATION NORMALIZED TO SAL
Chromium	26.8	210	0.13
2,4,6-Trichlorophenol	0.048	40	0.0012
Total			0.13

5.2.7.2 Risk Assessment

No human health risk assessment was performed at this PRS. A human health risk assessment is not needed to define the decision. A CMS/CMI will be required. The constituents RDX, HMX, and TNT are present at levels several orders of magnitude greater than SALs over much of the area of PRS 16-021(c). A human health risk assessment under either a residential or industrial scenario would yield carcinogenic and systemic risks far greater than the EPA's target range of 10^{-4} to 10^{-6} for carcinogens and a hazard index of 1 for systemic toxicants. In addition, the distribution of contaminant concentrations is so non-normal that a realistic 95 UCL on the mean, as prescribed in Risk Assessment Guidance for Superfund (RAGS) (EPA 1989, 0305) guidance, cannot legitimately be calculated. Using maximum concentrations in lieu of 95 UCLs, as is done for background constituents with non-normal or non-log normal distributions, suggests that risks are on the order of 10^{-2} and 10^{-3} for RDX and TNT and a hazard index greater than 1 for HMX under an industrial scenario. In addition, the high levels of HE in the soil (greater than 5 wt %) suggest that the soils pose an acute (explosive) hazard not just a chronic hazard to receptors.

A more detailed baseline risk assessment, which includes Phase II information on surface and groundwaters, may be completed as part of the CMS/CMI process.

5.2.8 Preliminary Ecological Assessment

In accordance with conversations between LANL ER Project personnel, DOE/LAAO, and the regulators, discussion of ecological risk assessment methodology will be deferred until the Ecological Exposure Unit (Ecozone) methodology that is being developed by LANL in conjunction with EPA Region 6 and the NMED has been approved by the regulators.

PRS 16-021(c) is known to have impacted ecological receptors. Dead trees are present in the drainage that are almost certainly due to impacts of COPCs from the outfall.

5.2.9 Extent of Contamination

The extent of contamination is not fully characterized for PRS 16-021(c) in either the lateral or vertical directions. None of the COPCs were bounded in the vertical direction. Table 5.2.9-1 and Fig. 5.2.9-1 indicate the status of lateral bounding relative to SALs for COPCs identified as part of the screening assessment.

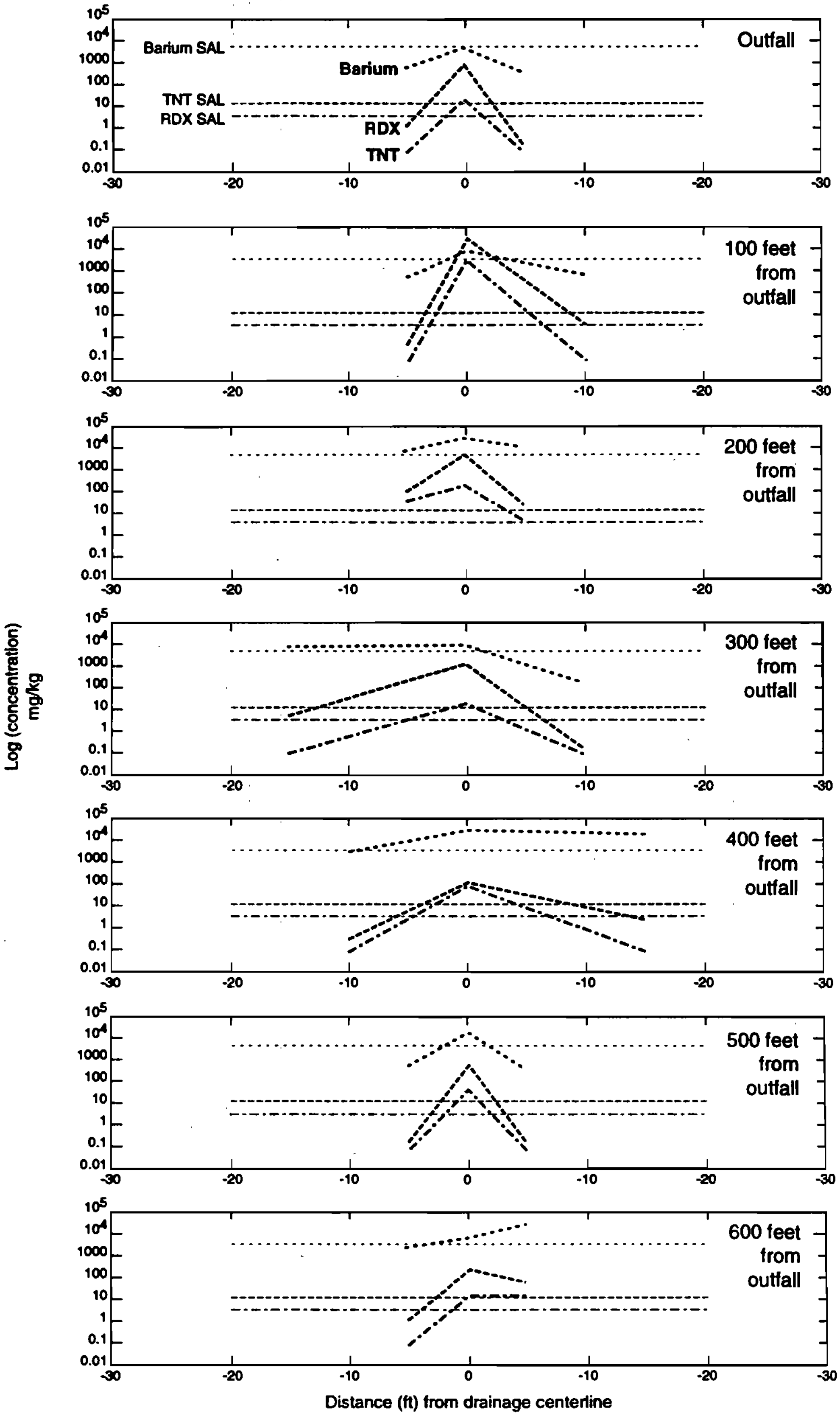


Fig. 5.2.9-1. Centerline and lateral bounding sample concentrations for barium, RDX, and TNT at PRS 16-021(c).

TABLE 5.2.9-1

STATUS OF LATERAL BOUNDING FOR PRS 16-021(c)

COPC	OUTFALL	100 FT	200 FT	300 FT	400 FT	500 FT	600 FT
Barium	Yes	Yes	No	No	No	Yes	No
DNT	Yes	Yes	No	Yes	No	Yes	Yes
HMX	Yes	Yes	Yes	Yes	Yes	Yes	Yes
RDX	Yes	Yes	No	No	Yes	Yes	No
TNB	Yes	Yes	Yes	Yes	Yes	Yes	Yes
TNT	Yes	Yes	No	Yes	Yes	Yes	Yes
Anthracene	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bis(2-ethylhexyl) phthalate	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Lateral traverses at the outfall, 100 ft, and 500 ft are bounded with more certainty for all COPCs. Traverses at 300 ft and 400 ft have COPCs at levels only slightly greater than SALs for barium, RDX, and DNT in lateral bounding samples. These traverses are bounded relative to EPA Region 9 industrial PRGs. Traverses at 200 and 600 ft have RDX in lateral bounding samples at levels significantly greater than SALs and EPA Region 9 industrial PRGs. Phase II sampling will focus on these traverses.

The extent of COPCs due to releases at PRS 16-021(c) to surface and groundwater is also unknown, and will be investigated as described in the Phase II sampling and analysis plan.

5.2.10 Conclusions and Recommendations

PRS 16-021(c) is contaminated with several constituents at levels that present a risk to human health and the environment. BMPs have been implemented at the PRS to minimize migration of COPCs to surface and groundwater.

COPCs identified in the screening assessment include: barium, DNT, HMX, RDX, TNB, TNT, anthracene, and bis(2-ethylhexyl)phthalate. Of these COPCs, barium, DNT, HMX, RDX, and TNT are widely distributed along the centerline of the drainage at PRS 16-021(c) from the outfall for at least a distance of 600 ft downgradient. The other COPCs are present in localized zones. The contaminated zone ranges up to 25 ft wide in traverses where bounding relative to SALs was achieved. At 200 ft and 600 ft the zone may be greater than 25 ft wide. Vertical bounding and knowledge the extent of contamination of downgradient surface and groundwater were not achieved in the Phase I sampling.

An explicit human health risk assessment for PRS 16-021(c) was not completed as part of Phase I characterization. It is clear, however, that both carcinogenic and noncarcinogenic risks are at unacceptable levels under any realistic exposure scenario for a distance of 600 ft down the drainage from the TA-16-260 outfall. Acute (explosive) risks are also present due to levels of HE in soil that are above explosive limits.

Potential waste types for PRS 16-021(c) may include D003 (RCRA reactive), D005 (TCLP for barium), and D030 (TCLP for 2,4 DNT). Radioactive and mixed waste are also possible due to the small amounts of uranium found at some locations.

This PRS is recommended for continued sampling to support a CMS. The sampling and analysis plan is provided in Subsection 5.2.11 of this report. Goals of this sampling are to determine extent of COPCs needing remediation and the impacts of COPCs from PRS 16-021(c) on surface and groundwater.

This PRS is also recommended for a CMS. Levels of COPCs present a risk to human health and the environment. Surface and groundwater in the vicinity of PRS 16-021(c) have been impacted at levels greater than MCLs, and that PRS is the most likely source for the water contamination. At the present time, there is no obvious, simple, or presumptive remedy for cleanup of COPCs, so VCA or expedited cleanup are not plausible decisions. A CMS is required. A CMS plan will be submitted to the NMED by September 30, 1997.

5.2.11 Phase II Sampling and Analysis Plan for PRS 16-021(c)

5.2.11.1 Problem Definition

Phase I sampling at the TA-16-260 outfall, PRS 16-021(c), included only surface samples of soils from the drainage below the outfall, plus a few near-surface samples (not more than 2 ft in depth) in the pond area within 100 ft of the outfall. Very high levels of HMX, RDX, TNT and barium, together with elevated levels of other HE, HE byproducts, and inorganics, were found in many of these samples, from the outfall down to the end of the drainage in Cañon de Valle. Concentrations of the major contaminants appeared to be decreasing with distance from the outfall, but the concentrations in near-surface samples were sometimes larger than on the surface, as discussed in Section 5.2.6.

HE contamination has also been observed in several TA-16 springs and seeps. Some springs and seeps emerge on the slopes of Cañon de Valle within 1 000 ft of the TA-16-260 outfall. Others are on the southeast side of TA-16. Whether any of these springs are hydrologically connected to the TA-16-260 area is not known. There are several other potential sources of

HE contamination at TA-16 that could be affecting springs both in Cañon de Valle and to the southeast. Existing surface and groundwater data are presented in Appendix C and summarized in Subsection 2 of this report.

Because the available information is limited, additional RFI investigations are being proposed in this Phase II sampling and analysis plan. This additional data will provide the information that is needed to prepare a CMS plan for source removal at the TA-16-260 outfall and that supports remediation or monitoring of perched groundwater and alluvial groundwater. This work will also provide data to support a baseline risk assessment, a required component of CMS planning. Specific questions and associated decisions to be addressed in Phase II include.

1) What are the lateral and vertical extents of contaminated soils requiring remediation at the outfall?

   Neither the lateral nor the vertical extent of contamination was entirely bounded by Phase I sampling. Any of the remediation options likely to be considered in CMS planning, including bioremediation, are expected to require at least temporary removal of the soil to be treated. Phase II sampling is designed to provide an upper bound on the amount and waste types of soil requiring remediation.

   The decision that will be affected by these data is what the ultimate cost of remediation will be under different remediation scenarios explored under a CMS. It is likely that different remediation methods will be more cost-effective, depending on the total volume and type of waste that needs to be remediated. These data will also facilitate waste minimization/segregation efforts.

2) What groundwater pathways, if any, connect the TA-16-260 outfall to TA-16 perched aquifers, seeps, and springs?

   As mentioned above, HE contamination has been observed both at springs near the TA-16-260 outfall [e.g., the sanitary wastewater system consolidation (SWSC) Line and Burning Ground Springs] and at more distant springs (Martin Spring, Fish Ladder Seep). There are unanswered questions both about the hydrologic connectivity between the TA-16-260 outfall and these springs and about the connections between these springs and other potential sources of HE contamination. The Phase II studies proposed below extend preliminary work in which springs, streams, and outfalls have been sampled on an irregular basis.

In particular, these studies will identify COPCs, if any, in perched aquifers that might require remediation, and assist in the siting of potential long-term monitoring wells and in designing a systematic monitoring program. Although deep groundwaters are not being investigated in this sampling and analysis plan, these studies will also support future investigations of deep groundwater at TA-16 that will be completed as part of site-wide hydrogeologic studies.

The decisions associated with these data are the following. 1) If the groundwater pathways connecting the TA-16-260 outfall with springs are identified and contain constituents at levels greater than MCLs, then implement groundwater monitoring in those pathways. 2) If the TA-16-260 outfall is shown to be contributing constituents to intermediate perched groundwater that present a current or future risk to human health and the environment, then evaluate appropriate remedial actions within the context of the CMS. A plausible remediation option for perched groundwater is pump and treat. Conceptual models for risk assessments at TA-16 are presented in the RFI work plan for OU 1082 (LANL 1993, 1094). 3) If groundwater pathways connecting the TA-16-260 outfall with springs are not identified, then examine other TA-16 discharge areas associated with other PRSs as potential sources.

3) What is the impact of contamination released through the TA-16-260 outfall on surface and alluvial water in Cañon de Valle?

Surface water and sediment sampling in Cañon de Valle are proposed in Subsection 5.9 of the work plan. That sampling will be supplemented in this sampling and analysis plan by alluvial wells in Cañon de Valle and by additional sediment and water samples in Cañon de Valle. The siting of this well is strongly constrained by access considerations and it will not be possible to distinguish the TA-16-260 outfall contribution from that of other sources to the west of MDA-P, such as the former 90s-Line outfalls. However, if it appears that remediation of sediment or water in Cañon de Valle may be required, this will be addressed in the CMS plan for PRS 16-021(c).

The decision associated with these data is: if contamination in surface and alluvial water or sediments present a current or future risk to human health and the environment under realistic exposure scenarios, then implement appropriate corrective action (interim action or remediation). Ecological risk assessment will be considered where appropriate.

A decision flow diagram for this sampling and analysis plan is presented in Fig. 5.2.11-1.

In addition to the investigations described in this document, upcoming RFI Phase I sampling scheduled for other PRSs may be augmented to determine the vertical extent of contamination at those sites that may have affected shallow perched groundwaters at TA-16: the V-Site pond (PRS 16-029(x), Subsection 5.25 in the work plan); the 90s-Line pond (PRS 16-008(a), Subsection 5.12 in the work plan); and the 300-Line outfall (PRS 16-003(d-g), Subsection 5.2 in the work plan) (LANL 1993, 1094; LANL 1994, 1160; LANL 1995, 1342). The RFI Phase I sampling plans for these sites presented in the work plan are intended primarily to identify the COPCs and obtain samples representing the highest levels of contamination present. These sampling plans may be augmented by boreholes and subsurface sampling in order to bound the vertical extent of contamination, and additional surface locations may be sampled in order to bound the lateral extent of contamination if necessary. The decision to collect additional sampling data will be based on evaluation of RFI sampling data. If constituent levels are not bounded in the vertical direction during RFI sampling, then additional samples will be collected. If remediation appears to be required at these sites, Phase II RFI sampling and analysis plans, VCA plans or expedited cleanup (EC) plans will be prepared as needed.

5.2.11.2 Sampling and Analysis Plan (SAP) Design

Seven components of RFI Phase II studies are described in the following subsections. They include a geological/geophysical survey, surface and subsurface sampling in and near the TA-16-260 outfall, mesa-top wells, alluvial wells in Cañon de Valle, additional sampling beyond that described in the work plan in Cañon de Valle, and systematic spring and seep sampling supporting tracer studies.

5.2.11.2.1 Geological/Geophysical Surveys

A geologic map of Bandelier Tuff units and subunits will be prepared for the north portion of TA-16. This mapping will focus on Cañon de Valle within one mile of TA-16-260. Other mapping will be reconnaissance in nature and will be tied to the existing map of Rogers (Rogers 1995, 1353) and the three-dimensional site-wide stratigraphic model. Emphasis of this mapping will be on the nature, structural dips, and continuity of units identified as potential high permeability units (i.e., the surge beds within Unit 4 and the spring-bearing units within the horizontal-fractured subunit of Unit 3). A detailed stratigraphic log, including whole-rock chemical analyses, will be completed near TA-16-260 for lithologic correlation purposes. Fracture characterization will be completed in Cañon de Valle near PRS 16-021(c).

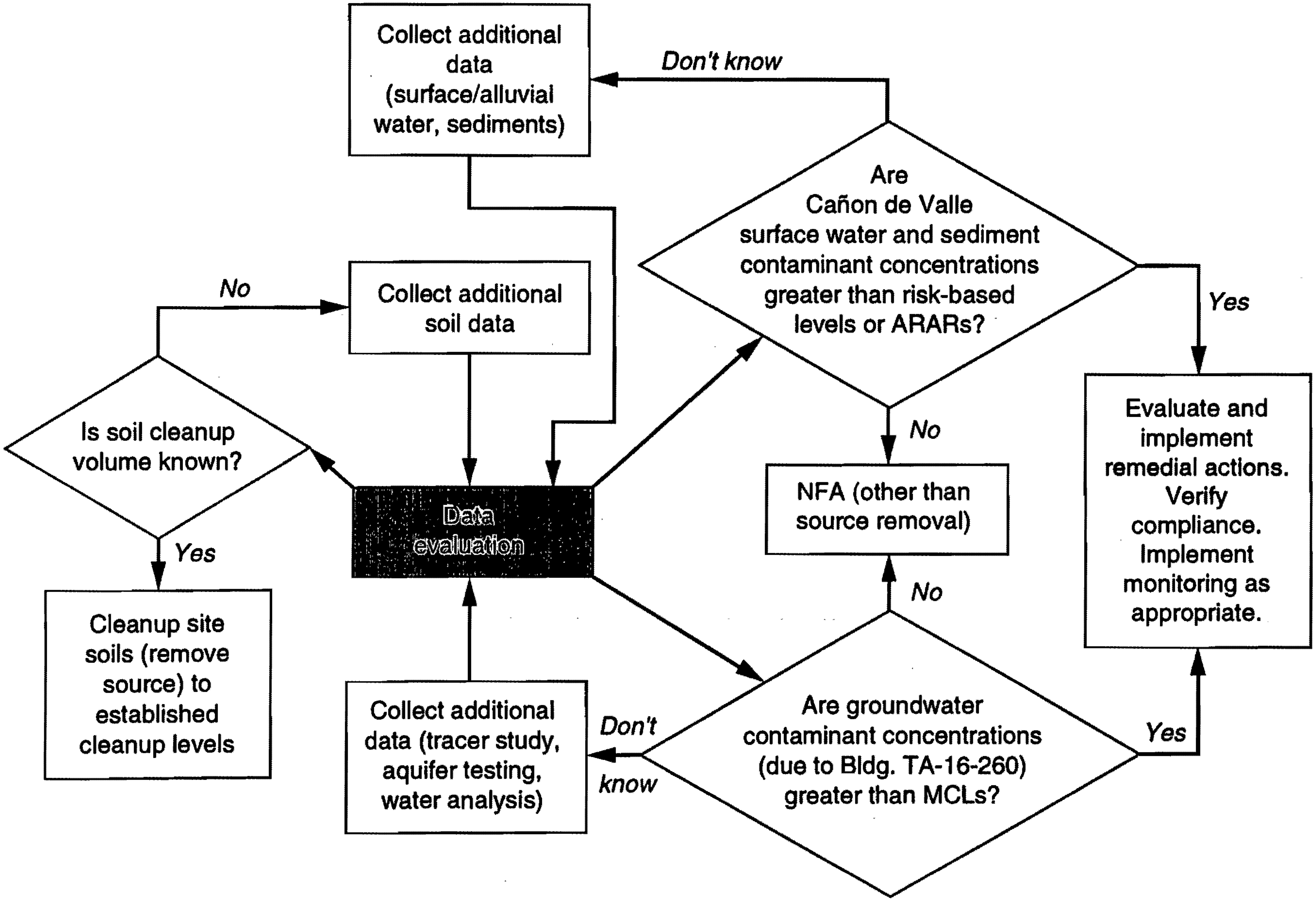


Fig. 5.2.11-1. TA-16-260 outfall decision flow.

If the known contaminated springs (SWSC Line Spring, Burning Ground Spring, Martin Spring, and Fish Ladder Seep) are fed primarily by fracture flow through welded tuff or if the saturated layer is thin and discontinuous, it may not be possible to detect saturated zones by surface geophysical methods. Saturated zones or perched water might be found either above the cliff-forming unit that crops out in Cañon de Valle and is approximately 10–40 ft below the surface at the TA-16-260 outfall, or in the surge bed that separates this cooling unit from the next lower cooling unit, at a depth of approximately 50–70 ft (Broxton et al. 1996, 1305). An attempt will be made to locate and trace saturated zones using Schlumberger resistivity and other electrical and magnetic methods, both in the neighborhood of the TA-16-260 outfall (Fig. 5.2.11.2.1-1) and also near the springs on the mesa tops at TA-16 (Fig. 5.2.11.2.1-2). If flow paths can be traced in this way, these results will be used to help locate the wells proposed in Sections 5.2.11.2.3 and 5.2.11.2.4.

5.2.11.2.2 Surface and Near-surface Sampling at the TA-16-260 Outfall

The lateral extent of sampling below the TA-16-260 outfall was determined during Phase I sampling using a field spot test HE kit with a relatively high detection level (nominally 100 ppm). While in general the lateral bounding samples selected in this way contained much lower concentrations of HE than the samples collected in the center of the drainage, some of the bounding samples had concentrations exceeding SALs. In particular, high RDX concentrations were found in the bounding samples collected 200 ft below the outfall and at the base of the outfall (600 ft below the outfall in Cañon de Valle, where the drainage is less well defined than it is higher up). In addition, no subsurface samples were collected downgradient from the dam that is located approximately 100 ft below the outfall.

Additional bounding samples will be collected along transects 200 and 600 ft below the outfall, at 5-ft lateral intervals for surface samples and 10-ft lateral intervals for subsurface samples (Fig. 5.2.11.2.1-1). Subsurface samples will be collected in soil at depths of 12–36 in., with greater depth preferred where practical. Subsurface sampling is constrained both by the large cobbles found in the outfall area and by restrictions on the use of power equipment in this HE area. Where the soil/tuff interface is encountered at a depth of less than 12 in., no sample will be collected. Each sample will be tested using the field spot-test kit, followed by an immunoassay test, if the spot-test result is negative. These data will be used to estimate the lateral extent of contamination. Once the lateral extent is believed to have been bounded based on these field results, surface and subsurface laboratory samples will be collected from each end of each transect. Splits of these homogenized samples will be submitted, both for immunoassay, and for laboratory HE and inorganic analyses.

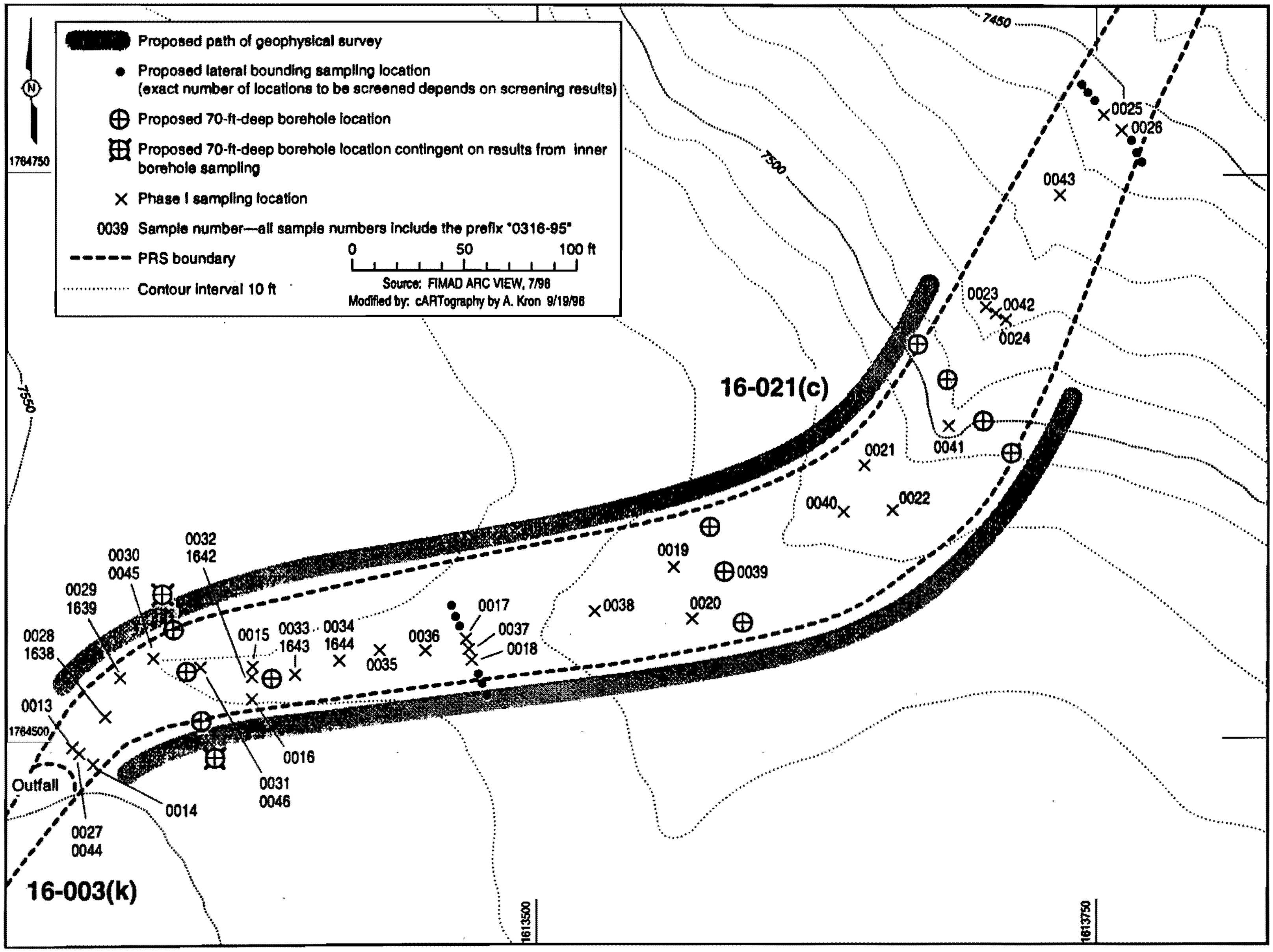


Fig. 5.2.11.2.1-1. Proposed Phase II sampling locations at PRS 16-021(c).

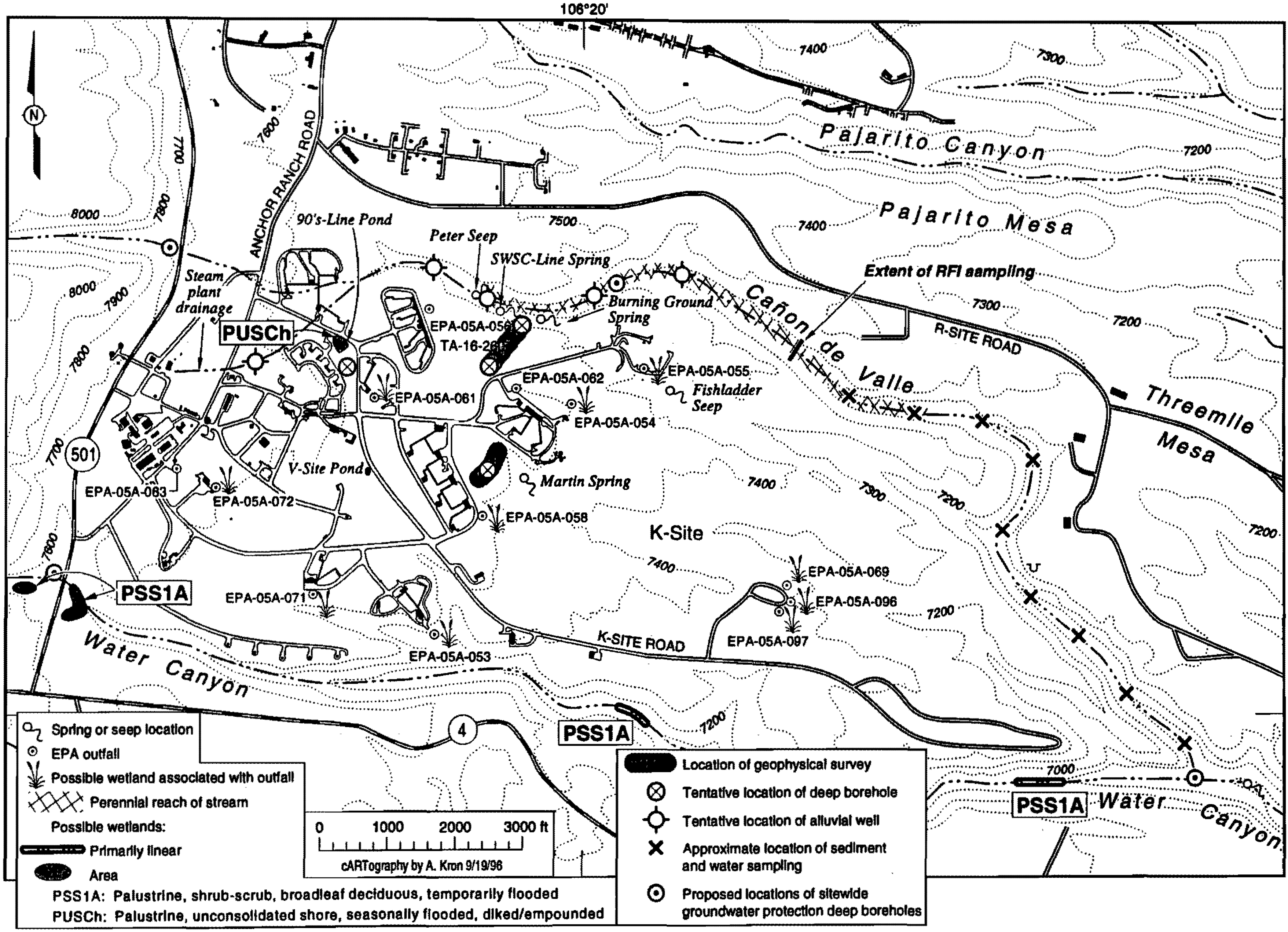


Fig. 5.2.11.2.1-2. **Proposed locations of hydrogeologic monitoring stations and boreholes at TA-16.**

One collocated sample (i.e., an independent sample from an adjacent point or segment of core, not a split of a homogenized sample) will be collected from one end of each transect for a total of two in order to estimate the effect of local heterogeneity, if any, in areas with low levels of contamination. One of these collocated samples should be a subsurface sample.

These observations (both field and laboratory results) will supplement Phase I data and data from additional transects described in Subsection 5.2.11.2.3 to bound the volume of soil requiring remediation and estimating the total amount of HE in the drainage. The laboratory results will also be used in conjunction with Phase I laboratory data for preliminary risk assessments.

5.2.11.2.3 Subsurface Sampling at the TA-16-260 Outfall

Eleven to 13 boreholes will be drilled with a remote-drilling rig, along three transects across the TA-16-260 drainage.

- Three to five boreholes will be drilled across the pond (approximately 75 ft below the outfall); drilling of the outermost boreholes is contingent on field test results for the adjacent boreholes closer to the centerline of the drainage.
- Three boreholes will be drilled along a transect where the drainage widens (approximately 320 ft below the outfall).
- Four boreholes will be drilled along a transect where a second drainage merges into the TA-16-260 line drainage from the south, providing access for the drill rig (approximately 450 ft below the outfall).

In addition, a single borehole in the center of the drainage will be drilled just below the dam of the pond (approximately 100 ft below the outfall). The placement of these boreholes, which is shown in Fig. 5.2.11.2.1-1, is based largely on logistical considerations for the remote drilling rig. If any geophysical anomalies that could be due to saturated zones are found by the geophysical survey, one or more of the boreholes proposed in this section will be resited to the location of the geophysical anomaly. The decision will to resite this borehole will be made by the field team in consultation with the Field Unit 3 technical team.

The central borehole in each transect will be drilled first (or the south-central borehole in the case of the transect 450 ft below the outfall). The total depth of contamination in that borehole, as determined by field test results, will determine the minimum depth for other boreholes in the same transect. Remaining boreholes in each transect will be drilled to at least five feet below the depth of contamination of the center borehole, making adjustments as needed to account for the fact that the surface elevation for some of these boreholes may be several feet above the center of the drainage. No borehole will be drilled deeper than the surge bed that is expected to lie between 50 and 70 ft below the surface, or deeper than 70 ft if the surge bed is not observed. The contingent outer borehole on each end of the first transect (75 ft below the outfall) will be drilled only if field-measured contamination is encountered deeper than 12 in. in either of the two boreholes to the north and south of the center borehole.

The deepest recovered segment of each five-foot core interval in each borehole will be field screened for HE using the field spot-test kit first, followed by an RDX-sensitive immunoassay measurement if spot-test results are negative. Additional screening samples will be taken based on visual inspection that reveals anomalies such as fractured zones or wet areas. A sample for laboratory analysis will be collected in each borehole from the first 5-ft interval, from a depth of at least 24 in. Surface laboratory samples will also be collected from the two inner drilling locations in the transect at 450 ft. A laboratory sample will be collected from the first 5-ft interval below the depth of contamination in the central borehole for which the field screening results are clean. If the surge bed (or the 70-ft depth) is reached before a clean interval is observed, the second laboratory sample will be collected from this final interval, if possible from surge bed material.

Laboratory samples will be analyzed for HE, VOCs, SVOCs, and inorganics.

The outermost boreholes on the transects at 75 and 450 ft below the outfall will be drilled to the surge bed (or 70 ft) regardless of field screening results. If permitted by requirements for drilling near HE-contaminated zones, at least the lower half of these deeper boreholes will be drilled dry to permit geologic logging of the core, borehole logging, and detection of saturated zones. Laboratory samples will be collected from the bottom of each borehole (specifically, from surge bed material if that is distinguishable in the cores) to be analyzed for HE, VOCs, and inorganics. If saturated zones are found, at least one of the two deep boreholes in each transect will be completed as a potential monitoring well. Both boreholes in a transect may be completed if saturated zones are found at different depths (in stratigraphically distinct layers).

If saturated zones are encountered in any borehole, water samples will be collected for laboratory analysis for the full suite of COPCs at TA-16-260 (HE, inorganics, SVOCs) and for VOCs. One sample for field and laboratory geotechnical parameter characterization will be collected in each distinct saturated zone. These analyses may include: pH, temperature, specific conductance, alkalinity, turbidity, and dissolved oxygen, hydraulic head measurements, bulk density, saturated moisture content, saturated hydraulic conductivity, moisture retention data, and whole-rock geochemistry of rock units (for lithologic correlations).

Laboratory data will supplement data from the TA-16-260 outfall collected in RFI Phase I and as described in Section 5.2.11.2.2 to bound the volume of soil requiring remediation. Contaminant and geotechnical analyses, if obtained from saturated zones, will provide some preliminary information on subsurface transport of HE contamination away from the outfall.

5.2.11.2.4 Mesa-top Wells

Four wells will be placed at mesa-top locations in the north-central portion of TA-16, which includes the TA-16-260 area. The nominal total depth of each of these wells is 200 ft, but if a saturated zone is encountered, the wells will be completed at shallower depths so that a potentiometric surface is defined. A depth of 200 ft penetrates Unit 3 to a depth equivalent to that of the SWSC Line and Burning Ground Springs. These multipurpose wells will provide geologic logs for the TA-16 mesas, and groundwater samples if a saturated zone is encountered. They may also become long-term monitoring wells if contaminants are observed above MCLs in groundwater samples.

The default locations for these four wells are shown on Fig. 5.2.11.2.1-2. Two are sited along the SWSC line cut, which runs between TA-16-260 and the SWSC Line and Burning Ground Springs in Cañon de Valle. In the absence of more specific indications from the geophysical survey (Section 5.2.11.2.1), one of these will be located near the canyon rim, on the line between the TA-16-260 outfall and Burning Ground Spring, and the second will be located near the line from the TA-16-260 outfall and Martin Spring to the southeast. A third well will be located between the V-Site Pond and Martin Spring, southwest of TA-16-340, its precise location may be determined by the geophysics survey results. The fourth will be sited east of the 90s-Line near the 90s-Line Pond.

One of these wells, probably the southern well within the SWSC Line cut, will be continuous cored (without casing). The others will be drilled (4-in. diameter) using air rotary methods (without casing). Geologic and fracture logs will be prepared for all boreholes based on either cuttings or cores. A teleview and neutron log will be prepared for each borehole. All lithologic and geologic variations will be noted during the drilling process. Particular note will be made of fractures and other potential water pathways. The continuously cored borehole will be sampled within each distinct lithologic unit for hydrologic and geologic parameters including: bulk density, saturated moisture content, moisture content, field saturation, saturated hydraulic conductivity, moisture retention parameters, and whole-rock geochemistry of rock units (for lithologic correlations). However, if a saturated zone or perched water is encountered at shallower depths, the well will be completed as a monitoring well at that depth.

Wells completed as monitoring wells will be redrilled to 6-in. diameter and will be completed at the depth of the uppermost saturated zone with a stainless steel screen. A dedicated pump and pressure transducer will be installed and a water monitoring program will be initiated. Seasonal response of the potentiometric surface will be monitored. The pressure transducer will be installed with an automated data-logging system.

If saturated zones are encountered, field measurements on water may include pH, temperature, specific conductance, alkalinity, turbidity, dissolved oxygen, and hydraulic head measurements. Field measurements may include pump and slug tests to determine *in-situ* saturated hydraulic conductivity. Lab measurements will include saturated hydraulic conductivity, grain size distribution, effective porosity, moisture retention parameters, and bulk density. Initial water samples from such wells (collected in four consecutive quarters) will be analyzed for the full suite of potential contaminants: VOCs, SVOCs, HE, and inorganics. In addition, they will be analyzed for concentrations of cations and anions, particularly the tracer constituent bromine. These analyses will be used to determine whether COPCs exist in perched groundwater below TA-16 and to characterize groundwater pathways between TA-16 source areas and springs.

Four deep-groundwater wells to the main aquifer are scheduled for the TA-16 area as part of site-wide groundwater protection investigations. These wells will be located within Water Canyon and Cañon de Valle at West Jemez Road, at the confluence of Water Canyon and Cañon de Valle, and in Cañon de Valle near MDA-P. These wells are currently scheduled to be drilled in FY97–01, at the earliest. Data from these wells will be used to support CMS/CMS decisions for PRS 16-021(c).

5.2.11.2.5 Alluvial Wells

Two to five shallow alluvial wells will be completed in Cañon de Valle and in the steam plant outfall drainage, which drains into Cañon de Valle. Five alluvial well locations are proposed, only the first two can be accessed with a drill rig with certainty: 1) at a point upstream from MDA-P, where the existing road that skirts MDA-P to the west provides access to the canyon bottom (Fig. 5.2.11.2.1-2). 2) in the drainage from the steam plan at a location upgradient from the 90s-Line drainage (Fig. 5.2.11.2.1-2); 3) at a location upgradient of the TA-16-260 outfall drainage but downgradient of MDA-R (Fig. 5.2.11.2.1-2); 4) at a location upgradient from SWSC Line Spring in Cañon de Valle (Fig. 5.2.11.2.1-2); and 5) at a location east of MDA-P in Cañon de Valle (Fig. 5.2.11.2.1-2). If any well location is inaccessible to an appropriate drill rig, then it will not be drilled. All wells will be drilled to five feet beneath the alluvium/tuff interface.

The shallow boreholes will be completed as alluvial monitoring wells with 3–4-in.-diameter polyvinyl chloride (PVC), or suitable equivalent. Each well screen is expected to be 5–10 ft in length. Each borehole will be completed in accordance with applicable guidance from the LANL SOPs listed in Subsection 5.2.11.3 of this document.

Water samples will be collected quarterly for one year from each well and analyzed for HE, VOCs, inorganics, and anions, including bromide. These data will be used to identify COPCs and seasonal variations in Cañon de Valle alluvial water. One or more of the wells will subsequently be used as a monitoring well in evaluating the effectiveness of corrective actions at several locations, including the 90s-Line, the silver outfall (PRS 16-020), and the TA-16-260 outfall.

5.2.11.2.6 Spring Sampling and Tracer Studies

A monitoring program for TA-16 springs and seeps will be instituted. The schedule for analyses for springs and seeps at TA-16 is provided in Table 5.2.11.2.6-1. Flow rates will also be monitored. A water balance calculation relating outfall and spring discharges will be completed. This schedule will be reevaluated following the first year (FY97) of sampling. These analyses are designed both to support tracer studies (described below) and to represent ongoing monitoring of constituents in springs. Locations of springs and seeps are shown on Fig. 5.2.11.2.1-2.

TABLE 5.2.11.2.6-1

SCHEDULE FOR SPRING AND SEEP SAMPLING

Spring	Bromide	Major and trace ions	RCRA Inorganics	HE	VOCs	SVOCs
SWSC Line Spring	Weekly	Quarterly	Quarterly	Quarterly	Quarterly	Annually
Burning Ground Spring	Weekly	Quarterly	Quarterly	Quarterly	Quarterly	Annually
Martin Spring	Weekly	Quarterly	Quarterly	Quarterly	Quarterly	Annually
Peter Seep	Quarterly	Quarterly	Quarterly	Quarterly	Quarterly	Annually
Fish Ladder Seep	Quarterly	Quarterly	Quarterly	Quarterly	Quarterly	Annually

A potassium bromide tracer will be deployed at PRS 16-021(c) during FY97. Approximately 100 kg of potassium bromide in solution will be deployed within the trough exiting the TA-16-260 sumps. Autosamplers for SWSC Line Spring, Burning Ground Spring, and Martin Spring will also be deployed prior to injecting the tracer. Baseline bromide levels in these springs will be determined based on existing data (see Appendix C) combined with 10 additional bromide samples collected prior to potassium bromide deployment. The autosampler will collect several milliliters of spring water daily; these samples will be collected every two weeks and one sample for each week will be submitted for anion, including bromide, analysis. If bromide levels appear to be elevated relative to baseline levels, then all samples from the two-week sampling interval will be submitted for anion analysis. All samples will be preserved pending analysis of the first sample. Sampling at an individual spring will continue for at least one year, then the data will be evaluated and it will be decided whether to continue sampling. Based on the tritium model ages of spring waters (see Appendix C) bromide breakthrough is anticipated in five years or less.

5.2.11.2.7 Sediment and Water Sampling in Cañon de Valle

Sediment and water sampling in Cañon de Valle between MDA-R and a distance of 2 500 ft downstream from MDA-P is described in Subsection 5.9 of the work plan (LANL 1993, 1094). This sampling is currently scheduled to be completed during FY97. However, non-RFI sampling (see Appendix C) indicates surface water contamination at levels greater than MCLs at a distance of roughly 7 000 ft downstream from MDA-P. The currently proposed Cañon de Valle sampling will not bound the downstream extent of contamination from PRS 16-021(c) and other PRSs that drain into Cañon de Valle. Thus, additional sediment and water sampling in Cañon de Valle is proposed in this Phase II sampling and analysis plan.

The existing sampling in Cañon de Valle, which is confined to the central channel, will be augmented with samples taken in the overbank region. Three locations, selected based on a geomorphologic survey, will be sampled in overbank sediments on both the north and south banks of the Cañon de Valle channel. These samples will be analyzed for HE, inorganics, SVOCs, and VOCs.

Sediment and water samples will be collected every 1 000 ft, starting at the last point of the currently-proposed Cañon de Valle sampling plan (see Fig. 5.2.11.2.1-2). This sampling will be terminated at the first point beyond the confluence of Cañon de Valle and Water Canyon. If contamination is still present in Water Canyon, it will be deferred to the ER Canyons OU. These samples will be submitted for HE and inorganic analysis.

5.2.11.2.8 Schedule constraints

Geophysics will be completed in October following the rainy season when saturation levels in the tuff may be highest. Operations in TA-16-260 permit surface and subsurface sampling directly behind TA-16-260 only on Fridays and weekends. Drilling operations will be closely coordinated with the site operating group. Tracers will be deployed prior to winter snowmelt.

5.2.11.3 Implementation

General Sampling and Screening (5.2.11.2.1 to 5.2.11.2.7)

All samples for laboratory analysis will be collected using the most current applicable LANL-ER SOPs for the collection, preservation, identification, storage, transport, and documentation of environmental samples, as described in the ER Project QAPP (LANL 1996, 1292).

General field activities will be controlled by the following SOPs: LANL-ER-SOP-01.01, General Instruction for Field Investigations, LANL-ER-SOP-01.02, Sample Container and Preservation, LANL-ER-SOP-01.03, Handling, Packaging and Shipping of Samples, LANL-ER-SOP-01.04, Sample Control and Field Documentation, LANL-ER-SOP-01.05, Field Quality Control Samples, and LANL-ER-SOP-03.01, Land Surveying Procedures. This sampling will be governed by LANL-ER-SOP-01.07, Operational Guidelines for Taking Soil and Water Samples in Explosives Areas because of the explosives hazards at this site. Applicable site safety SOPs will also be followed.

Field screening will be completed for radionuclides with a sodium iodide detector using LANL-ER-SOP-06.23, Measurement of Gamma-ray field using a Sodium Iodide Detector and LANL-ER-SOP-10.10, Radiation Scoping Surveys, and high explosives by spot test following LANL-ER-SOP-10.06, High Explosives Spot Test.

Field activities will be documented according to LANL-ER-SOP-03.12, Field and Laboratory Notebook Documentation for Environmental Restoration Earth Sciences Studies. In particular, all field test results will be recorded, whether or not they correspond to locations and depths where laboratory samples are collected.

Decontamination of sampling equipment will be performed in accordance with LANL-ER-SOP-01.08, Field Decontamination of Drilling and Sampling Equipment. Wash water and other wastes generated during the sampling operation will be managed and disposed of in accordance with LANL-ER-AP-05.3, Management of ER Program Wastes.

Borehole samples will be transmitted to the SMO following LANL-ER-SOP-12.02, Transportation, Receipt, and Admittance of Borehole Samples for the Sample Management Facility. Non-borehole samples will follow LANL-ER-SOP-12.03, Acceptance of Non-Borehole Samples by the Sample Management Facility. Sample management facility personnel follow LANL ER-SOP-12.04, Physical Processing and Storage of Borehole Samples at the Sample Management Facility.

The Sample Management Organization tracks samples between LANL and the external laboratories and uploads laboratory and QA data into FIMAD. The field team will upload the field database information into FIMAD and will generate a post-field operations report.

Geophysical survey method(s) (5.2.11.2.1).

Geophysical studies will be completed following LANL-ER-SOP-03.02, General Surface Geophysics. Specific procedures used for the Schlumberger resistivity, electromagnetic, magnetic and any other methods used will follow the manufacturers' instructions.

Geological survey method(s) (5.2.11.2.1)

Geologic mapping will be completed following LANL-ER-SOP-03.09, Geologic Mapping of Bedrock Units. Fracture characterization will follow methods outlined in LANL-ER-SOP-03.06, Fracture Characterization. Documentation of results from these investigations will follow LANL-ER-SOP-03.12, Field and Laboratory Notebook Documentation for Environmental Restoration Earth Science Studies.

Surface and near-surface sample collection methods in outfall area (5.2.11.2.2)

Surface sampling will be completed using LANL-ER-SOP-06,09, Spade and Scoop Method for Collection of Soil Samples. Shallow subsurface sampling will be completed using LANL-ER-SOP-06.10, Hand Auger and Thin-Wall Tube Sampler, where this procedure is allowed by the operating group. In HE-contaminated regions a remote auger rig is required.

Borehole drilling methods with modifications as required in HE areas (5.2.11.2.3).

Drilling at the TA-16-260 outfall will be controlled by LANL-ER-SOP-04.01, Drilling Methods and Drill Site Management. These boreholes will be drilled remotely and will be drilled wet, due to site safety requirements concerning drilling in HE-contaminated areas. Wells will be logged using LANL-ER-SOP 04.04, General Borehole Logging. Core holes will also be handled following LANL-ER-SOP-12.01, Field Logging, Handling, and Documentation of Borehole Samples.

Mesa-Top Wells and Alluvial Wells (5.2.11.2.4 and 5.2.11.2.5)

Drilling at the TA-16-260 outfall will be controlled by LANL-ER-SOP-04.01, Drilling and Drill Site Management. Core hole samples will also be handled following LANL-ER-SOP-12.01, Field Logging, Handling, and Documentation of Borehole Samples. Wells will be logged using LANL-ER-SOP 04.04, General Borehole Logging. Any mesa-top wells completed as monitoring wells will follow LANL-ER-SOP-5.01, Monitor Well Construction and LANL-ER-SOP-05.02, Well Development. Depth to saturated water will be determined using LANL-ER-SOP-07.02, Fluid Level Measurements. Slug tests for saturated hydraulic conductivity will be completed using LANL-ER-SOP-07.03, Well Slug Tests. Pump tests will be completed using LANL-ER-SOP-07.04, Aquifer Pumping Tests. Water samples from mesa-top wells will be collected using LANL-ER-SOP-06.01, Purging of Wells for Representative Sampling of Ground Water, and LANL-ER-SOP-06.02, Field Analytical Measurements of Groundwater Samples. Soil pH will be measured using LANL-ER-SOP-11.04, Soil and Core pH. Volatile organics samples of groundwater will be taken following LANL-ER-SOP-06.03, Sampling for Volatile Organics. If pressure transducers are installed in saturated zones follow LANL-ER-SOP-07.01, Pressure Transducers.

Spring and Surface water Sampling (5.2.11.2.6)

Quarterly surface water, including spring discharge, will be sampled following LANL-ER-SOP-06.13, Surface Water Sampling.

Cañon de Valle Sampling (5.2.11.2.7)

Sediment samples will be collected following LANL-ER-SOP-06.14, Sediment Material Collection. Water samples will follow LANL-ER-SOP-06.13, Surface Water Sampling.

5.2.11.4 Data Assessment

Laboratory data packages will be checked for completeness (LANL 1996, 1292). Focused validation will be performed only if verification or subsequent data assessment indicates possible problems with analytes of concern. Data packages will be retained under chain-of-custody control by the SMO.

Hydrogeologic data will be reviewed by a hydrologist and will be compared with existing data for Bandelier Tuff at LANL, particularly with data for Unit 3 and Unit 4.

5.2.11.5 Administration

Records Maps will be prepared of all sampling localities and each sample will be photographed. These maps will be based in FIMAD. Core logs based on chips or cuttings will be prepared for all core holes. Copies of field logs and other field information will be supplied to the records processing facility, together with information captured in the field database.

Reports A field summary report prepared following the field activities will be submitted to the ER records processing facility.

Field data will be preserved in a 4-D™ database and provided to FIMAD. The analytical laboratories will prepare electronic deliverables, as well as hard copy reports of the results.

Training Field personnel will complete all training as identified in the Field Unit 3 training matrix.

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APPENDIX A ANALYTICAL SUITES

Results of analyses can be found in the Facility for information Management and Display (FIMAD). Hard copies of supporting information will be provided upon request.

Chemicals that are reported by analytical laboratories as not detected have not been included in the tables of this RFI report. Nonetheless, undetected analytes are often part of the decision-making process and it is important to note that these chemicals were analyzed for (Tables A-1 to A-6). This appendix lists the target analytes in each analytical suite included in the Tables 5.x.4.x.

TABLE A-1

INORGANIC SUITE

Aluminum	Beryllium	Cobalt	Lead	Nickel	Sodium
Antimony	Cadmium	Copper	Magnesium	Potassium	Thallium
Arsenic	Calcium	Cyanide	Manganese	Selenium	Vanadium
Barium	Chromium	Iron	Mercury	Silver	Zinc

TABLE A-2

RADIONUCLIDES

Total Uranium

TABLE A-3

VOLATILE ORGANIC COMPOUND (VOC) SUITE

Acetone	1,2-Dibromoethane	Methyl iodide
Benzene	Dibromomethane	4-Methyl-2-pentanone
Bromobenzene	1,2-Dichlorobenzene	Methylene chloride
Bromochloromethane	1,3-Dichlorobenzene	n-Propylbenzene
Bromodichloromethane	1,4-Dichlorobenzene	Styrene
Bromoform	Dichlorodifluoromethane	1,1,1,2-Tetrachloroethane
Bromomethane	1,1-Dichloroethane	1,1,2,2,-Tetrachloroethane
2-Butanone	1,2-Dichloroethane	Tetrachloroethene
n-Butylbenzene	1,1-Dichloroethene	Toluene
sec-Butylbenzene	cis-1,2-Dichloroethene	Trichlorotrifluoroethane
tert-Butylbenzene	trans-1,2-Dichloroethene	1,1,1-Trichloroethane
Carbon disulfide	1,2-Dichloropropane	1,1,2-Trichloroethane
Carbon tetrachloride	1,3-Dichloropropane	Trichloroethene
Chlorobenzene	2,2-Dichloropropane	Trichlorofluoromethane
Chlorodibromomethane	1,1-Dichloropropene	1,2,3-Trichloropropane
Chloroethane	cis-1,3-Dichloropropene	1,2,4-Trimethylbenzene
Chloroform	trans-1,3-Dichloropropene	1,3,5-Trimethylbenzene
Chloromethane	Ethylbenzene	Vinyl chloride
2-Chlorotoluene	2-Hexanone	o,m,p-Xylene (mixed)
4-Chlorotoluene	Isopropylbenzene	
1,2-Dibromo-3-chloropropane	p-Isopropyltoluene	

TABLE A-4

SEMIVOLATILE ORGANIC COMPOUND (SVOC) SUITE

Acenaphthene	Chrysene	Isophorone
Acenaphthylene	Dibenzo(a,h)anthracene	2-Methyl-4,6-dinitrophenol
Aniline	Dibenzofuran	2-Methylnaphthalene
Anthracene	1,2-Dichlorobenzene	2-Methylphenol
Azobenzene	1,3-Dichlorobenzene	4-Methylphenol
Benzo(a)anthracene	1,4-Dichlorobenzene	Naphthalene
Benzo(b)fluoranthene	3,3'-Dichlorobenzidine	2-Nitroaniline
Benzo(k)fluoranthene	2,4-Dichlorophenol	3-Nitroaniline
Benzo(g,h,i)perylene	Diethylphthalate	4-Nitroaniline
Benzo(a)pyrene	Dimethylphthalate	Nitrobenzene
Benzoic acid	Di-n-butylphthalate	2-Nitrophenol
Benzyl alcohol	Di-n-octyl phthalate	4-Nitrophenol
Bis(2-chloroethoxy)methane	2,4-Dimethylphenol	N-Nitrosodimethylamine
Bis(2-chloroethyl)ether	2,4-Dinitrophenol	N-Nitrosodiphenylamine
Bis(2-chloroisopropyl)ether	2,4-Dinitrotoluene	N-Nitroso-di-n-propylamine
Bis(2-ethylhexyl)phthalate	2,6-Dinitrotoluene	Pentachlorophenol
4-Bromophenylphenyl ether	Fluoranthene	Phenanthrene
Butylbenzylphthalate	Fluorene	Phenol
4-Chloroaniline	Hexachlorobenzene	Pyrene
4-Chloro-3-methylphenol	Hexachlorobutadiene	1,2,4-Trichlorobenzene
2-Chloronaphthalene	Hexachlorocyclopentadiene	2,4,5-Trichlorophenol
2-Chlorophenol	Hexachloroethane	2,4,6-Trichlorophenol
4-Chlorophenylphenyl ether	Indeno(1,2,3-cd)pyrene	

TABLE A-5

PESTICIDE AND POLYCHLORINATED BIPHENYL SUITES

gamma-BHC (Lindane)	Heptachlor epoxide
Chlordane	Methoxychlor
Endrin	Toxaphene
Heptachlor	

TABLE A-6

HIGH EXPLOSIVES SUITE

2, Amino-4,6-Dinitrotoluene	HMX	RDX
4, Amino-2,6-Dinitrotoluene	Nitrobenzene	Tetryl
1,3 Dinitrobenzene	2-Nitrotoluene	1,3,5-Trinitrobenzene
2,4 Dinitrotoluene	3-Nitrotoluene	2,4,6-Trinitrotoluene
2,6 Dinitrotoluene	4-Nitrotoluene	

APPENDIX B DATA VALIDATION

The following tables summarize the results of quality assurance/quality control data validation for all analytical results used to support recommendations in this RFI report. Tables are presented in order of request number for each sample delivery group sent for laboratory analysis. Request numbers for each PRS are cited in Subsection 5.X.4 in Table 5.X.4-1.

TABLE B-1

DATA VALIDATION TABLE FOR INORGANIC SAMPLES

SUITE[a]	REQUEST NUMBER	COMMENTS
Inorganics	564	Spike recoveries for manganese and zinc were outside the acceptable value of 125%. All manganese and zinc data were qualified as J+[b]. Spike recoveries for selenium and arsenic were below the acceptable value of 75%. All selenium data were qualified as UJ[c]. All arsenic data were qualified as J-[d]. Duplicate recovery for aluminum, barium, chromium, copper, iron, zinc, and manganese was outside the acceptable 20% range. This did not affect the quality of the data for the purposes of this report. All data are considered valid.
Inorganics	978	Spike recovery for barium was outside the acceptable value of 125%. All barium data were qualified as J+. Spike recovery for selenium was below the acceptable value of 75%. All selenium data were qualified as UJ. Matrix spike criteria for lead were not met in sample 0316-95-0110, but this does not affect the quality of the data for the purposes of this report. Duplicate recovery for barium, lead, and manganese was outside the acceptable 20% range. This did not affect the quality of the data for the purposes of this report. All data were accepted as valid with qualification.
Inorganics	1106	Calibration blank for mercury was out of control. All mercury values were less than five times the value found in the blank and thus U-qualified. Spike recovery for selenium and cyanide was outside the acceptable range. However, all selenium and cyanide data were below the detection limit and thus qualified as UJ. All data were accepted as valid with qualification.
Inorganics	1174	Duplicate recovery for aluminum, chromium, iron, manganese, and zinc was outside the acceptable 20% range. This did not affect the quality of the data for the purposes of this report. All data are valid.
Inorganics	1204	Duplicate recovery for cobalt, copper, manganese, nickel, and zinc was outside the acceptable 20% range and qualified as P[e]. This did not affect the quality of the data for the purposes of this report. Spike recovery for lead, nickel, and zinc was well above the recommended 125%. These data were qualified as J+. The spike recovery for selenium was 66%, but all selenium values were below the detection limit and thus qualified as UJ. All data are valid as qualified.
Inorganics	1223	Spike recovery for selenium was 45% and all selenium data were UJ-qualified. Spike recovery for arsenic and barium was lower than the acceptable 75% and all arsenic and barium data were qualified as estimated with a low bias (J-). Duplicate recovery for barium, lead, and calcium was outside the acceptable 20% range. This did not affect the quality of the data for the purposes of this report. All data were accepted as valid with qualification.
Inorganics	1269	Duplicate recovery for chromium and iron was outside the acceptable 20% range. This did not affect the quality of the data for the purposes of this report. All data for this report are considered valid. (Samples 0316-95-0164 and -0165 had chromium values near the action levels and should be J-qualified.)
TU[f]	565	All data are valid.
TU	979	All data are valid.
TU	1108	All data are valid.
TU	1175	All data are valid.
TU	1205	All data are valid.
TU	1224	All data are valid.
TU	1270	All data are valid.
Inorganic TCLP[g]	563	All data are valid.

[a] This is a table reference text.

[b] J+ = The analyte was positively identified, and the result is likely to be biased high.

[c] UJ = The analyte was not positively identified in the sample, and the associated value is an estimate of the sample-specific EQL/EDL.

[d] J- = The analyte was positively identified, and the result is likely to be biased low.

[e] P = Professional judgment should be applied to using the data in decision making.

[f] TU = Total uranium.

[g] Inorganic TCLP = Inorganic toxicity characteristic leaching procedure.

TABLE B-2

DATA VALIDATION TABLE FOR ORGANIC SAMPLES

SUITE	REQUEST NUMBER	COMMENTS
VOCs	1102	Acetone, trichlorofluoromethane, and methylene chloride were found in the blank analysis. These analytes were qualified as U[a] in all samples because sample contained less than 10 times the concentration found in the blank. All data are valid.
VOCs	1173	One internal standard did not meet QC criteria for all samples. Sample 0316-95-0046 had three internal standards that did not meet QC criteria. Surrogate recovery was poor in all samples. Samples 0316-95-0044 through -0046 were reanalyzed. The reanalyzed results should be considered valid and the original results invalid. Methylene chloride was present in the method blank due to lab contamination.
VOCs	1222	Acetone, trichlorofluoromethane, and methylene chloride were found in the blank analysis. These analytes were qualified as U in all samples because sample contained less than 10 times the concentration found in the blank. All data are valid.
HE	563	Data considered valid.
HE	972	All data are valid for the purposes of this report.
HE	1102	Data are considered valid for the purposes of this report.
HE	1173	Samples were extracted and analyzed twice. The first extraction showed high concentrations of HE that may have saturated the extract. The second analysis showed that extract was not saturated. The first set of analytical results are valid without qualification.
HE	1203	Data are considered valid for the purposes of this report.
HE	1222	Data are considered valid for the purposes of this report.
HE	1268	Lab control sample recovery was poor. Data are considered valid for the purposes of this report.
Pesticides	563	Validation incorrectly indicated that holding times were missed. Data were qualified PM[b] as a results. Data are valid without qualification.
SVOCs	563	Phthalate contamination of method blank due to lab contamination. Internal standards did not meet QC criteria. As a result, some data are PM-qualified. For the purposes of this report, data are considered acceptable.
SVOCs	972	Phthalate contamination of method blank due to lab contamination. All data are valid.
SVOCs	1102	Phthalate contamination of blank due to lab contamination. Phthalate data qualified as U because it was below 10 times the detection limit One internal standard for sample 316-95-0048 was below the acceptable 50% level and some undetected compounds were qualified as UJ[c]. One internal standard for sample 0316-95-0051 was significantly below the acceptable 50% level and some undetected compounds were rejected.
SVOCs	1173	All data are valid.
SVOCs	1203	Phthalate contamination of method blank. All data are valid.
SVOCs	1222	Phthalate contamination of method blank due to lab contamination. Sample 0316-95-0024 missed holding times by one day. Usability of data was not affected. QC results within allowable limits; all data are valid.
SVOCs	1268	All data are valid.
SVOCs TCLP[d]	563	All data are valid.

[a] U = The analyte was not positively identified in the samples and the associated value is the sample-specific EQL/EDL.

[b] PM = Professional judgment should be applied to using the data in decision-making. A manual review of the raw data is recommended.

[c] UJ = The analyte was not positively identified in the sample, and the associated value is an estimate of the sample-specific EQL/EDL.

[d] SVOCs TCLP = Semivolatile organics toxicity characteristic leaching procedure.

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APPENDIX C PRELIMINARY ENVIRONMENTAL GEOCHEMISTRY OF SURFACE AND SPRING WATERS AT TA-16, LOS ALAMOS NATIONAL LABORATORY, NEW MEXICO

1.0 INTRODUCTION

This appendix provides chemical data and preliminary interpretations of the data for spring, surface, and outfall waters collected in the high explosives (HE) area at Technical Area (TA)-16, Los Alamos National Laboratory (LANL), New Mexico. These data are compared with data from background springs issuing from similar rock units in the Jemez Mountains. These data are provided in this Resource Conservation and Recovery Act (RCRA) Facilities Investigation (RFI) report because PRS 16-021(c) is the most likely source of contamination found in surface and groundwaters at TA-16. The primary constituents of concern are listed in Table C-1. These are constituents that were consistently found at levels greater than regional backgrounds and that, in some cases, exceed screening action levels (SALs).

TABLE C-1

CONTAMINANTS OF CONCERN IN THE SPRINGS AND SEEPS AT TA-16

SPRING/SEEP	BANDELIER TUFF UNIT	CONSTITUENTS
Burning Ground Spring	3	Barium, HMX, RDX
Fish Ladder Seep	3	Barium, HMX, RDX
Martin Spring	4	Barium, boron, HMX, RDX
Peter Seep	3	Barium[a]
SWSC Line Spring	3	Barium, HMX, RDX

[a] Peter seep was not analyzed for high explosives.

2.0 METHODS AND PROCEDURES

TA-16 water sampling began in April 1994 and has continued through fiscal year (FY) 1996. Surface water sampling in canyons and outfalls began in March 1995 and also has continued through FY96. All spring, outfall, surface water, and assorted sampling locations are shown in Fig. C-1 and C-2. All TA-16 springs issue from the Upper Bandelier Tuff. Two springs, Burning Ground and SWSC Line, appear to issue from Tshirege Subunit 3, and one spring, Martin Spring, appears to issue from Tshirege Subunit 4. Two sets of background spring analyses were chosen from the literature for comparison with the TA-16 data. Background springs were chosen to represent water that is "pre laboratory" in composition. These springs are located on and around the Pajarito Plateau but away from LANL, and issue from the Bandelier Tuff or similar volcanic rock units. Locations of these background springs are shown in Blake et al., 1995 (1355). These springs were also chosen because they are relatively dilute, have a neutral pH, and low temperatures (5–15°C). In addition, many of these springs have shown relatively constant abundances of background constituents over the last 20 years or more of sampling. One set of data was collected from July 1974 through April 1979, and the second set was collected from May 1987 through October 1991. Three springs in the background set were resampled in April 1996.

The waters discussed in this appendix were sampled by two organizations. Analyses labeled with NMED were collected by the New Mexico Environment Department (NMED) Agreement in Principle Group (Dale et al. in press, 15-16-630). Their samples were submitted to external Environmental Protection agency (EPA)-qualified laboratories for analysis using SW-846 methods. All other samples were collected by LANL Earth and Environmental Sciences (EES)-1 group. EES-1 procedures for sampling are as follows. Four sample splits are taken at each site. Two chemistry samples are taken, both in 125 ml polyethylene bottles, and sealed with Polyseal™ caps. These samples are filtered with 0.45 µm filter paper using a hand-operated vacuum pump. One sample is acidified with nitric acid to a pH less than two, and the other is not acidified. Two samples are left unfiltered and unacidified, one collected in a 500 ml polyethylene bottle for tritium analysis, and the other in a 30 ml glass bottle for stable isotope analysis. Both are capped with Polyseal™ caps. A colorimetric HE spot test was performed on unfiltered waters before removing samples from the high explosives area at TA-16. The detection limits of the HE spot test are at levels such that a positive reading for HE indicates a sample with contamination at a level above its SAL.

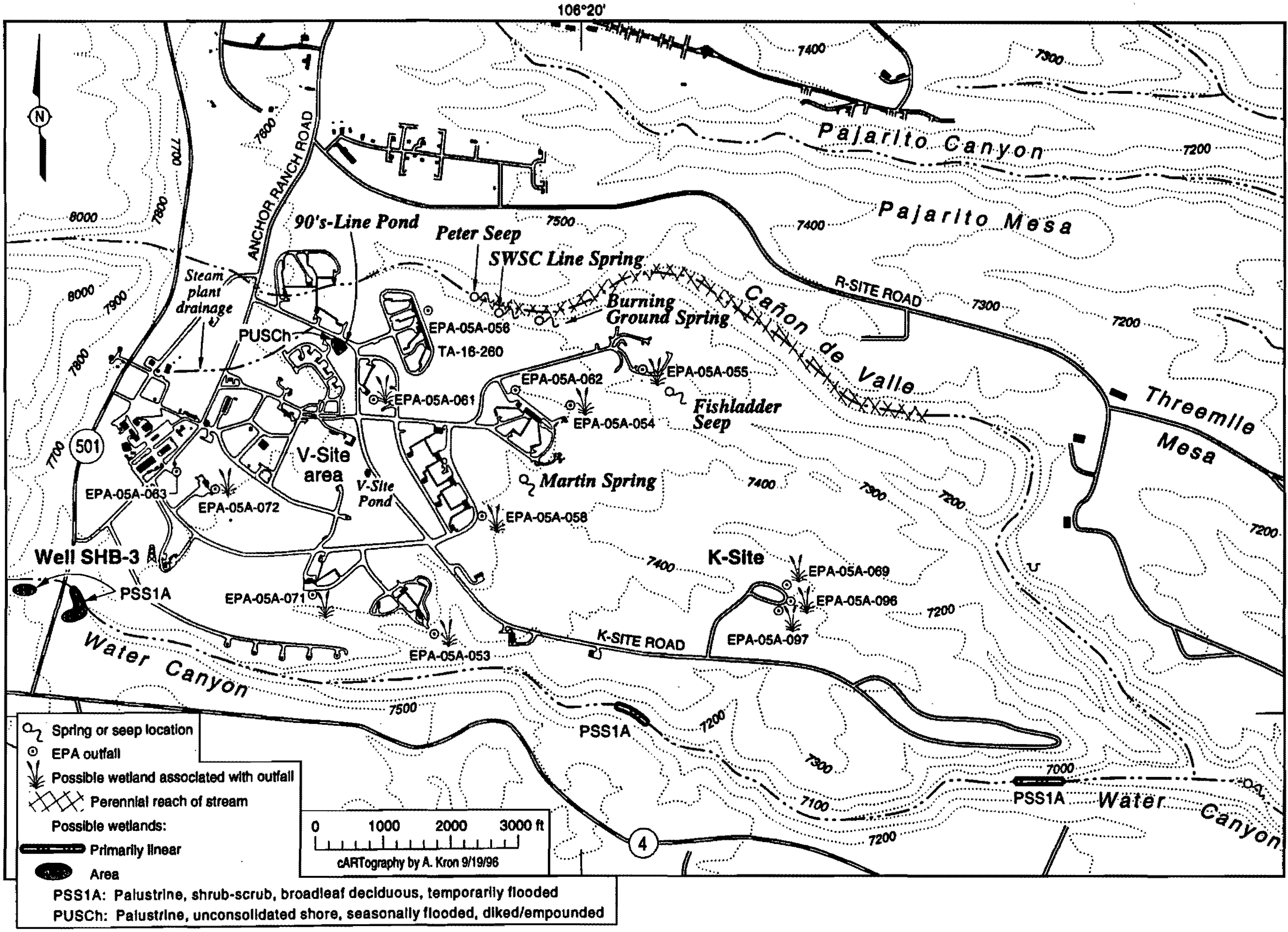

Fig. C-1. Spring, surface water and assorted sampling locations.

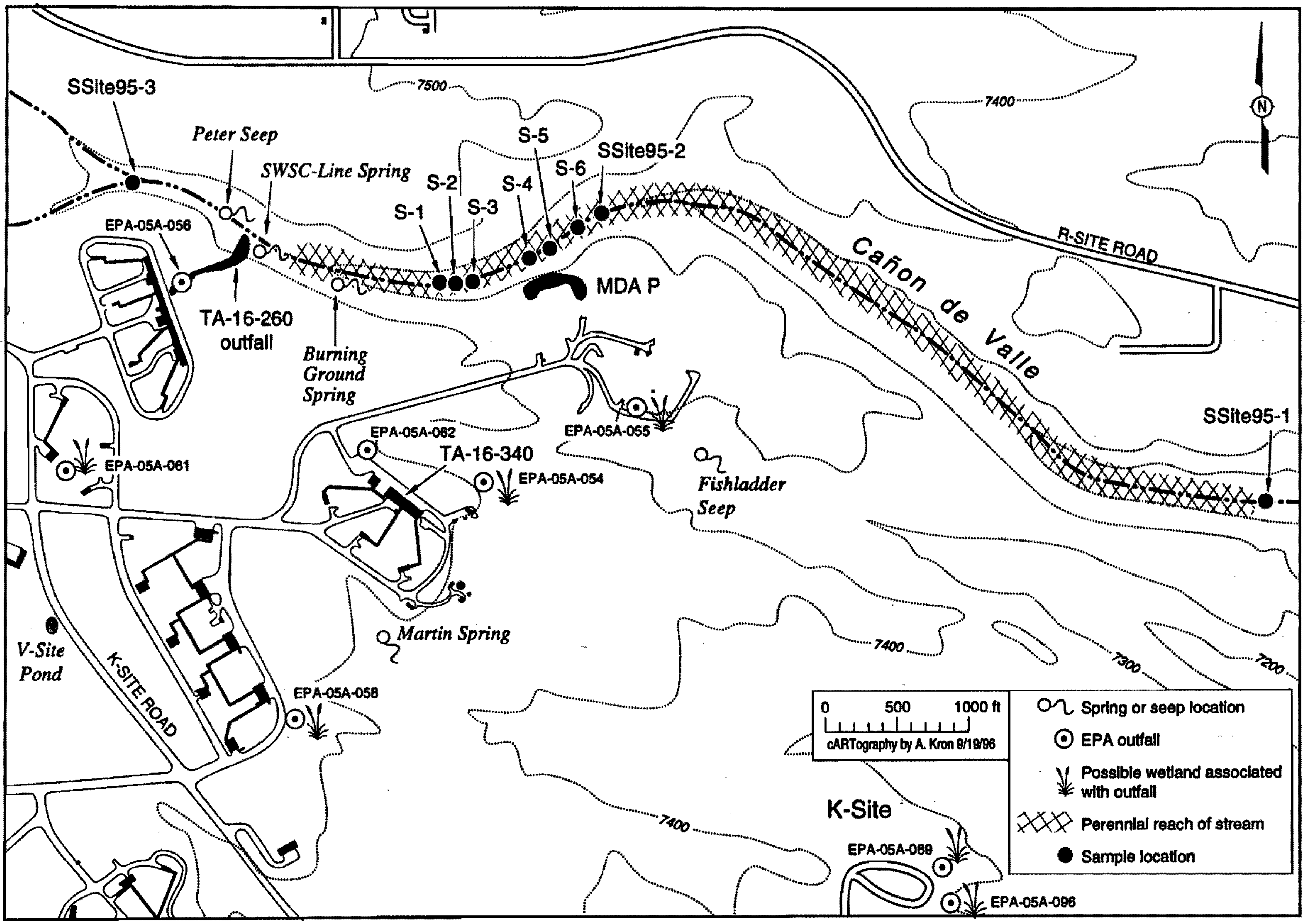

Fig. C-2. Sampling locations in Cañon de Valle.

Waters were analyzed for selected metals, anions, cations, and high explosives. For the EES-1 samples, methods of analysis and detection limits for all constituents are outlined in Table C-2. Analytes consistently below detection limits were not reported in the tables. Other analyses include tritium by the Tritium Laboratory at the University in Miami, Florida, and deuterium and oxygen-18 by Western Michigan University in Kalamazoo, Michigan. Four springs sampled by NMED were analyzed for organic constituents.

TABLE C-2

METHODS OF CHEMICAL ANALYSIS AND DETECTION LIMITS (ppm) FOR WATER SAMPLES

ANALYTE	METHOD	DETECTION LIMIT
Ag	GFAA[a]	0.0005
Al	ICP-AES[b]	0.01
As	Hydride AA[c]	0.001
B	ICP-AES	0.01
Ba	ICP-AES	0.01
Be	ICP-AES	0.002
Br	IC[d]	0.02
Ca	ICP-AES	0.01
Cd	GFAA	0.0002
Cl	IC	0.01
Co	GFAA	0.002
CO_3/HCO_3	Titration	0.5
Conductivity	Eloctrode	0.5
Cr	GFAA	0.002
Cs	GFAA	0.002
Cu	GFAA	0.002
F	IC	0.01
Fe	ICP-AES	0.01
Hg	Cold vapor AA	0.0002
I	IC	0.01
K	ICP-AES	0.2
Li	ICP-AES	0.01
Mg	ICP-AES	0.01
Mn	ICP-AES	0.01

ANALYTE	METHOD	DETECTION LIMIT
Mo	GFAA	0.002
Na	ICP-AES	0.05
NH_4	Electrode	0.02
Ni	GFAA	0.002
NO_2	IC	0.02
NO_3	IC	0.02
Pb	GFAA	0.002
pH	Electrode	0.01
PO_4	IC	0.05
Rb	GFAA	0.002
Sb	Hydride AA	0.001
Se	Hydride AA	0.001
Si	ICP-AES	0.02
SO_4	IC	0.02
S_2O_3	IC	0.01
Sr	ICP-AES	0.01
Ti	ICP-AES	0.002
V	ICP-AES	0.002
Zn	ICP-AES	0.005
HMX	HPLC[e]	0.02
NQ	HPLC	0.01
PETN	HPLC	0.05
RDX	HPLC	0.01
TNT	HPLC	0.01

[a] GFAA = Graphite furnace atomic absorption spectoscopy.
[b] ICP-AES = Inductively coupled plasma atomic emission spectroscopy.
[c] AA = Atomic absorption spectroscopy.
[d] IC = Ion chromatography.
[e] HPLC = High pressure liquid chromatography.

3.0 FLUID GEOCHEMISTRY

All major and minor element chemical analyses are listed in Tables C-3 and C-4. High explosives are listed in Table C-5, stable isotopes and tritium values are listed in Table C-6, and organic analyses are listed in Table C-7. SALs for each constituent are listed at the top of the HE table.

TA-16 spring data (Fig. C-1) were compared with background spring data, which are presumably free of anthropogenic contamination. Even though TA-16 waters issue from rock units similar to the background suite, the major-element water chemistries are different. Elements not of concern, but higher than background, at TA-16 include sodium, chloride, calcium, and magnesium. Sodium and chloride are possibly derived from road salt.

Boron is found in many TA-16 springs at levels above regional background. The high boron concentrations are possibly linked to the use of Boracitol, an explosive composed of boric acid and TNT used historically at TA-16 (specifically at V-Site, Fig. C-1). However, boron is also found in warmer and deeper ground waters due to water-rock interactions (Blake et al. 1995, 1355). However, it is unlikely that a connection exists between a deep aquifer and the TA-16 springs due to the differences in isotopic compositions between TA-16 waters and deep groundwaters. Because the detection limit for boron has decreased since the majority of background sampling occurred, only analyses of four background waters show detectable boron. All 1996 background samples have boron values below 0.013 ppm. Even though boron concentrations in TA-16 waters fall below SAL, the majority of the waters show boron exceeding background levels. Boron concentrations in Martin Spring (1.4—1.8 ppm) are anomalously high relative to other springs and surface waters at TA-16. These data suggest interaction of shallow groundwaters with leachable boron found in soils in the vadose zone and suggest a different source for Martin Spring than for the other springs at TA-16. Anthropogenic boron has been found in other LANL waters such as a spring at TA-21 (Blake et al. 1995,1355 Broxton and Eller 1995, 1162).

Analytes above SALs in TA-16 waters include barium, manganese, and RDX. Barium is elevated above background in all TA-16 waters except for the outfall waters collected at buildings TA-16-300, TA-16-340 and TA-16-222. High barium is related to the use of Baratol, an explosive made from barium nitrate and TNT that was used extensively site-wide in many explosive components from 1945 through the 1950s. In addition to the remobilization of barium from the soil in the outfall at PRS 16-021(c), discharges from the TA-16-260 outfall (0.5 ppm) are a potential source for elevated levels of barium in Burning Ground and SWSC Line springs

TABLE C-3

MAJOR ELEMENTS OF TA-16 WATERS

SAMPLE ID	DESCRIPTION	DATE	BORON (ppm)	BROMINE (ppm)	CALCIUM (ppm)	CHLORINE (ppm)	FLUORINE (ppm)	HYDROGEN CARBONATE (ppm)	LITHIUM (ppm)	MAGNESIUM (ppm)	POTASSIUM (ppm)	SODIUM (ppm)	SILICATE (ppm) calc	SULFATE (ppm)	STRONTIUM (ppm)	TOTAL DISSOLVED SOLVENTS (ppm)	CATION SUM	ANION SUM
Springs/Seeps																		
PP94-50	Burning Ground Spring	4/15/94	0.01	0.08	18.7	21.8	0.20	87.4	<0.01	4.86	3.30	21.4	49.86	8.31	0.14	220.5	2.461	2.279
NMED	Burning Ground Spring	8/12/94	<0.1	NA[a]	20	15	0.2	92	NA	4.9	5	19	NC[b]	10	0.1	NC	NC	NC
NMED	Burning Ground Spring	3/17/95	<0.01	<0.4	14	19	<0.5	85	<0.01	4.5	3	25	NC	30	<0.01	180	NC	NC
SSite96-5	Burning Ground Spring	3/01/96	0.021	0.09	17.5	16.6	0.16	104	<0.01	5.03	3.33	25.4	47.72	9.84	0.11	206.8	0.121	4.851
SSite96-17	Burning Ground Spring	4/10/96	0.021	0.07	16.4	14.3	0.14	100	<0.01	4.71	3.26	24.0	46.44	9.02	0.11	223.8	2.396	2.313
NMED	Martin Spring	5/12/95	1.4	<0.5	24	19	<0.5	104	<0.01	6	3	22	NC	20	0.12	200	NC	NC
PP95-132	Martin Spring	7/21/95	1.58	0.13	24.6	20.2	0.61	122	0.01	5.71	3.31	30.9	47.08	17.9	0.13	290.2	3.164	3.298
SSite96-4	Martin Spring	3/01/96	1.81	0.16	28.1	20.6	0.70	130	0.01	6.45	2.89	34.1	51.36	20.7	0.14	275.3	0.552	6.047
SSite96-15	Martin Spring	4/10/96	1.81	0.16	28.1	20.3	0.67	137	0.01	6.47	2.85	36.4	52.00	21.0	0.16	325.9	3.618	3.675
PP94-74	SWSC Spring	8/12/94	0.026	0.09	18.4	17.3	0.18	92.9	<0.01	4.97	3.04	20.2	45.37	10.2	0.13	219	2.318	2.322
NMED	SWSC Spring	8/12/94	<0.1	NA	18	15	0.2	90	NA	5.4	5	19	NC	10	0.1	NC	NC	NC
NMED	SWSC Spring	3/17/95	<0.01	<0.4	16	19	<0.5	80	<0.01	4.8	3	24	NC	31	<0.01	174	NC	NC
SSite96-18	SWSC Spring	4/10/96	0.029	0.09	16.3	14.3	0.13	100	<0.01	4.83	3.26	24.8	46.44	9.18	0.11	225.2	2.419	2.324
SSite96-6	SWSC Spring	3/01/96	0.033	0.10	18.2	16.8	0.16	104	<0.01	5.19	3.38	25.4	44.94	10.1	0.12	206.6	0.132	4.851
NMED	Fish Ladder Seep	6/2/95	0.2	NA	4	7	<0.5	25	0.02	1	<1	12	NC	84	0.04	250	NC	NC
SSite96-11	Fish Ladder Seep	3/27/96	0.040	<0.01	5.44	5.21	0.07	11.5	0.04	1.88	3.10	9.36	72.55	17.7	0.04	130.2	1.141	0.709
NMED	Peter Seep	6/2/95	0.04	NA	15	16	<0.5	83	<0.01	4	3	16	NC	18	0.11	140	NC	NC
Outfalls																		
---	260 outfall	---	0.02	NA	11	NA	NA	NA	NA	3	NA	NA	NC	NA	0.05	NC	NC	NC
PP95-133	300 outfall	7/21/95	0.035	<0.02	8.95	2.55	0.20	64	0.02	2.21	2.25	10.8	63.56	1.82	0.05	159.2	1.226	1.197
---	300 outfall	---	0.02	NA	9	NA	NA	NA	NA	3	NA	NA	NC	NA	0.05	NC	NC	NC
—	340 outfall	---	0.02	NA	10	NA	NA	NA	NA	4	NA	NA	NC	NA	0.05	NC	NC	NC
SSite96-10	340 outfall	3/27/96	0.021	0.04	11.1	2.94	0.21	67.6	0.03	3.68	2.58	12.7	84.32	2.32	0.06	195.5	1.496	1.500
SSite96-21	Silver outfall	4/10/96	0.020	0.04	9.09	2.63	0.18	66.5	0.03	3.03	2.31	11.7	81.32	3.75	0.04	183.7	1.306	1.296
Creeks																		
PP95-134	300-line Canyon TA-16	7/21/95	0.21	0.03	13.4	3.79	0.21	83	0.01	3.41	5.36	13.6	33.17	5.16	0.09	163.2	1.741	1.609
SSite95-1	Cañon de Valle Creek	3/17/95	0.038	0.03	13.5	16.8	0.14	69.9	<0.01	4.12	3.08	18.2	29.10	15.5	0.13	175.5	1.983	1.953
SSite95-2	Cañon de Valle Creek	3/17/95	0.033	0.07	14.8	20.9	0.20	81.0	<0.01	4.48	3.24	22.1	35.74	9.78	0.11	196.8	2.222	2.143
SSite95-3	Cañon de Valle Creek	3/17/95	0.015	0.08	19.6	22.9	0.27	92.6	<0.01	5.48	3.88	22.7	47.08	11.1	0.12	233.6	2.588	2.47
MDA P S-1	Cañon de Valle Creek	4/94	NA	NA	19	NA	NA	NA	NA	5.6	3	21	NC	NA	NA	NC	NC	NC
MDA P S-2	Cañon de Valle Creek	4/94	NA	NA	19	NA	NA	NA	NA	5.5	3.1	20	NC	NA	NA	NC	NC	NC
MDA P S-3	Cañon de Valle Creek	4/94	NA	NA	19	NA	NA	NA	NA	5.5	2.5	20	NC	NA	NA	NC	NC	NC
MDA P S-4	Cañon de Valle Creek	4/94	NA	NA	18	NA	NA	NA	NA	5.3	2.7	20	NC	NA	NA	NC	NC	NC
MDA P S-5	Cañon de Valle Creek	4/94	NA	NA	18	NA	NA	NA	NA	5.2	2.8	20	NC	NA	NA	NC	NC	NC
MDA P S-6	Cañon de Valle Creek	4/94	NA	NA	17	NA	NA	NA	NA	5.1	2.5	20	NC	NA	NA	NC	NC	NC
PP94-52	Snowmelt, Cañon de Valle	4/15/94	<0.01	<0.02	7.56	1.50	0.04	38.0	<0.01	2.26	1.47	3.29	25.89	3.39	0.07	84.4	0.827	0.738
PP94-51	Weirbox, Cañon de Valle	4/15/94	0.04	0.07	15.5	19.8	0.23	82.0	<0.01	4.09	2.89	20.0	35.31	7.76	0.14	191.3	2.147	2.079

TABLE C-3 (CONTINUED)

MAJOR ELEMENTS OF TA-16 WATERS

SAMPLE ID	DESCRIPTION	DATE	BORON (ppm)	BROMINE (ppm)	CALCIUM (ppm)	CHLORINE (ppm)	FLUORINE (ppm)	HYDROGEN CARBONATE (ppm)	LITHIUM (ppm)	MAGNESIUM (ppm)	POTASSIUM (ppm)	SODIUM (ppm)	SILICATE (ppm) calc	SULFATE (ppm)	STRONTIUM (ppm)	TOTAL DISSOLVED SOLVENTS (ppm)	CATION SUM	ANION SUM
Assorted locations																		
SSite96-8	90s-line Drainage	3/05/96	0.049	0.12	9.19	16.7	0.74	311	0.04	2.20	6.24	134	145.73	17.5	0.05	636.0	0.089	14.453
SSite96-19	90s-line Drainage	4/10/96	0.056	0.10	10.3	27.8	0.61	345	0.05	2.36	7.97	154	150.23	13.7	0.07	749.4	7.751	7.696
SSite96-9	90s-line Pond	3/05/96	0.007	0.01	5.05	0.98	0.14	23.7	<0.01	1.12	2.71	1.76	3.60	0.84	0.05	54.3	0.025	1.130
SSite96-20	90s-line Pond	4/10/96	0.017	<0.01	7.42	1.26	0.18	32.2	<0.01	1.27	4.12	2.89	5.84	0.81	0.07	59.8	0.873	0.591
PP95-135	K-Site	7/21/95	0.74	0.11	15.3	15.4	0.28	85	0.01	3.54	8.90	24.4	29.96	14.2	0.09	208.3	2.525	2.327
SHB-3	TA-16 well	7/20/93	0.09	0.02	16	7.54	0.28	0	0.04	0.85	15.50	24	82.40	7.54	0.2	205.7	2.33	2.284
SSite96-7	WWTP	3/05/96	0.022	0.03	30.2	216	0.30	101	0.04	9.17	9.65	117	76.61	3.80	0.14	319.5	0.411	4.791
SSite96-16	WWTP	4/10/96	0.017	<0.01	23.5	136	0.11	93.2	0.02	7.87	6.03	80.9	83.03	3.06	0.11	440.1	5.677	5.482
Background springs																		
SSite96-13	Apache Spring	4/03/96	0.005	0.01	10.9	7.72	0.04	69.0	<0.01	4.86	4.75	9.77	56.07	5.93	0.10	171.1	1.532	1.498
44	Cold Spring west cal	6/1/80	0.73	0.06	12	1.9	0.25	53.7	0.03	1.5	3	8	30.00	5.5	0.06	NC	NC	NC
62	Frijoles Spring #49	5/22/91	<0.01	<0.02	8	14	0.03	39	<0.01	2.98	2.9	6.8	17.00	3.85	0.09	NC	NC	NC
63	Frijoles Spring #50	5/22/91	<0.01	<0.02	7.9	6.11	0.04	53.6	<0.01	3.71	2.5	7.2	25.00	2.66	0.07	NC	NC	NC
66	Pine Spring	5/24/91	<0.01	<0.02	10.7	1.47	0.08	61	<0.01	3.55	3.6	6.4	25.00	7.7	0.08	NC	NC	NC
0	Pine Spring	3/26/95	0.02	<0.4	11	<5	<0.5	NA	0.01	3.6	3	5.1	NC	66	0.09	NC	NC	NC
0	Pine Spring	10/16/95	<0.1	NA	10	2	<0.2	48	<0.01	3	3	6	NC	<10	0.07	NC	NC	NC
44	Seven Springs	10/1/79	<0.003	NA	12.3	3.6	0.21	49	0.018	1.54	2.1	7.23	41.00	8.7	0.071	NC	NC	NC
44	Seven Springs	5/1/83	NA	0.27	11	1.9	0.25	53.7	0.05	1.4	4	8	30.00	5.9	0.05	NC	NC	NC
76	Seven Springs	5/10/91	<0.02	<0.02	12.9	1.22	0.16	61	<0.01	1.71	2.4	6.3	31.00	3.85	0.06	NC	NC	NC
SSite96-12	Seven Springs	4/3/96	0.013	<0.01	12.5	1.85	0.12	59.5	<0.01	1.63	2.13	7.26	31.03	4.03	0.06	121.5	1.148	1.137
52	Unnamed Cold	7/1/80	<0.01	<0.2	10.6	7.1	0.3	75	0.024	3.4	3.1	9.4	65.00	3.4	0.049	NC	NC	NC
53	Unnamed Cold	7/1/80	<0.01	<0.2	10.4	7.5	0.35	73	0.024	3.4	3.2	9	69.00	2.4	0.051	NC	NC	NC
67	Unnamed Spring	5/28/91	<0.01	<0.02	9.1	1.34	0.14	56.1	<0.01	2.44	4.6	7	21.00	5.73	0.05	NC	NC	NC
89	Unnamed Spring	9/10/93	<0.05	0.02	11.4	4.38	0.34	80.8	0.03	2.9	2.49	16.2	60.10	4.04	0.1	NC	NC	NC
1	Water Canyon Gallery	8/1/78	<0.05	NA	7	NA	0.12	52	0.02	3.3	1.4	5.8	43.00	NA	0.05	NC	NC	NC
25	Water Canyon Gallery	8/18/92	<0.05	<0.02	7.2	0.64	0.05	52.8	<0.01	3.05	1.72	6.3	43.70	1.05	0.07	NC	NC	NC
25	Water Canyon Gallery	5/20/93	<0.01	0.01	6.94	0.69	0.06	44.6	0.01	2.79	1.79	4.9	39.80	2.85	0.07	NC	NC	NC
SSite96-14	Water Canyon Gallery	4/03/96	0.004	<0.01	6.18	0.77	0.03	48.9	0.02	3.15	1.75	5.99	44.30	1.20	0.05	113.6	0.900	0.865

[a] NA = Not analyzed.

[b] NC = Not calculated.

TABLE C-4

MINOR ELEMENTS OF TA-16 WATERS

SAMPLE ID	DESCRIPTION	DATE	SILVER (ppm)	ALUMINUM (ppm)	ARSENIC (ppm)	BARIUM (ppm)	CADMIUM (ppm)	COBALT (ppm)	CHROMIUM (ppm)	CESIUM (ppm)	COPPER (ppm)	IRON (ppm)	MERCURY (ppm)	IODINE (ppm)	MANGANESE (ppm)	MOLYBDENUM (ppm)	AMMONIUM (ppm)	NICKEL (ppm)	NITRITE (ppm)	NITRATE (ppm)	LEAD (ppm)	PHOSPHATE (ppm)	RUBIDIUM (ppm)	ANTIMONY (ppm)	SELENIUM (ppm)	THIOSULFATE (ppm)	ZINC (ppm)
Springs/Seeps																											
PP94-50	Burning Ground Spring	4/15/94	<0.0005	0.75	0.0008	0.29	0.0003	<0.002	<0.002	<0.002	0.004	0.31	0.0002	<0.01	<0.01	<0.002	0.10	0.005	<0.02	2.91	0.003	<0.05	0.005	<0.0002	<0.0002	<0.01	0.01
NMED	Burning Ground Spring	8/12/94	<0.1	0.4	0.0005	0.3	<0.001	<0.001	0.002	NA[a]	<0.01	0.3	<0.0005	NA	<0.05	<0.001	NA	<0.1	NA	1.1	<0.001	NA	NA	NA	<0.005	NA	<0.1
NMED	Burning Ground Spring	3/17/95	<0.01	0.4	<0.005	0.3	<0.005	<0.01	<0.01	NA	<0.01	0.1	<0.0002	NA	<0.01	<0.01	NA	<0.02	NA	NA	<0.003	NA	NA	<0.06	<0.005	NA	<0.02
SSite96-5	Burning Ground Spring	3/01/96	0.0004	0.55	0.0035	0.23	<0.001	<0.002	<0.002	<0.002	0.004	0.22	0.0002	<0.01	<0.01	0.002	0.05	<0.002	<0.02	3.91	<0.002	0.44	0.005	<0.0002	<0.0002	<0.01	0.01
SSite96-17	Burning Ground Spring	4/10/96	<0.0002	0.41	0.0009	0.21	<0.0002	<0.002	<0.002	0.003	<0.002	0.16	<0.0002	<0.01	<0.01	0.003	0.05	0.002	<0.01	4.08	<0.002	0.42	0.008	<0.0001	<0.0001	<0.01	<0.01
NMED	Martin Spring	5/12/95	<0.01	<0.2	<0.01	0.2	<0.005	<0.01	<0.01	NA	<0.01	<0.1	<0.003	NA	<0.01	<0.01	NA	<0.02	NA	NA	<0.003	NA	NA	<0.02	<0.005	NA	<0.02
PP95-132	Martin Spring	7/21/95	<0.0005	0.16	0.0013	0.17	<0.0002	<0.002	<0.002	<0.002	<0.002	0.08	<0.0002	<0.01	<0.01	0.007	0.19	<0.002	0.04	15.2	<0.002	0.21	0.003	<0.0002	<0.0002	<0.01	0.01
SSite96-4	Martin Spring	3/01/96	<0.0002	0.08	0.0019	0.19	<0.001	<0.002	<0.002	<0.002	0.005	0.04	0.0006	0.04	<0.01	0.009	0.10	0.003	<0.02	18.3	<0.002	0.28	0.002	<0.0002	<0.0002	<0.01	0.01
SSite96-15	Martin Spring	4/10/96	<0.0002	0.16	0.0018	0.19	<0.0002	<0.002	0.002	0.002	<0.002	0.01	<0.0002	0.03	<0.01	0.010	0.03	<0.002	<0.01	18.3	<0.002	0.21	0.004	0.0001	<0.0001	<0.01	<0.01
PP94-74	SWSC Spring	8/12/94	<0.0005	0.09	<0.0005	0.32	0.0006	<0.002	<0.002	<0.002	0.018	0.07	<0.0002	<0.01	0.06	<0.002	0.15	0.003	<0.01	5.32	<0.002	0.09	0.002	<0.0002	<0.0002	<0.01	0.10
NMED	SWSC Spring	8/12/94	<0.1	0.3	0.001	0.3	<0.001	<0.05	<0.001	NA	<0.01	0.2	<0.0005	NA	<0.001	<0.1	NA	<0.1	NA	1	<0.001	NA	NA	NA	<0.005	NA	0.02
NMED	SWSC Spring	3/17/95	<0.01	0.9	<0.005	0.3	<0.005	<0.01	<0.01	NA	<0.01	0.4	<0.0002	NA	<0.01	<0.01	NA	<0.02	NA	NA	<0.003	NA	NA	<0.08	<0.005	NA	0.04
SSite96-18	SWSC Spring	4/10/96	<0.0002	0.29	0.0016	0.27	<0.0002	<0.002	<0.002	0.002	<0.002	0.10	<0.0002	<0.01	<0.01	0.003	0.04	<0.002	<0.01	4.80	<0.002	0.41	0.005	<0.0001	<0.0001	<0.01	<0.01
SSite96-6	SWSC Spring	3/01/96	0.0003	0.52	0.0016	0.28	<0.001	<0.002	<0.002	<0.002	0.003	0.22	<0.0002	<0.01	<0.01	0.002	0.07	0.004	0.07	4.31	<0.002	0.33	0.008	<0.0002	<0.0002	<0.01	0.01
NMED	Fish ladder Seep	6/2/95	<0.01	2	<0.01	1.7	<0.005	<0.01	<0.01	NA	<0.01	1	<0.0002	NA	0.01	<0.1	NA	<0.02	NA	0.1	0.003	0.27	NA	<0.02	0.008	NA	0.06
SSite96-11	Fish ladder Seep	3/27/96	<0.0002	1.20	0.0024	0.29	<0.0002	<0.002	0.002	<0.002	0.008	1.28	<0.0002	<0.01	0.05	<0.002	0.22	0.003	<0.01	<0.02	0.005	<0.05	0.003	<0.0001	<0.0001	<0.01	0.04
NMED	Peter Seep	6/2/95	<0.01	<0.2	<0.01	1	<0.005	<0.01	<0.01	NA	<0.01	<0.1	<0.0002	NA	<0.01	<0.1	NA	<0.02	NA	0.5	<0.003	0.12	NA	<0.02	<0.005	NA	0.07
Outfalls																											
—	260 outfall	—	NA	NA	NA	0.5	NA	NA	NA	NA	0.01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
PP95-133	300 outfall	7/21/95	<0.0005	0.04	0.0013	0.04	<0.0002	<0.002	<0.002	0.008	0.010	0.39	<0.0002	<0.01	<0.01	0.009	0.71	<0.002	0.09	1.44	<0.002	<0.02	0.004	0.0003	<0.0002	<0.01	0.02
—	300 outfall	—	NA	NA	NA	NA	NA	NA	NA	NA	0.02	NA	NA	NA	NA	0.02	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
—	340 outfall	—	NA	NA	NA	NA	NA	NA	NA	NA	0.01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.02
SSite96-10	340 outfall	3/27/96	<0.0002	0.09	0.0026	0.03	<0.0002	<0.002	0.005	<0.002	0.003	0.03	<0.0002	<0.01	<0.01	0.004	0.08	<0.002	<0.01	0.50	<0.002	<0.05	0.008	0.0002	<0.0001	<0.01	<0.01
SSite96-21	Silver outfall	4/10/96	0.0037	0.11	0.0017	0.03	<0.0002	<0.002	0.006	<0.002	0.003	0.04	<0.0002	<0.01	<0.01	<0.002	0.27	<0.002	0.25	2.31	<0.002	<0.05	0.004	<0.0001	<0.0001	<0.01	0.02
Creeks																											
PP95-134	300-line Canyon TA-16	7/21/95	<0.0005	0.32	0.0019	0.24	0.0008	<0.002	<0.002	<0.002	<0.002	0.21	<0.0002	<0.01	0.02	0.007	0.14	0.008	<0.01	0.17	0.002	0.85	0.003	<0.0002	<0.0002	<0.01	0.01
SSite95-1	Cañon de Valle Creek	3/17/95	<0.0005	0.51	0.0003	3.28	0.0018	<0.002	<0.002	<0.002	0.031	0.58	<0.0002	<0.01	0.04	<0.002	0.21	<0.002	<0.02	0.10	0.004	<0.05	0.002	0.0004	<0.0002	<0.01	0.15
SSite95-2	Cañon de Valle Creek	3/17/95	<0.0005	0.68	0.0008	2.44	<0.0002	<0.002	<0.002	<0.002	0.020	0.32	<0.0002	<0.01	0.01	<0.002	0.26	0.005	<0.02	0.56	<0.002	<0.05	0.004	0.0002	<0.0002	<0.01	0.02
SSite95-3	Cañon de Valle Creek	3/17/95	<0.0005	2.39	0.0008	0.43	<0.0002	<0.002	<0.002	<0.002	0.020	0.97	<0.0002	<0.01	<0.01	<0.002	0.20	0.002	<0.02	3.71	<0.002	<0.05	0.005	<0.0002	<0.0002	<0.01	0.02
MDA P S-1	Cañon de Valle Creek	4/94	ND[b]	0.31	ND	3	ND	ND	ND	NA	ND	ND	ND	NA	ND	NA	NA	ND	NA	0.1	ND	NA	NA	ND	ND	NA	ND
MDA P S-2	Cañon de Valle Creek	4/94	ND	0.56	ND	3	ND	ND	ND	NA	ND	0.34	ND	NA	ND	NA	NA	ND	NA	0.12	ND	NA	NA	ND	ND	NA	ND
MDA P S-3	Cañon de Valle Creek	4/94	ND	0.74	ND	3.1	ND	ND	ND	NA	ND	0.35	ND	NA	ND	NA	NA	ND	NA	ND	ND	NA	NA	ND	0.003	NA	ND
MDA P S-4	Cañon de Valle Creek	4/94	ND	0.37	ND	3.4	ND	ND	ND	NA	ND	0.31	ND	NA	ND	NA	NA	ND	NA	ND	ND	NA	NA	ND	ND	NA	ND
MDA P S-5	Cañon de Valle Creek	4/94	ND	0.18	ND	3.4	ND	ND	ND	NA	ND	ND	ND	NA	ND	NA	NA	ND	NA	ND	ND	NA	NA	ND	ND	NA	ND
MDA P S-6	Cañon de Valle Creek	4/94	ND	ND	ND	3.3	ND	ND	ND	NA	ND	ND	ND	NA	ND	NA	NA	ND	NA	ND	ND	NA	NA	0.003	ND	NA	ND
PP94-52	Snowmelt, Cañon de Valle	4/15/94	<0.0005	0.59	<0.0005	0.05	0.0004	<0.002	<0.002	<0.002	0.008	0.20	<0.0002	<0.01	<0.01	<0.002	0.08	<0.002	<0.02	<0.02	<0.002	<0.05	<0.002	<0.0002	<0.0002	<0.01	<0.01
PP94-51	Weirbox, Cañon de Valle	4/15/94	<0.0005	0.29	0.0016	2.90	<0.0002	<0.002	<0.002	<0.002	0.003	0.16	0.0006	<0.01	0.02	<0.002	0.11	0.008	<0.02	<0.02	<0.002	<0.05	0.004	<0.0002	<0.0002	<0.01	<0.01
Springs/Seeps																											
SSite96-8	90s-line Drainage	3/05/96	<0.0002	2.12	0.0053	0.06	<0.001	<0.002	0.002	<0.002	0.011	1.30	<0.0002	<0.01	0.02	0.004	0.12	0.005	<0.02	0.02	0.002	10.3	0.003	0.0008	<0.0002	<0.01	0.02
SSite96-19	90s-line Drainage	4/10/96	0.0002	0.83	0.0040	0.05	<0.0002	0.002	0.002	<0.002	0.010	0.67	<0.0002	<0.01	0.04	0.003	0.11	0.005	<0.01	<0.02	0.002	18.1	0.005	0.0004	0.0001	<0.01	<0.01
SSite96-9	90s-line Pond	3/05/96	<0.0002	0.71	0.0008	1.44	<0.001	<0.002	<0.002	<0.002	0.005	0.48	<0.0002	<0.01	<0.01	<0.002	0.14	<0.002	<0.02	0.09	<0.002	<0.05	0.002	<0.0002	<0.0002	<0.01	0.02
SSite96-20	90s-line Pond	4/10/96	<0.0002	0.94	0.0017	2.27	0.0012	<0.002	<0.002	<0.002	0.007	0.49	<0.0002	<0.01	<0.01	<0.002	0.03	0.005	<0.01	<0.02	0.002	<0.05	0.002	0.0001	<0.0001	<0.01	<0.01
PP95-135	K-Site	7/21/95	<0.0005	0.87	0.0045	0.20	0.0015	<0.002	<0.002	<0.002	0.014	1.12	<0.0002	<0.01	0.32	0.025	0.10	0.004	5.72	0.51	<0.002	1.39	0.007	0.0003	<0.0002	<0.01	0.03
SHB-3	TA-16 well	7/20/93	<0.001	<0.05	<0.001	0.08	<0.0005	<0.002	0.005	0.002	0.014	0.08	<0.001	<0.01	<0.01	0.11	0.46	0.005	<0.02	0.52	0.022	0.02	0.069	<0.001	<0.001	NA	0.14
SSite96-7	WWTP	3/05/96	<0.0002	0.07	0.0018	0.08	<0.001	<0.002	0.004	0.004	0.008	0.20	<0.0002	<0.01	0.01	0.002	6.04	<0.002	<0.02	2.09	<0.002	2.24	0.017	0.0004	0.0004	<0.01	0.03
SSite96-16	WWTP	4/10/96	<0.0002	0.08	0.0016	0.06	<0.0002	<0.002	0.004	0.002	0.003	0.05	<0.0002	<0.01	0.01	0.079	3.02	<0.002	<0.01	1.59	<0.002	1.38	0.018	<0.0001	<0.0001	<0.01	<0.01
Background springs																											
SSite96-13	Apache Spring	4/03/96	<0.0002	0.28	<0.0002	0.07	<0.0002	<0.002	<0.002	<0.002	<0.002	0.10	<0.0002	<0.01	<0.01	<0.002	0.04	<0.002	0.02	1.33	<0.002	0.07	0.010	<0.0001	<0.0001	<0.01	<0.01
44	Cold Spring west cal	8/1/80	NA	NA	NA	0.02	0.003	NA	NA	NA	NA	0.2	NA	NA	NA	NA	NA	NA	NA	0.19	NA	NA	NA	NA	NA	NA	NA
62	Frijoles Spring #49	5/22/91	<0.001	1	<0.05	0.06	<0.001	<0.002	<0.002	<0.005	0.003	2.12	<0.1	<0.01	<0.02	<0.002	0.09	<0.002	<0.02	0.3	<0.002	<0.05	0.008	<0.05	<0.1	NA	<0.01
63	Frijoles Spring #50	5/22/91	<0.001	0.5	<0.05	0.03	<0.001	<0.002	<0.002	<0.005	0.003	1.08	<0.1	<0.01	<0.02	<0.002	0.08	<0.002	<0.02	0.71	<0.002	0.11	0.007	<0.05	<0.1	NA	0.02
66	Pine Spring	5/24/91	<0.003	1.4	<0.05	0.05	<0.001	<0.002	0.004	0.006	0.004	4.17	<0.1	<0.01	<0.02	<0.002	0.24	<0.002	<0.02	0.04	0.003	<0.05	0.007	<0.05	<0.1	NA	0.07
0	Pine Spring	3/26/95	<0.01	1	<0.005	0.1	<0.005	<0.01	<0.01	NA	<0.01	0.5	<0.0002	NA	<0.01	<0.01	NA	<0.02	NA	0.2	<0.003	NA	NA	<0.06	<0.005	NA	<0.02
0	Pine Spring	10/16/95	<0.01	<0.2	<0.01	<0.1	<0.005	<0.01	<0.01	NA	<0.01	<0.1	<0.0002	NA	<0.01	<0.01	NA	<0.02	NA	0.1	<0.003	NA	NA	<0.02	<0.005	NA	<0.02
44	Seven Springs	10/1/79	<0.03	0.2	NA	0.036	<0.03	<0.06	0.001	NA	<0.04	0.038	NA	NA	0.001	0.001	NA	<0.05	NA	NA	<0.14	NA	NA	NA	NA	NA	<0.01
44	Seven Springs	5/1/83	NA	0.2	NA	0.02	0.003	NA	NA	NA	NA	0.2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
76	Seven Springs	5/10/91	<0.001	<0.1	<0.05	0.01	<0.001	<0.002	0.011	<0.005	<0.002	0.52	<0.1	<0.01	<0.02	<0.002	0.04	<0.002	<0.02	0.47	<0.002	<0.05	0.02	<0.1	<0.1	NA	0.01
SSite96-12	Seven Springs	4/3/96	<0.0002	0.12	0.0004	0.02	<0.0002	<0.002	<0.002	<0.002	0.002	0.02	<0.0002	<0.01	<0.01	<0.002	0.06	<0.002	<0.01	1.16	<0.002	<0.05	0.019	<0.0001	0.0003	<0.01	0.01
52	Unnamed Cold	7/1/80	<0.03	NA	NA	0.016	<0.001	<0.001	<0.001	NA	<0.001	0.15	NA	NA	0.002	<0.002	NA	<0.002	NA	<0.2	<0.004	<0.2	NA	NA	NA	NA	0.024
53	Unnamed Cold	7/1/80	<0.03	NA	NA	0.022	<0.001	<0.001	0.004	NA	<0.001	1.19	NA	NA	0.135	<0.002	NA	<0.002	NA	0.7	<0.004	<0.2	NA	NA	NA	NA	0.009
67	Unnamed Spring	5/28/91	<0.001	3.9	<0.05	0.08	0.001	<0.002	0.004	0.007	0.007	13.4	<0.1	<0.01	<0.02	<0.002	0.38	<0.002	<0.02	0.09	0.005	<0.05	0.01	<0.05	<0.1	NA	0.06
89	Unnamed Spring	9/10/93	<0.0005	0.6	0.006	0.03	<0.0002	<0.002	0.003	<0.002	0.008	0.44	<0.0002	<0.01	<0.01	<0.002	0.16	<0.002	<0.01	1.82	0.002	<0.02	0.007	<0.002	<0.002	NA	0.1
1	Water Canyon Gallery	8/1/78	<0.03	NA	NA	<0.12	<0.03	<0.06	<0.03	NA	<0.04	<0.04	NA	NA	<0.02	<0.1	NA	<0.05	NA	NA	<0.14	NA	NA	NA	NA	NA	<0.01
25	Water Canyon Gallery	8/18/92	<0.001	<0.1	<0.05	0.01	<0.001	<0.002	0.003	<0.002	<0.002	<0.01	0	<0.02	<0.01	0.009	<0.05	<0.002	<0.02	0.48	0.004	<0.05	0.004	<0.1	0	NA	0.02
25	Water Canyon Gallery	5/20/93	<0.001	0.2	<0.05	0.02	0.001	<0.002	<0.002	<0.002	0.002	0.05	0	<0.01	<0.01	<0.002	<0.02	<0.002	<0.01	0.98	0.005	0.07	0.006	<0.1	0	NA	0.05
SSite96-14	Water Canyon Gallery	4/03/96	<0.0002	0.15	0.0004	0.01	<0.0002	<0.002	<0.002	<0.002	<0.002	0.05	<0.0002	<0.01	<0.01	<0.002	0.06	<0.002	0.02	0.91	<0.002	<0.05	0.006	<0.0001	<0.0001	<0.01	<0.01

[a] NA = Not analyzed.

[b] NC = Not calculated.

TABLE C-5

HIGH EXPLOSIVES IN TA-16 WATERS

SAMPLE ID	DESCRIPTION	DATE	A-DNT (ppm)	DNT (ppm)	HMX (ppm)	NQ (ppm)	PETN (ppm)	RDX (ppm)	1,3,5-TNB (ppm)	TNT (ppm)
SAL[a]	N/A[b]	N/A	NC[c]	NC	1.8	3.7	0.7	0.00061	0.0018	0.0022
Springs/Seeps										
PP94-50	Burning Ground Spring	4/15/94	NA[d]	NA	<0.02	<0.01	<0.05	<0.02	NA	<0.02
NMED	Burning Ground Spring	8/12/94	NA	NA	NA	NA	NA	NA	NA	NA
NMED	Burning Ground Spring	3/17/95	NA	NA	NA	NA	NA	NA	NA	NA
SSite96-5	Burning Ground Spring	3/01/96	NA	NA	0.04	<0.01	<0.05	0.01	NA	<0.01
SSite96-17	Burning Ground Spring	4/10/96	NA	NA	<0.02	<0.01	<0.05	<0.01	NA	<0.01
NMED	Martin Spring	5/12/95	0.0033	ND[e]	0.011	NA	NA	0.1	ND	ND
PP95-132	Martin Spring	7/21/95	NA	NA	0.05	<0.01	<0.05	0.11	NA	<0.02
SSite96-4	Martin Spring	3/01/96	NA	NA	0.03	<0.01	<0.05	0.11	NA	<0.01
SSite96-15	Martin Spring	4/10/96	NA	NA	0.02	<0.01	<0.05	0.12	NA	<0.01
PP94-74	SWSC Spring	8/12/94	NA	NA	<0.02	<0.01	<0.05	<0.02	NA	<0.02
NMED	SWSC Spring	8/12/94	NA	NA	NA	NA	NA	NA	NA	NA
NMED	SWSC Spring	5/12/95	0.0023	ND	0.0055	NA	NA	0.083	ND	ND
SSite96-18	SWSC Spring	4/10/96	NA	NA	<0.02	<0.01	<0.05	<0.01	NA	<0.01
SSite96-6	SWSC Spring	3/01/96	NA	NA	0.03	<0.01	<0.05	0.02	NA	<0.01
NMED	Fish ladder Seep	6/2/95	ND	ND	0.0076	NA	NA	0.0027	ND	ND
SSite96-11	Fish ladder Seep	3/27/96	NA	NA	<0.02	<0.01	<0.05	<0.01	NA	<0.01
NMED	Peter Seep	6/2/95	ND	ND	ND	NA	NA	ND	ND	ND
Outfalls										
—	260 outfall	—	NA	NA	1.1	NA	NA	0.077	NA	0.068
SSite96-25	260 outfall (filtered)	7/12/96	NA	0.146	1.213	NA	NA	0.484	0.418	19.998
SSite96-25	260 outfall (unfiltered)	7/12/96	NA	0.145	1.15	NA	NA	0.419	NA	21.201
PP95-133	300 outfall	7/21/95	NA	NA	0.02	<0.01	<0.05	0.02	NA	<0.02
—	300 outfall	—	NA	NA	NA	NA	NA	NA	NA	0.068
—	340 outfall	—	NA	NA	0.0046	NA	NA	NA	NA	0.068
SSite96-10	340 outfall	3/27/96	NA	NA	<0.02	<0.01	<0.05	<0.01	NA	<0.01
SSite96-21	Silver outfall	4/10/96	NA	NA	<0.02	<0.01	<0.05	<0.01	NA	<0.01
Creeks										
PP95-134	300-line canyon TA-16	7/21/95	NA	NA	<0.02	<0.01	<0.05	<0.02	NA	<0.02
SSite95-1	Cañon de Valle Creek	3/17/95	NA	NA	0.04	<0.01	<0.05	0.07	NA	<0.02
SSite95-2	Cañon de Valle Creek	3/17/95	NA	NA	0.05	<0.01	<0.05	0.12	NA	<0.02
MDA P S-1	Cañon de Valle Creek	4/94	NA	NA	NA	NA	NA	0.18	NA	NA
MDA P S-2	Cañon de Valle Creek	4/94	NA	NA	NA	NA	NA	0.152	NA	NA
MDA P S-3	Cañon de Valle Creek	4/94	NA	NA	NA	NA	NA	0.196	NA	NA
MDA P S-4	Cañon de Valle Creek	4/94	NA	NA	NA	NA	NA	0.133	NA	NA
MDA P S-5	Cañon de Valle Creek	4/94	NA	NA	NA	NA	NA	0.146	NA	NA
MDA P S-6	Cañon de Valle Creek	4/94	NA	NA	NA	NA	NA	0.162	NA	NA
SSite95-3	Cañon de Valle Creek	3/17/95	NA	NA	0.02	<0.01	<0.05	<0.02	NA	<0.02
PP94-52	Snowmelt, Cañon de Valle	4/15/94	NA	NA	<0.02	<0.01	<0.05	<0.02	NA	<0.02
PP94-51	Weirbox, Cañon de Valle	4/15/94	NA	NA	0.04	<0.01	<0.05	0.16	NA	<0.02
Assorted locations										
SSite96-8	90s-line Drainage	3/05/96	NA	NA	0.04	0.03	<0.05	<0.01	NA	<0.01
SSite96-19	90s-line Drainage	4/10/96	NA	NA	<0.02	0.03	<0.05	<0.01	NA	<0.01
SSite96-9	90s-line Pond	3/05/96	NA	NA	0.04	0.01	<0.05	<0.01	NA	<0.01
SSite96-20	90s-line Pond	4/10/96	NA	NA	<0.02	<0.01	<0.05	<0.01	NA	<0.01
PP95-135	K-Site	7/21/95	NA	NA	<0.02	<0.01	<0.05	<0.02	NA	<0.02
SSite96-7	WWTP	3/05/96	NA	NA	0.01	0.02	<0.05	<0.01	NA	<0.01
SSite96-16	WWTP	4/10/96	NA	NA	<0.02	<0.01	<0.05	<0.01	NA	<0.01
Background springs										
SSite96-13	Apache Spring	4/03/96	NA	NA	<0.02	<0.01	<0.05	<0.01	NA	<0.01
44	Cold Spring west cal	6/1/80	NA	NA	NA	NA	NA	NA	NA	NA
62	Frijoles Spring #49	5/22/91	NA	NA	NA	NA	NA	NA	NA	NA
63	Frijoles Spring #50	5/22/91	NA	NA	NA	NA	NA	NA	NA	NA
66	Pine Spring	5/24/91	NA	NA	NA	NA	NA	NA	NA	NA
0	Pine Spring	3/26/95	NA	NA	NA	NA	NA	NA	NA	NA
0	Pine Spring	10/16/95	NA	NA	NA	NA	NA	NA	NA	NA
44	Seven Springs	10/1/79	NA	NA	NA	NA	NA	NA	NA	NA
44	Seven Springs	5/1/83	NA	NA	NA	NA	NA	NA	NA	NA
76	Seven Springs	5/10/91	NA	NA	NA	NA	NA	NA	NA	NA
SSite96-12	Seven Springs	4/3/96	NA	NA	<0.02	<0.01	<0.05	<0.01	NA	<0.01
52	Unnamed Cold	7/1/80	NA	NA	NA	NA	NA	NA	NA	NA
53	Unnamed Cold	7/1/80	NA	NA	NA	NA	NA	NA	NA	NA
67	Unnamed Spring	5/28/91	NA	NA	NA	NA	NA	NA	NA	NA
89	Unnamed Spring	9/10/93	NA	NA	NA	NA	NA	NA	NA	NA
1	Water Canyon Gallery	8/1/78	NA	NA	NA	NA	NA	NA	NA	NA
25	Water Canyon Gallery	8/18/92	NA	NA	NA	NA	NA	NA	NA	NA
25	Water Canyon Gallery	5/20/93	NA	NA	NA	NA	NA	NA	NA	NA
SSite96-14	Water Canyon Gallery	4/03/96	NA	NA	<0.02	<0.01	<0.05	<0.01	NA	<0.01

[a] SAL=Screening action level.

[b] N/A= Not applicable.

[c] NC=Not calculated.

[d] NA=Not analyzed.

[e] ND=Not detected.

TABLE C-6

TRITIUM AND STABLE ISOTOPES IN TA-16 WATERS

SAMPLE ID	DESCRIPTION	DATE	∂D (‰)	∂18O (‰)	TRITIUM UNITS
Springs/Seeps					
SSite96-5	Burning Ground Spring	3/01/96	NA[a]	NA	-33.5
SSite96-17	Burning Ground Spring	4/10/96	--79.0	–11.8	NA
SSite96-27	Burning Ground Spring	7/12/96	--71.0	–11.1	NA
PP95-132	Martin Spring	7/21/95	–73.0	–11.2	-32.9
SSite96-4	Martin Spring	3/01/96	NA	NA	-0.2
SSite96-15	Martin Spring	4/10/96	–73.0	–11.2	NA
SSite96-23	Martin Spring	7/12/96	--66.0	--9.9	NA
SSite96-6	SWSC Spring	3/01/96	NA	NA	-35.7
SSite96-18	SWSC Spring	4/10/96	--76.0	–11.7	NA
SSite96-26	SWSC Spring	7/12/96	--64.0	–11.1	NA
SSite96-11	Fish ladder Seep	3/27/96	–70.0	–10.4	-11.3
Outfalls					
SSite96-10	340 outfall	3/27/96	NA	NA	-1.0
Assorted locations					
PP95-134	300-line canyon TA-16	7/21/95	--70.0	--7.6	-3.1
PP95-135	K-Site	7/21/95	--52.0	–7.9	-46.3
SSite96-8	90s-line Drainage	3/05/96	--64.0	–9.2	-3.9
SSite96-9	90s-line Pond	3/05/96	--43.0	--3.1	-51.9
SHB-3	TA-16 well	7/20/93	--75.1	–11.3	-0.9
SSite96-7	WWTP	3/05/96	NA	NA	-4.5

[a] NA=Not analyzed.

TABLE C-7

ORGANICS IN TA-16 WATERS

SAMPLE ID	DESCRIPTION	DATE	CIS-1,2-DICHLOROPROPENE (ppm)	TETRACHLOROETHENE (ppm)	TRICHLOROETHENE (ppm)
Springs/Seeps					
NMED	Burning Ground Spring	3/17/95	ND[a]	0.0028	0.0026
NMED	Burning Ground Spring	5/12/95	ND	0.0032	0.0034
NMED	Martin Spring	5/12/95	ND	ND	0.0009
NMED	SWSC Spring	3/17/95	ND	0.0023	0.0022
NMED	SWSC Spring	5/12/95	ND	0.0022	0.0024
NMED	Fish ladder Seep	6/2/95	ND	ND	0.0003
NMED	Peter Seep	6/2/95	0.021 D(5)	0.015	0.0031

[a] ND=Not detected.

(all approximately 0.3 ppm). These spring levels have remained fairly constant over the sampling period, but fall below the SAL. The highest levels of barium (≤ 3.28 ppm) occur in Cañon de Valle surface waters and in seeps (Peter and Fish Ladder) located in canyon bottoms. Fish Ladder Seep, which contained 1.7 ppm barium in 1995, was resampled in 1996 and showed lower levels of barium (0.29 ppm). Elevated levels of barium (2.27 and 1.44) were also found in the 90s-Line pond, which is located in the middle of the mesa. A complete sampling effort is needed to determine if barium levels are still high in surface waters and to determine connection with site-wide source waters. However, due to the differences in stable isotopic composition between springs and outfall waters, elevated barium is most likely related to leaching of historically-contaminated soils by rainwater.

Most background waters are below detection limits for manganese. Most TA-16 waters fall above background, but below SAL. However, one surface water sample (located at K-Site, Fig. C-1) had a value (0.32 ppm) above SAL. The reason for elevated levels of manganese in this sample has not been determined.

Many water samples at TA-16 contain high explosives (Table C-5). HMX, NQ, and TNT were detected, but are all at levels below SALs. Almost all positive analyses for RDX, a commonly used explosive at TA-16, fall above SAL levels. The water SAL for RDX is 0.006 ppm and TA-16 sample concentrations range up to 0.15 ppm. High levels of RDX (approximately 0.11 ppm) are found consistently in Martin Spring. Values at that spring appear to have increased slightly since 1995. Two Cañon de Valle creek samples collected in 1994 also gave high values. Not surprisingly, the highest RDX level recorded (0.484 ppm) was from waters collected at the TA-16-260 outfall. The TA-16-260 outfall also contains extremely high values of RDX in the soil (up to 118 000 ppm). Discharges from TA-16-260 contributed to contamination of the soils and potentially to spring waters until the outfall, which is currently scheduled to be plugged in fall 1996.

The limited set of tritium and stable isotope data (Table C-6) gives variable results for TA-16 spring, surface water, and outfall samples. The variability seen in the stable isotope data of TA-16 surface waters and springs most likely reflects isotopic changes associated with different storm events. All TA-16 waters analyzed are isotopically heavier than background spring waters because of the lower elevation at TA-16, but fall along the meteoric water line for the Jemez Mountains (Vuataz and Goff 1986, 0390). Pooling surface waters such as those collected below K-Site must reflect isotopically heavy, monsoon-season rainfall that has not had time to evaporate. The exceptionally heavy values for the 90s Line Pond are due to evaporation.

Burning Ground, SWSC, and Martin Springs have tritium values generally ranging from 29 to 36 tritium units (T.U.), and surface water samples reached values of ≤47 T.U. Tritium values of outfall waters are consistently ≤ 5 T.U., similar to waters from the main aquifer, implying that these waters contain a component that is much older than the recharge waters for TA-16 springs. Pre-bomb tritium was about 6 T.U. in precipitation. Tritium in precipitation today has decreased to 10 T.U. from a high of 2 700 T.U. in 1963, and will continue to decrease. Rainwaters at TA-16 and around LANL however are significantly higher, with values of about 12 to 60 T.U. from 1990—1993. Because TA-16 rain waters have shown evidence of anthropogenic impact, and because spring and surface waters give similar tritium results, it is believed that spring waters are recharged through local precipitation and are possibly ≤ 5 years old.

4.0 CONCLUSIONS

The purpose behind the systematic sampling of springs and outfalls at TA-16 was to link contamination in spring waters with known sources using the information already available for the springs. This study has shown possible chemical connections of outfall sediments to spring waters. Stable isotope data link spring and surface water recharge with local and relatively young precipitation. It is likely that the contamination in the Burning Ground and SWSC Springs are connected to the TA-16-260 outfall, whereas the source of contamination for Martin Spring is not as easily identified.

Martin Spring has a unique chemistry when compared with other TA-16 waters, consistently showing higher levels of boron and RDX. This spring appears to issue from Unit 4 of the Upper Bandelier Tuff, whereas Burning Ground and SWSC Line Springs issue from unit 3. Tritium values suggest that Martin Spring has a similar residence time (approximately 5 years) to the other springs at TA-16. Although more outfalls need to be sampled, the contamination is likely a product of precipitation-induced leaching of historically-contaminated soils into a saturated zone that surfaces at Martin Spring. V-site (Fig. C-1) is possibly the site of chemically-similar historic soil contamination because it is a site that is known to have handled boracitol. The potential release sites (PRSs) at V-site are scheduled to be investigated and remediated in association with decommissioning and decontamination (D&D) in 1997.

Burning Ground and SWSC Line Springs are located downgradient of the TA-16-260 outfall. It is believed that contamination seen in these springs is due to historic TA-16-260 discharges. Waters in the outfall have been analyzed twice revealing elevated RDX, HMX, TNT, 1,3,5-TNB and 2,4-DNT. Soil samples at depth in the TA-16-260 outfall have had up to 25 wt % HE.

Because SWSC Line and Burning Ground Springs have tritium values similar to local precipitation, rainwater is the likely main recharge source. Thus, contamination in these spring waters is likely a product of leaching of historically-contaminated soils and tuff from PRS 16-021(c). A potassium bromide tracer is scheduled to be introduced at the TA-16-260 outfall during FY97. This study may confirm that PRS 16-021(c) is the source of contamination for the Burning Ground and SWSC Line Springs.