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Date: February 7, 2000
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HSWA LANL 3/1082/16/16-021(c)

Mr. John Kieling
NMED-HRMB
P.O. Box 26110
Santa Fe, NM 87502

SUBJECT: SUBMITTAL OF INTERIM MEASURE (IM) PLAN FOR POTENTIAL RELEASE SITE (PRS) 16-021(c)-99

Dear Mr. Kieling:

Enclosed is the IM Plan for PRS 16-021(c)-99. The activities outlined in this IM Plan are designed to remove contamination at PRS 16-021(c), the 260 Outfall, which is part of consolidated PRS 16-021(c)-99. PRS 16-021(c), the 260 Outfall, is currently listed on Table A of Module VIII of Los Alamos National Laboratory's Hazardous Waste Facility Permit.

If you have any questions, please call Dave McInroy at (505) 667-0819 or Joe Mose at (505) 667-5808.

Sincerely,

James M. Rayfors

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Los Alamos National Laboratory
Environmental Restoration

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Enclosure: IM Plan for PRS 16-021(c)-99

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Interim Measures Plan for Consolidated Potential Release Site 16-021(c)-99

Los Alamos
NATIONAL LABORATORY
Los Alamos, NM 87545

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Produced by the High Explosives Production Sites Team,
part of the Remedial Actions Focus Area

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EXECUTIVE SUMMARY

This plan presents the objectives, scope, and methods for implementing an interim measure (IM) under the Resource Conservation and Recovery Act (RCRA) corrective action program. This IM will abate potential releases from contamination at the 260 outfall site, a site associated with technical area 16 (TA-16) of the Los Alamos National Laboratory (the Laboratory, or LANL). The potential release site (PRS) associated with this IM, 16-021(c)-99, was created in 1999 by consolidating PRS 16-021(c) with PRS 16-003(k), each of which is described below.

PRS 16-021(c) was comprised of an outfall, a pond, and a drainage channel that led to the confluence with Cañon de Valle. Collectively, this area is referred to as the 260 drainage. The drainage channel contains a ponding area (approximately 50 ft long and 20 ft wide) immediately below the outfall. The drainage then flows approximately 600 ft north to the bottom of Cañon de Valle, traveling over a 15-ft cliff at a distance of approximately 400 ft from the outfall. The upper part of the drainage (above the cliff) contains very little vegetation and relatively little accumulated soils and sediments. The lower part of the drainage (below the cliff) is very steep and rocky.

PRS 16-003(k) was comprised of 13 sumps and their drain lines (approximately 1200 ft) which led from an active high explosives (HE) machining building (TA-16-260) to the outfall.

PRS 16-021(c) is included in Table A of the Hazardous and Solid Waste Amendments module of LANL's Hazardous Waste Facility Permit. This PRS has a site-ranking score of 76, qualifying it as a high-priority PRS (EPA 1990, 01585). Land adjacent to the 260 outfall site is dedicated to continued laboratory operations. The PRSs in the vicinity of the 260 outfall include material disposal area R (MDA R), MDA P, and the TA-16 Burning Ground.

The goal of the IM is to reduce the risk to human health and the environment posed by the contaminant mass (source material) in the 260 drainage area. The risk posed by the site following the IM will be evaluated in subsequent corrective action phases.

Results of previous outfall and drainage area investigations indicate high levels of HE and barium within the outfall and drainage, from the surface to the soil/tuff interface. Phase II RFI surface sampling demonstrated that surface contamination does not extend laterally beyond the drainage. Concentrations of the major contaminants—barium and HMX (1,3,5,7-tetranitro-1,3,5,7-tetrazacyclooctane), RDX (cyclonite), and TNT (trinitrotoluene)—decrease rapidly downgradient of the pond area, although significant levels of HMX and barium continue to the confluence with Cañon de Valle. Several other metals, including cadmium, chromium, copper, lead, nickel, vanadium, and zinc, are consistently observed above background levels in the drainage. Organic compounds, particularly anthracene and phthalates, have also been detected in several samples.

Subsurface sampling in the outfall and drainage indicated that concentrations decrease rapidly below the soil/tuff interface; however, up to 1% (10,000 mg/kg) of HE was reported in a sample from a surge bed encountered at approximately 16 ft beneath the pond. HE is observed only sporadically, and at much lower concentrations (typically less than 5 mg/kg), below the surge bed.

Human health and ecological screening assessments, which were performed as part of the Phase II RFI (LANL 1998, 59891), listed barium, bis(2-ethylhexyl)phthalate, HMX, RDX, and TNT as the contaminants of greatest potential concern. Cañon de Valle, in the area of the 260 outfall site, is identified as biotically rich in both terrestrial and aquatic species. The known presence of the Mexican spotted owl (*Strix occidentalis lucida*) in Cañon de Valle poses special challenges for the containment and remediation of contamination associated with the 260 outfall site.

A potassium bromide tracer was deployed at PRS 16-021(c) during April 1997. A breakthrough of bromide was observed in SWSC Spring during August 1997. Bromide breakthrough also appears to have occurred at Burning Ground Spring during August 1997. Although the magnitude and concentrations are small and irregular, these data suggest that the TA-16-260 outfall is hydrogeologically connected to Cañon de Valle springs. This then suggests that contamination found at the 260 outfall area is a source of contamination in Cañon de Valle springs, seeps, surface water, and alluvium. However, TA-16 is one of the most complex sites at the Laboratory in terms of hydrologic behavior as well as contaminant fate and transport. One result of this complexity is uncertainty regarding contaminant pathways at the site.

The PRS 16-021(c)-99 IM incorporates the following major components:

- removal of contaminated soils and sediments,
- waste management and treatment,
- off-site disposal,
- post-IM site characterization, and
- restoration of the site.

All soils and sediments in the pond area and upper drainage channel will be removed during the IM. The material in the lower drainage channel will be screened for contamination, and localized hot spots will be removed.

To protect the safety of IM site workers, soils and sediments from areas identified as potentially containing very high levels of HE [a concentration greater than 5% (50,000 mg/kg) total HE] will be blended robotically in situ with material from other locations (containing less than 5% total HE) within the IM area until the HE concentration of the resulting mixture is no longer a safety concern. This will be accomplished prior to any non-robotic mechanical removals from the pond and upper drainage channel. Removals will then proceed in the following sequence:

1. hand removal of localized high concentrations of barium,
2. removal of lower drainage channel materials with hand tools and/or vacuum equipment,
3. removal of upper drainage channel materials using an excavator with blast shield, and
4. removal of pond area materials using a robotic excavator.

Following removals, sampling will be conducted. During the CMS, the resultant data will be used to assess residual contamination, refine the physical site conceptual model, perform human and ecological site-specific risk screening (and/or risk assessment), and supplement CMS data.

Excavated wastes may be treated using composting technology (or other similar technology) to reduce total HE constituent concentrations prior to disposal off-site in an engineered landfill facility.

CONTENTS

1.0 INTRODUCTION 1

1.1 Purpose and Scope 1

1.2 Regulatory Context 4

1.3 Rationale for Proposed IM 5

2.0 PREVIOUS SITE CHARACTERIZATION 7

2.1 Site Description and Operational History 7

2.2 Previous Field Investigations—260 Outfall Source Region 9

2.3 Results of Previous Investigations—260 Outfall Source Region 9

3.0 PROPOSED IM 17

3.1 Conceptual Model 18

3.2 Supplemental Sampling 20

3.2.1 Pre-excavation Screening Sampling of the Lower Drainage Channel 20

3.2.2 Pre-excavation Screening Sampling of the Upper Drainage Channel 20

3.2.2.1 HE Screening in Support of Soil Blending and Soil Removals 20

3.2.2.2 Barium Screening and Barium Hot Spot Delineation 21

3.2.3 Post-Blending Pond Screening 22

3.2.4 CMS Investigation Sampling: The Bromide Inventory 22

3.3 Cleanup Activities 24

3.3.1 Mobilization 24

3.3.2 Infrastructure Installation 25

3.3.3 IM Stormwater Control Practices and BMPs 27

3.3.4 Excavation 27

3.3.4.1 Lower Drainage Channel Excavation 29

3.3.4.2 Upper Drainage Channel Excavation 29

3.3.4.3 Pond Excavation 30

3.3.5 Decontamination and Demobilization of Equipment 31

3.4 Site Restoration 31

4.0 CONFIRMATORY SAMPLING 32

5.0 WASTE MANAGEMENT 35

5.1 Waste Characterization 36

5.1.1 Listed Hazardous Waste Characterization 37

5.1.2 Potential Classification as Characteristic Hazardous Waste 38

5.1.2.1 Reactivity 38

5.1.2.2 D030 39

5.1.2.3 D005 39

5.1.3 Radioactivity 40

5.2 Anticipated Waste Types and Volumes of Waste 40

5.2.1 Excavated Wastes 40

5.2.2 Investigation-Derived Waste 41
5.3 Method of Management and Disposal 42
5.3.1 Waste Treatment 42
5.3.1.1 Treatment of D005 Hazardous Waste 42
5.3.1.2 Composting of HE Constituents 42
5.3.1.3 Treatment of Underlying Hazardous Constituents for Treated Formerly Characteristic Hazardous Waste 43
5.3.2 Waste Minimization 43
5.3.3 Waste Staging and Documentation 43
5.3.4 Waste Transport and Disposal 44

6.0 PROPOSED SCHEDULE AND UNCERTAINTIES 45
6.1 Project Schedule 45
6.2 Logistical Uncertainties 45
6.3 Administrative, Technical, and Regulatory Uncertainties 45

7.0 REFERENCES 47

Appendix A. Acronyms and Abbreviations A-1

Appendix B. Comparison of TCLP to Laboratory Barium B-1

Attachment A. Section 2 of the RFI Report for PRS 16-021(c)

Attachment B. Section 5 of the RFI Report for PRS 16-021(c)

Attachment C. Section 3 of the CMS Plan for PRS 16-021(c)

Attachment D. Stormwater Pollution Prevention Plan, OU 1082, TA-16, Remedial Actions Focus Area, High Explosives Production Sites Team

List of Figures

Figure 1.0-1. Location of TA-16 with respect to Laboratory technical areas and surrounding landholdings 2
Figure 1.0-2. Former and consolidated PRS boundaries at 16-021(c)-99 3
Figure 1.3-1. Location of PRS 16-021(c)-99 and associated hydrogeologic features 6
Figure 2.1-1. Location of upper drainage, lower drainage, and pond within the 260 drainage 8
Figure 2.3-1. Barium (mg/kg) contaminant distribution in the 260 drainage 10
Figure 2.3-2. Total HE (%) contaminant distribution in the 260 drainage 11
Figure 2.3-3. HMX (mg/kg) contaminant distribution in the 260 drainage 12
Figure 2.3-4. RDX (mg/kg) contaminant distribution in the 260 drainage 13
Figure 2.3-5. Toluene (mg/kg) contaminant distribution in the 260 drainage 14
Figure 2.3-6. TNT (mg/kg) contaminant distribution in the 260 drainage 15
Figure 2.3-7. 2,4-DNT (mg/kg) contaminant distribution in the 260 drainage 16
Figure 3.1-1. TA-16 site conceptual model 19
Figure 3.2-1. Randomly ordered bromide sample locations and intervals 23
Figure 3.3-1. Schematic of the site setup at PRS 16-021(c)-99 for IM operations 26
Figure 3.3-2. Schematic of zero-discharge BMP 28
Figure 3.3-3. Schematic of material processing within the drainage channel, using the screen plant to sort size fractions 30
Figure 4.0-1. Confirmatory sampling locations in the three strata 34
Figure 5.0-1. Treatment and disposal paths for excavated wastes 36
Figure 5.3-1. Proposed construction of soil treatment pad 44
Figure 6.1-1. Proposed 260 IM schedule 46

List of Tables

Table 5.1-1. Detected Constituent Concentrations 39
Table 5.2-1. Potential and Expected Excavation Waste Types and Volumes. 41
Table 5.2-2. Anticipated IDW Types and Volumes. 41

1.0 INTRODUCTION

This document describes the IM to be performed under the RCRA corrective action program at consolidated PRS 16-021(c)-99. The PRS is located in LANL's TA-16 (Figure 1.0-1). The IM described in this plan is designed to remove contamination at the PRS, pending final remedy of the PRS. PRS 16-021(c)-99 was created in 1999 by consolidating PRS 16-021(c) and PRS 16-003(k) (Figure 1.0-2). PRS 16-021(c) was comprised of an outfall, a pond, and a drainage channel. PRS 16-003(k) was comprised of 13 sumps and the drain lines that led from the active HE machining building TA-16-260 to the outfall. All of the soil removal in this IM will take place in former PRS 16-021(c).

A RCRA facility assessment (RFA) and two phases of a RCRA facility investigation (RFI) have been conducted on PRS 16-021(c) (LANL 1990, 07512; LANL 1996, 55077; LANL 1998, 59891, respectively). The results of these investigations have demonstrated the need for corrective action at this PRS. To examine the alternatives for remediating this site, a corrective measures study (CMS) was planned (LANL 1998, 59672.3) and is currently being conducted.

LANL is a multidisciplinary research facility owned by the U.S. Department of Energy (DOE) and managed by the University of California. LANL is located in north-central New Mexico, approximately 60 miles northeast of Albuquerque and 20 mi northwest of Santa Fe. The LANL site covers 43 mi^2 of the Pajarito Plateau, which consists of a series of finger-like mesas separated by deep canyons that contain ephemeral and intermittent streams running from west to east. Mesa tops range in elevation from approximately 6200 to 7800 ft above mean sea level. The eastern portion of the plateau stands 300–900 ft above the Rio Grande.

1.1 Purpose and Scope

The purpose of the IM is to reduce the risk to human health and the environment posed by the contaminant mass (source material) in the 260 drainage area which may be contributing to contamination in the subsurface and in Cañon de Valle. This will be accomplished by removing contaminated material from the outfall, pond, and drainage areas (Section 3.3.4). The risk posed by the site once the IM is complete will be evaluated in subsequent corrective action phases that will include human health and ecological risk evaluations.

The sampling conducted within the IM will generate post-removal characterization data that will be used to assess residual contamination. The resultant data will also be used to refine the physical site conceptual model, perform human and ecological site-specific risk screening and risk assessment, and supplement CMS data. The bromide profile sampling that was described in Section 6.3.1 of the CMS plan (LANL 1998, 59672.3) will also be conducted during the IM (Section 3.2.4). Following the source removal, the site will be restored to control erosion and to limit sediment contribution to Cañon de Valle (Section 3.4).

The PRS 16-021(c)-99 IM incorporates the following major components:

- removal of contaminated soils and sediments (Section 3.3.4),
- waste management and treatment (Section 5),
- off-site waste disposal,
- post-IM site characterization (Section 4), and
- restoration of the site (Section 3.4).

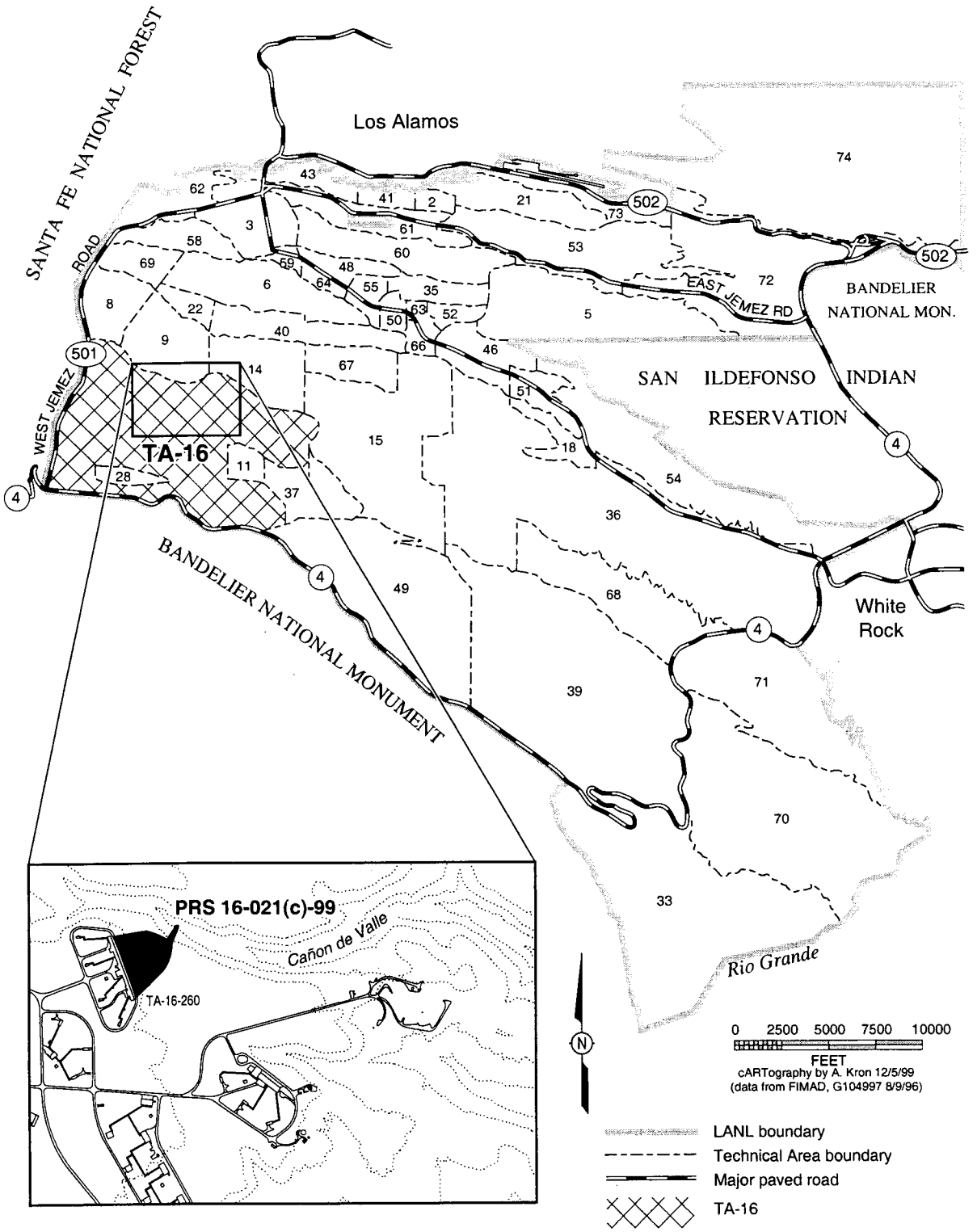


Figure 1.0-1. Location of TA-16 with respect to Laboratory technical areas and surrounding landholdings

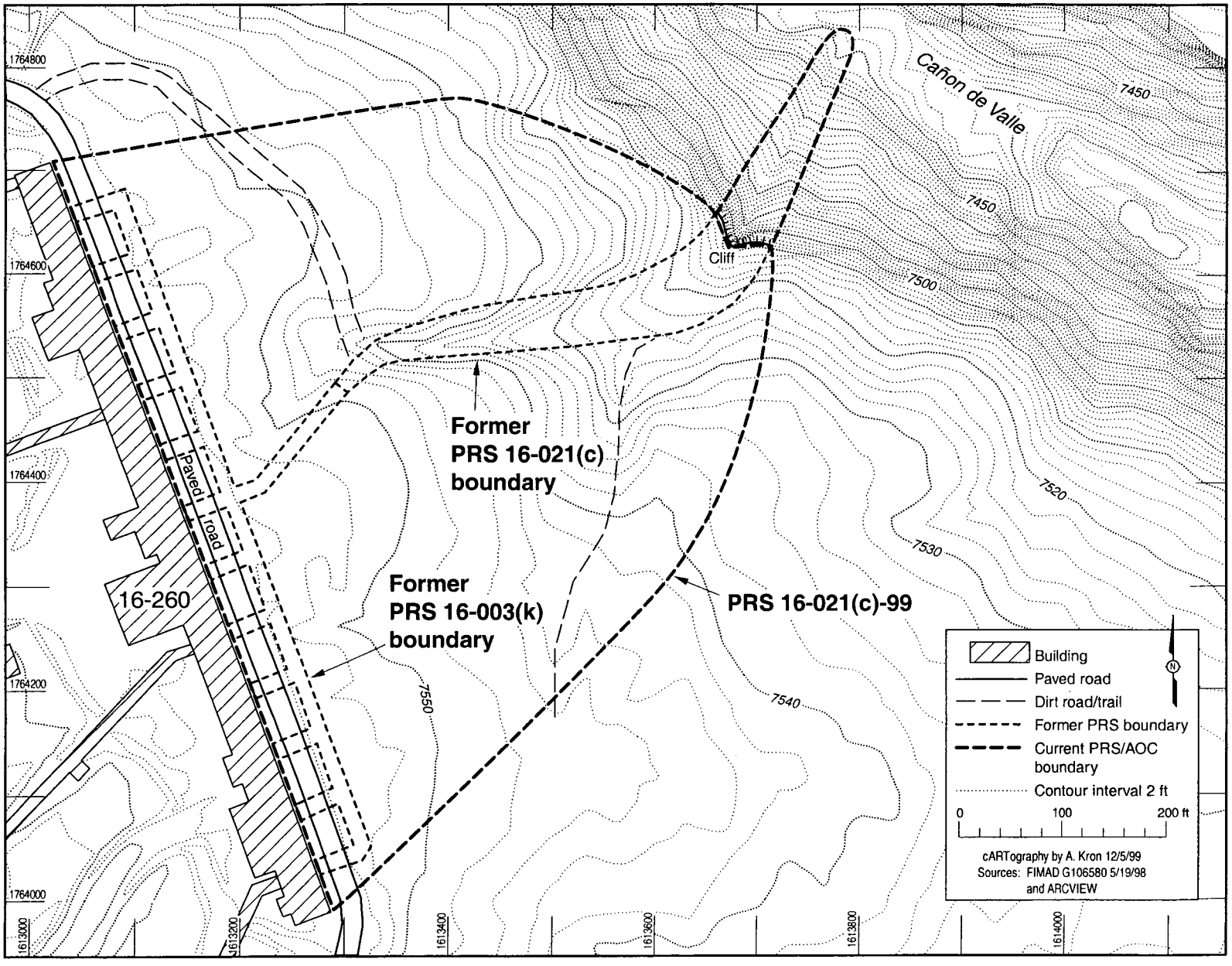


Figure 1.0-2. Former and consolidated PRS boundaries at 16-021(c)-99

Removals will be conducted in the following four phases:

1. Spot removals of barium-contaminated sediments that could potentially be classified as hazardous waste following waste generation (see Section 3.2.2.2).
2. Excavation of contaminated sediments in the lower drainage channel (see Section 3.3.4.1).
3. Excavation of the upper drainage channel (see Section 3.3.4.2).
4. Robotic excavation of the pond area (see Section 3.3.4.3).

Prior to excavation, soils and sediments from those areas identified as potentially containing very high levels of HE (> 5%) will be screened for total HE concentration (Section 3.2.2.1). If screening results indicate total HE to be greater than 5%, the following steps will be taken to protect the safety of site workers. Material containing less than 5% total HE will be taken from other locations within the IM area. This material will be blended with the higher concentration material (in situ) until the HE concentration of the resulting mixture is less than 5%. The operating group has required the use of this 5% blending criterion.

Excavated rock with a diameter greater than 3 in. (i.e., oversized material) will be segregated from the excavated (contaminated) material as described in Section 3.3.4. Since very little of the contaminant mass is associated with the rock media, this oversized material will be used for site restoration erosion control activities as described in Section 3.4. The remainder of the excavated material will be considered waste and will be segregated into appropriate waste streams (Section 5). Excavated wastes may be treated to reduce total HE constituent concentrations prior to disposal at an off-site engineered treatment-and-disposal facility.

1.2 Regulatory Context

This IM is being conducted under the requirements of RCRA and Module VIII of the Laboratory's Hazardous Waste Facility Permit (EPA 1990, 01585). PRS 16-021(c) is included in Table A of Module VIII and has a site-ranking score of 76, qualifying it as a high-priority PRS for the Environmental Restoration (ER) Project. Module VIII was issued to the Laboratory by the EPA on May 23, 1990, and was modified on May 19, 1994. Under RCRA corrective action, DOE established the ER Project to conduct corrective action in order to protect human health and the environment from past releases of hazardous waste or hazardous constituents at the Laboratory. RCRA corrective action at PRS 16-021(c)-99 has been, or will be, implemented in the following phases:

1. RFA—initial site assessment (LANL 1990, 07512)
2. RFI—site characterization (LANL 1996, 55077; LANL 1998, 59891)
3. IM—control or abatement of ongoing risks (the activities covered in this plan)
4. CMS—evaluation of alternatives (LANL 1998, 59672.3)
5. corrective measures implementation (CMI)—implementation of the selected alternative(s)
6. long-term monitoring—verification that remedies were effective

The EPA discussed interim measures in "RCRA Section 3008(h) Corrective Action Interim Measures Guidance (Interim Final)" (OSWER Directive 9902.4, June 1988). This process was subsequently clarified in "Corrective Action for Releases from Solid Waste Management Units at Hazardous Waste Management Facilities" (1996 ANPR) published in 61 FR 19446, in which *interim measures* are referred to as *interim actions:*

> Typically, interim actions are used to control or abate ongoing risks to human health or the environment in advance of final remedy selection... Interim actions at

> RCRA facilities can include a wide range of activities such as source removal, installation of a pump and treat system, and institutional controls. In accordance with the Stabilization Initiative, interim actions should be employed as early in the corrective action process as possible...interim actions should be compatible with, or a component of, the final remedy.

Submission of this document to the Administrative Authority fulfills the requirements of Module VIII, Section J, from the Laboratory's Hazardous Waste Facility Permit (EPA 1990, 01585). The section states, in part, "If, for institutional reasons not related to permit work, i.e., routine construction, an interim measure is required, the permittee will submit appropriate documentation to the Administrative Authority for approval."

Excavated material that is potentially hazardous waste will be managed within an area of contamination (AOC) boundary (in accordance with the EPA's AOC concept) until it is processed, treated, or shipped off-site. In a March 25, 1996, letter from Michael Shapiro, Director of the EPA's Office of Solid Waste, to Norman H. Nosenchuck, Director of New York State Department of Environmental Quality, Director Shapiro states, "...movement of soil contaminated with hazardous waste within an area of contamination would not typically trigger RCRA...." Therefore, in the case of this IM, excavated material that might contain hazardous waste will be staged in covered piles either within the AOC boundary or at the treatment site (location and waste management requirements to be determined under the temporary authorization permit).

1.3 Rationale for Proposed IM

The contaminants in the sediments of the 260 outfall drainage are assumed to be an ongoing source of the contamination found in downgradient hydrologic systems (Cañon de Valle surface water, shallow alluvial water, and deeper groundwater) (Figure 1.3-1). The IM will remove the bulk of the 260 drainage area contamination and reduce potential contaminant migration such that attenuation in the downgradient hydrologic systems will be accelerated.

The following contaminants are known to be present in the 260 drainage area: barium, RDX, TNT, HMX, dinitrotoluene (DNT), amino-DNT, 1,3,5-trinitrobenzene (TNB), acetone, chloromethane, dichloroethane, isopropyltoluene, tetrachloroethene, trichloroethene, anthracene, bis(2-ethylhexyl)phthalate, butylbenzylphthalate, copper, cadmium, chromium, cobalt, lead, nickel, silver, vanadium, uranium, and zinc. HE, barium, and/or low levels of other constituents have also been observed in waters from the TA-16 springs, Cañon de Valle, the R-25 regional aquifer monitoring well, and nearby shallow boreholes (approximately 17–80 ft deep). RDX (due to toxicity) and HMX (due to high concentrations) present the most significant potential risks to human health and the environment. Detailed contaminant information was presented in the Phase II RFI report for PRS 16-021(c) (LANL 1998, 59891).

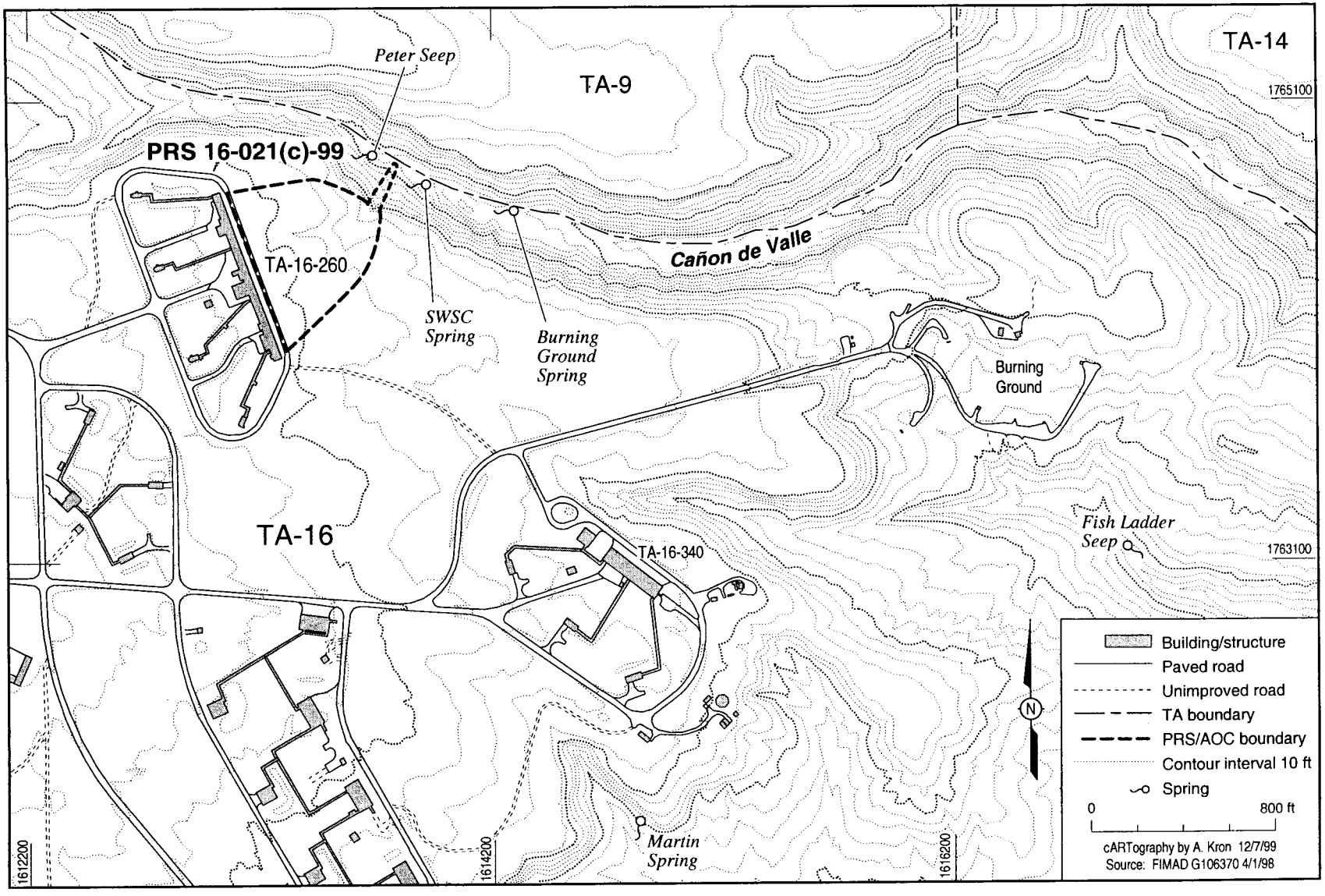


Figure 1.3-1. Location of PRS 16-021(c)-99 and associated hydrogeologic features

2.0 PREVIOUS SITE CHARACTERIZATION

2.1 Site Description and Operational History

TA-16 was established during World War II to develop explosive formulations, to cast and machine explosive charges, and to assemble and test explosive components for the United States 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. Current use of this site is essentially unchanged, although facilities have been upgraded and expanded as explosive and manufacturing technologies have advanced.

TA-16-260 is an HE machining facility that processes large quantities of HE. The building, which is located on the north side of TA-16, was originally built in 1951; only minor modifications have been made since that date. Machine turnings and HE wash water are routed to the 13 sumps associated with the building. Historically, discharge from the sumps was routed to an outfall; at one point, discharge was reportedly as high as several million gal. per year.

In the late 1970s, the EPA permitted the outfall to operate as EPA 05A056 under the Laboratory's national pollution discharge elimination system (NPDES) permit. The last NPDES permitting effort for this outfall occurred in 1994. The permitted outfall was deactivated in November 1996, and the EPA officially removed it from the Laboratory's NPDES permit in January 1998. Currently this waste stream is managed by pumping the sumps and treating the water at the TA-16 HE wastewater treatment facility.

As the drainage channel flows approximately 600 ft from the outfall to the bottom of Cañon de Valle, the drainage makes an elevation drop of 80 ft. Only 93 ft from the outfall is a rock dam behind which a small pond (approximately 55 ft long) has formed. HE-contaminated water from the outfall entered the pond about 40 ft from the outfall. At present, there is no water in the pond area, although the soil and sediment are occasionally wet. Underlying the pond is a layer of surge material (granular tuff with increased porosity and permeability). It was found at 17–18.5 ft below ground surface (bgs) while drilling a borehole during the Phase II RFI investigation. It appears this surge material is limited to the pond area: boreholes drilled around the pond did not encounter this feature. (See Section 2.2 for a description of the Phase II RFI investigation and borehole locations.)

The drainage channel leading away from the pond area is well defined, with apparent high-water marks. Approximately 400 ft from the outfall, the water flows over a 15-ft-high cliff. The upper drainage area is defined as the portion of the drainage between the pond and the cliff. The upper drainage is moderately sloped and contains trees that have died, most likely due to discharges from the outfall (either from contamination or from high moisture conditions). Soil depths are about 5.5 ft within the pond area and approximately 1 ft within the lower drainage channel. Figure 2.1-1 illustrates the location of the pond as well as the upper and lower drainages.

Rainwater from the roadway on the northeast side of TA-16-260 flowed into and through the pond and the drainage prior to installation of best management practices (BMPs) as an interim action (LANL 1996, 53838) during 1995 and 1996. These BMPs were implemented when the first sampling efforts indicated a significant amount of inorganic and HE contamination in nearby springs and surface waters. These BMPs consisted of three engineered controls:

1. a sandbag dam and diversion pipe upgradient from the HE pond,
2. geotextile fabric matting in the HE pond area, and
3. straw-bale check dams within the PRS drainage, between the rock dam and the 15-ft-high cliff.

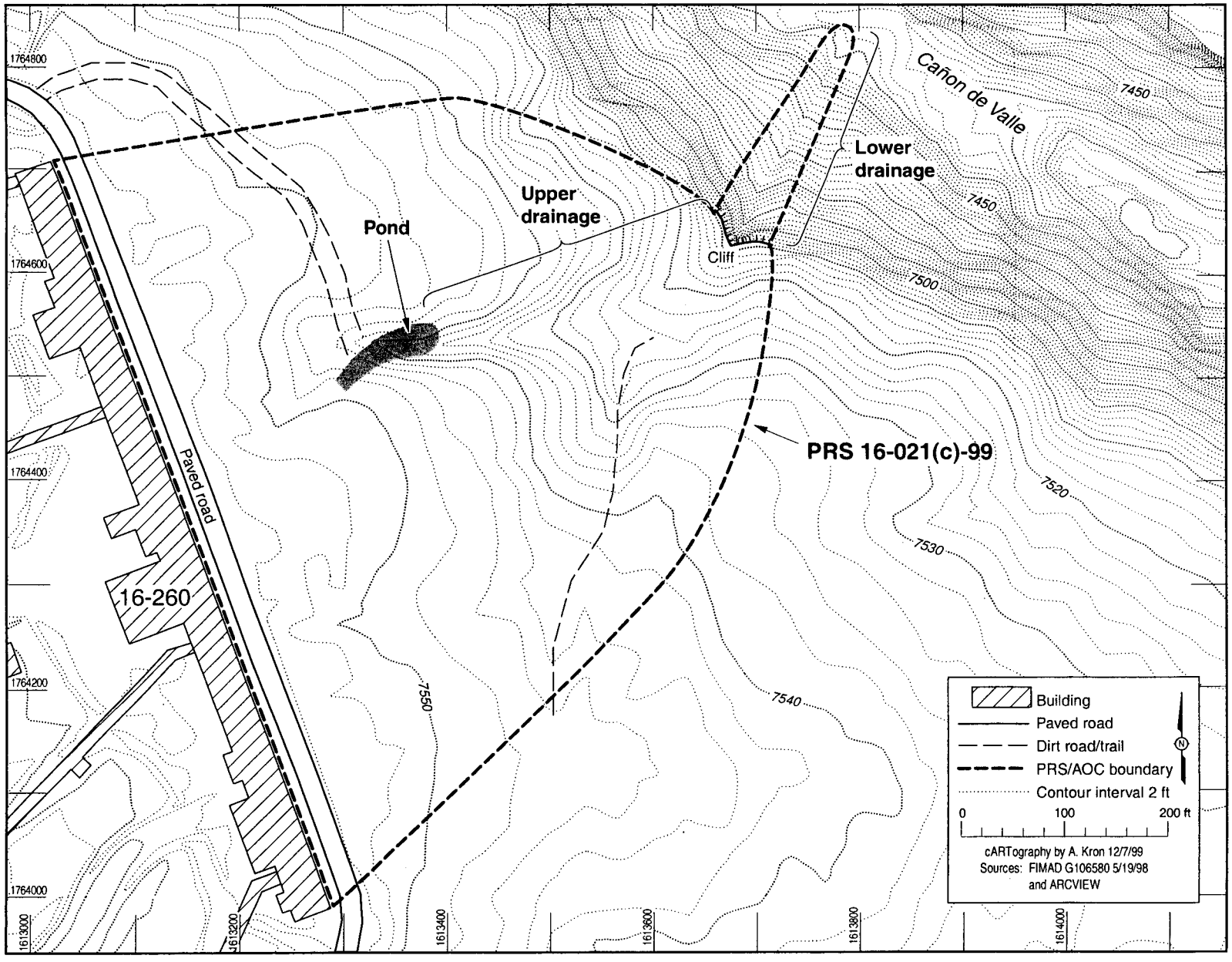


Figure 2.1-1. Location of upper drainage, lower drainage, and pond within the 260 drainage

In 1998, additional BMPs were instituted at PRS 16-021(c) to minimize runoff over the pond. The 1998 BMPs consisted of three engineered controls:

1. concrete curbing along the east end of the asphalt behind TA-16-260,
2. high-density polyethylene (HDPE) sheeting to seal the steel plates that cover the troughs associated with PRS 16-003(k), and
3. a 4-in. polyvinyl chloride diversion pipe leading from the outfall to the drainage's confluence with Cañon de Valle.

The rationale for implementing these BMPs is to minimize both the infiltration into the 260 pond area and the runoff from the PRS. This should decrease contaminant migration to surface water and groundwater. These BMPs are inspected regularly (at least quarterly) and are maintained and upgraded to ensure that runoff and infiltration from this site are minimized. (See Section 3.3.3. for information about surface water protection during IM activities.)

2.2 Previous Field Investigations—260 Outfall Source Region

Both Phase I and II RFI source region investigations have been conducted at PRS 16-021(c). The Phase I investigation, conducted from June to October of 1995, focused on surficial materials within the drainage. The Phase II investigation, conducted from November 1996 to December 1997, involved the collection of 13 near-surface samples from transects across the drainage at locations of 200 and 600 ft from the outfall. The Phase II investigation included drilling 13 boreholes with depths ranging from 17 to 115 ft bgs. Four of these boreholes were developed into monitoring wells. A potassium bromide tracer was deployed in the pond area to evaluate any subsurface link between pond contamination and springs in Cañon de Valle. Samples from monitoring wells and nearby springs have been analyzed to monitor for bromide breakthrough.

RFI Phase I and II field investigations also included extensive sampling of TA-16 springs and the Cañon de Valle alluvial system that is not directly relevant to this IM. Data collection is ongoing and will be summarized in future documents.

Prior to the RFI sampling (from 1970 through 1985, and again in 1991), sediment surveys were conducted within the drainage. The results have been summarized in Section 2 of the Phase II RFI report (LANL 1998, 59891). That section is attached to this plan as Attachment A.

2.3 Results of Previous Investigations—260 Outfall Source Region

The main contaminants identified in the PRS were barium, the major constituents of HE (HMX, RDX, and TNT), and HE-degradation products (DNT, amino-DNT, and TNB). Other inorganic contaminants found in sediments included copper, cadmium, chromium, cobalt, lead, nickel, silver, vanadium, uranium, zinc, arsenic, mercury, and manganese. Non-HE organics detected among surface/near-surface sediments included toluene, bis(2-ethylhexyl)phthalate and anthracene; other phthalates, other polycyclic aromatic hydrocarbons, and other organic constituents were detected at lower concentrations in subsurface samples where detection levels were lower due to lower concentrations of HE. The data regarding the constituents that are key to this IM are graphically depicted in Figure 2.3-1 through Figure 2.3-7.

Surface concentrations of the major contaminants within the drainage channel decrease rapidly downgradient from the pond area. The majority (80–95%) of the total contaminant load exists in the pond and upper drainage channel; however, elevated concentrations of barium (20,600 mg/kg) and HMX (20,300 mg/kg) are present in the lower drainage channel sediments. The Phase II RFI report states that no significant contamination of surface material is present outside the drainage channel boundary (LANL 1998, 59891).

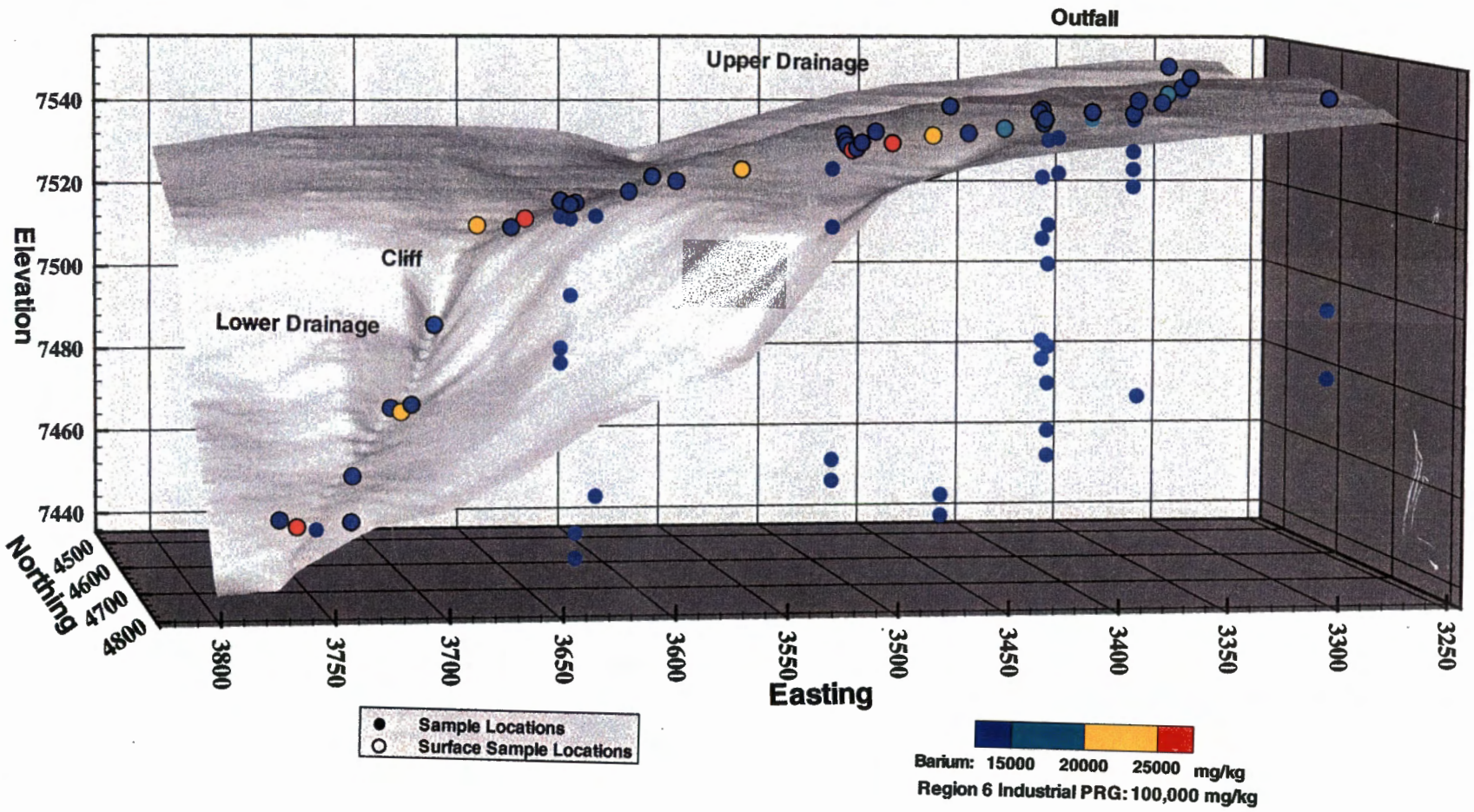


Figure 2.3-1. Barium (mg/kg) contaminant distribution in the 260 drainage

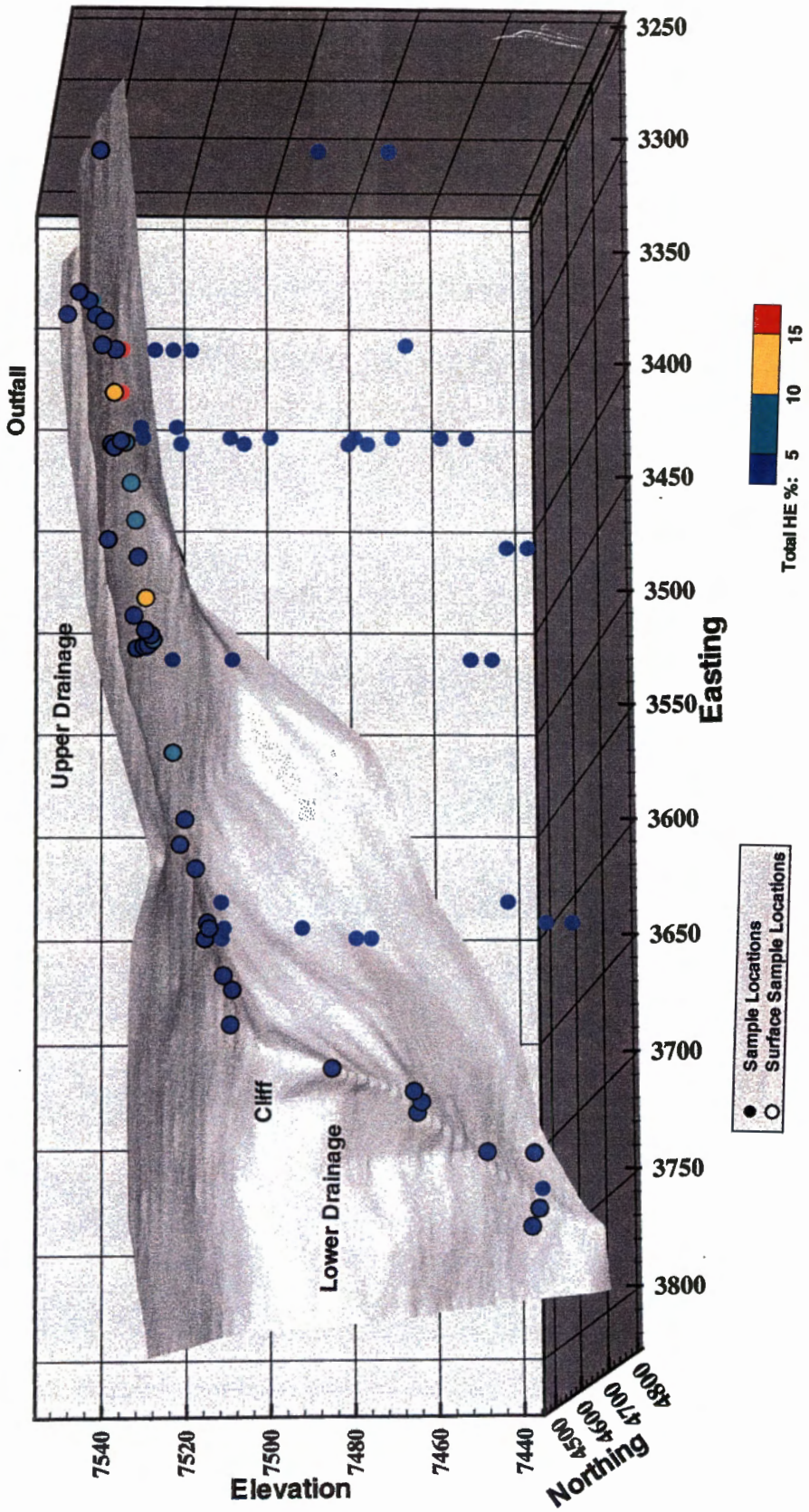


Figure 2.3-2. Total HE (%) contaminant distribution in the 260 drainage

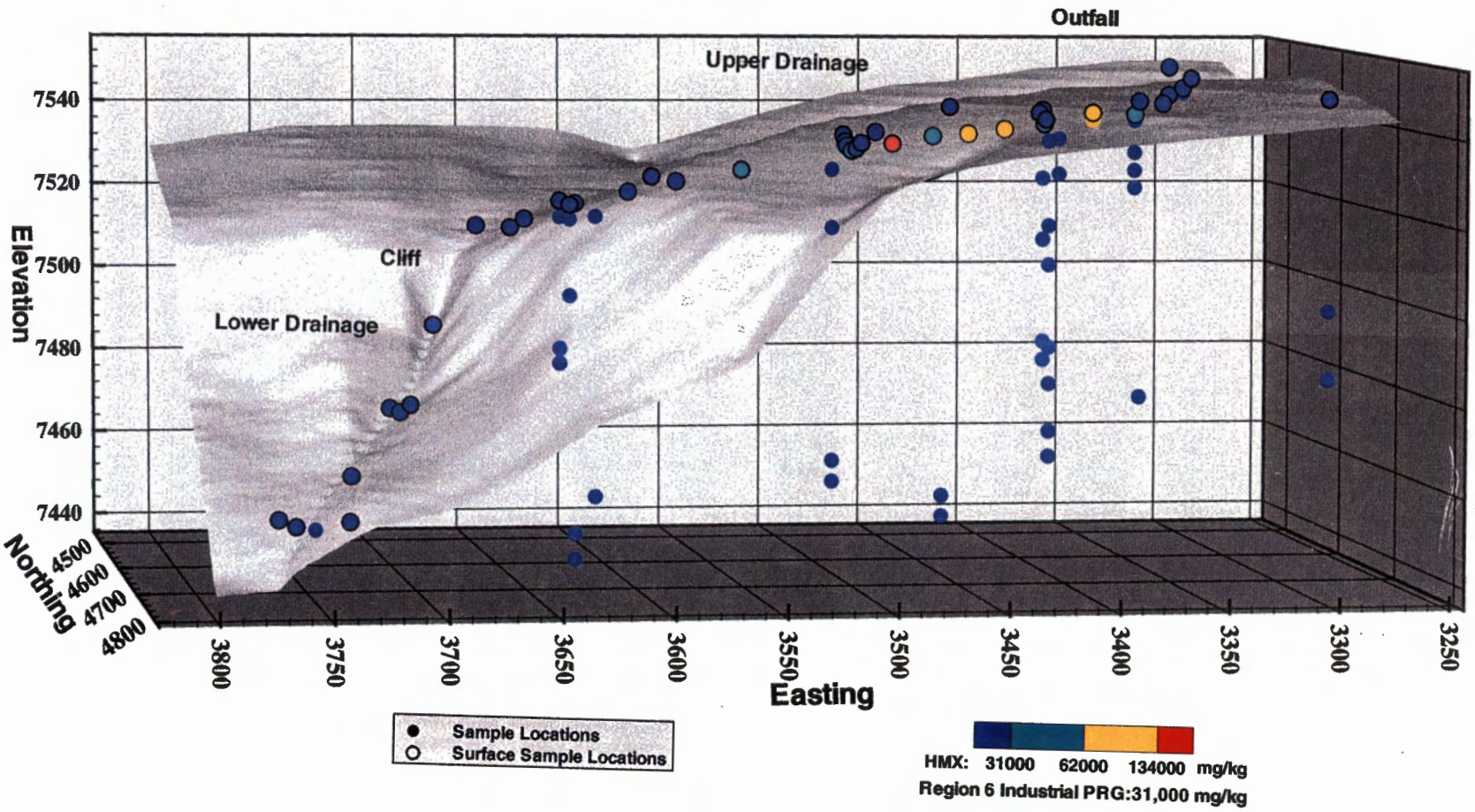


Figure 2.3-3. HMX (mg/kg) contaminant distribution in the 260 drainage

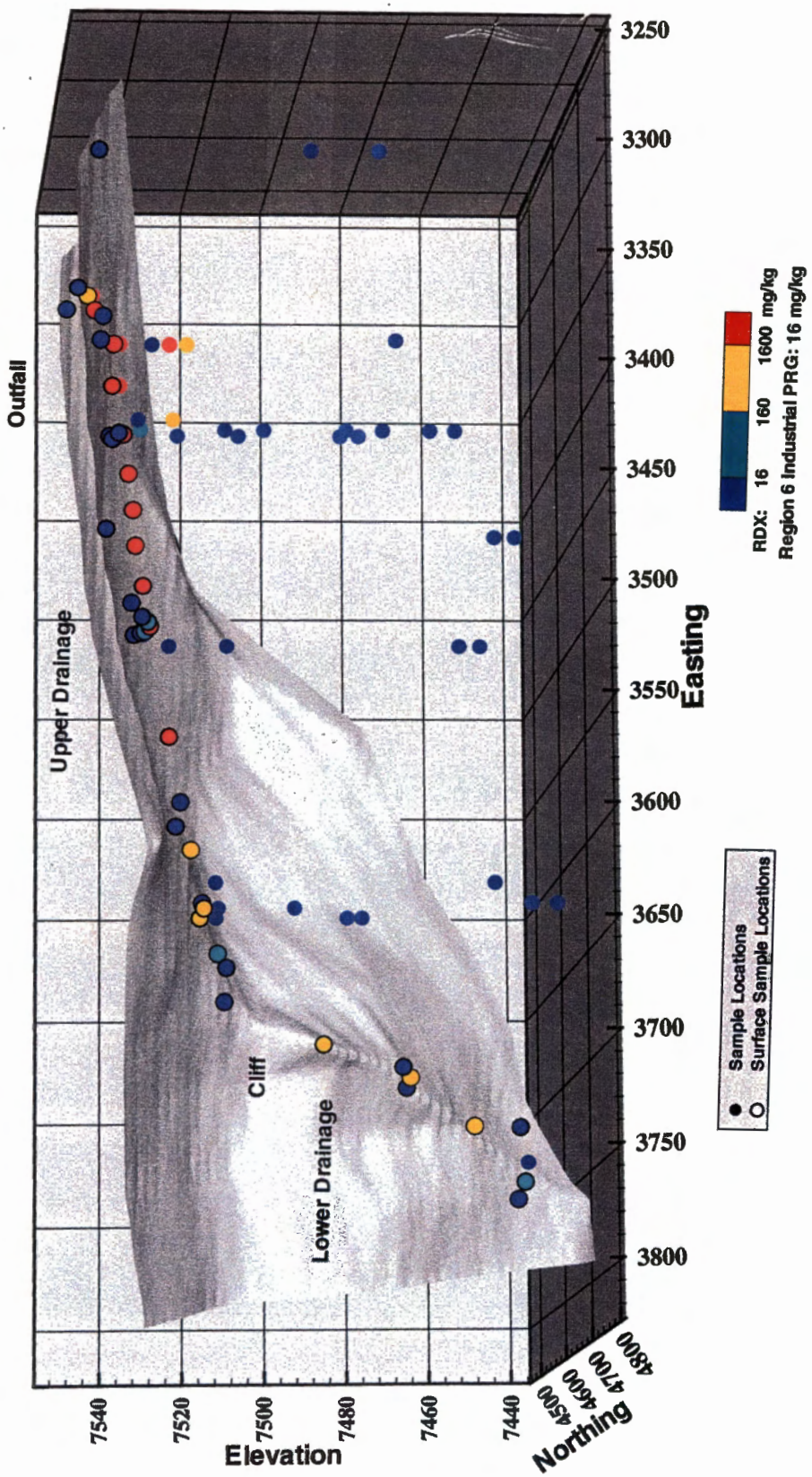


Figure 2.3-4. RDX (mg/kg) contaminant distribution in the 260 drainage

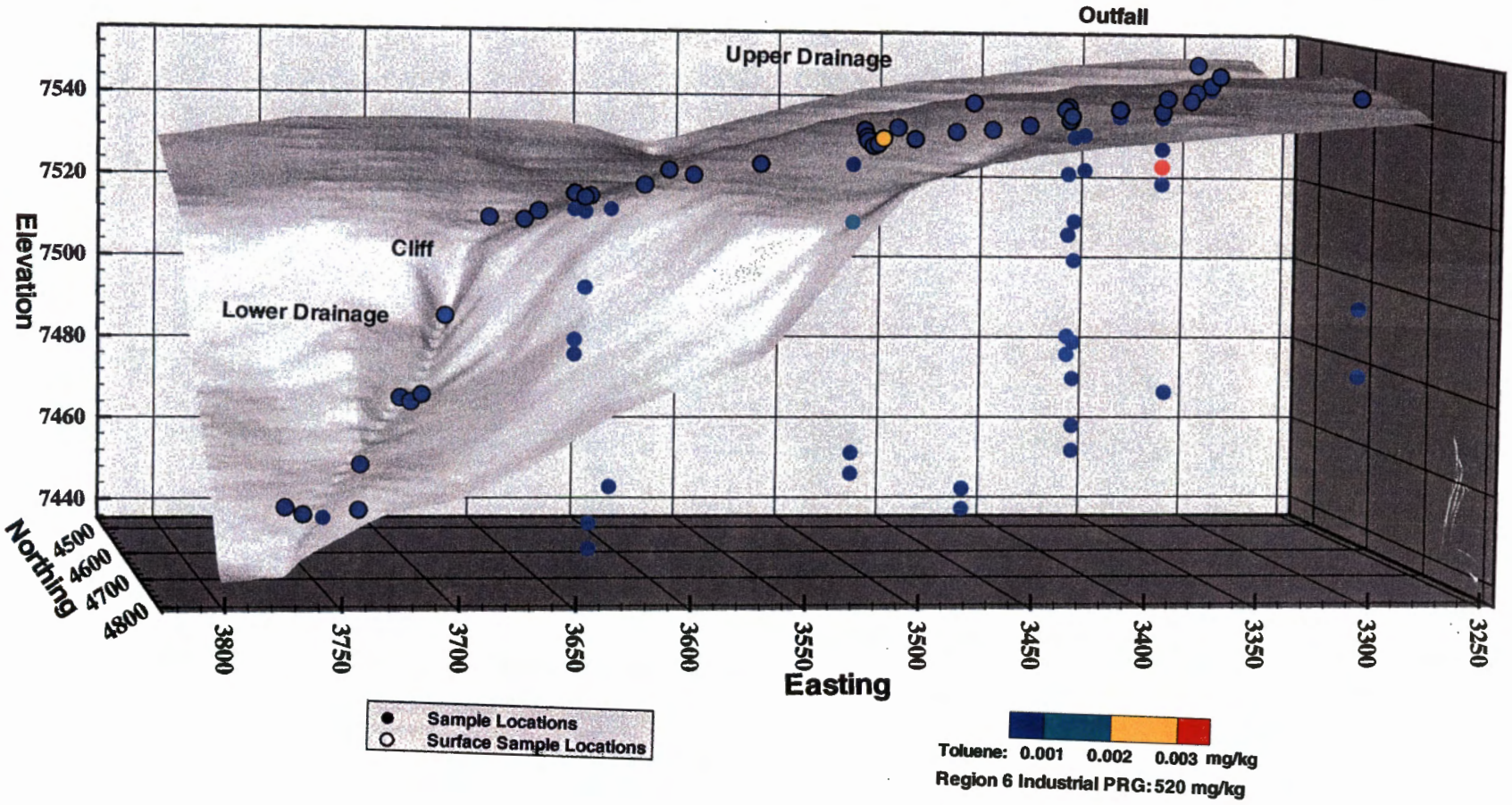


Figure 2.3-5. Toluene (mg/kg) contaminant distribution in the 260 drainage

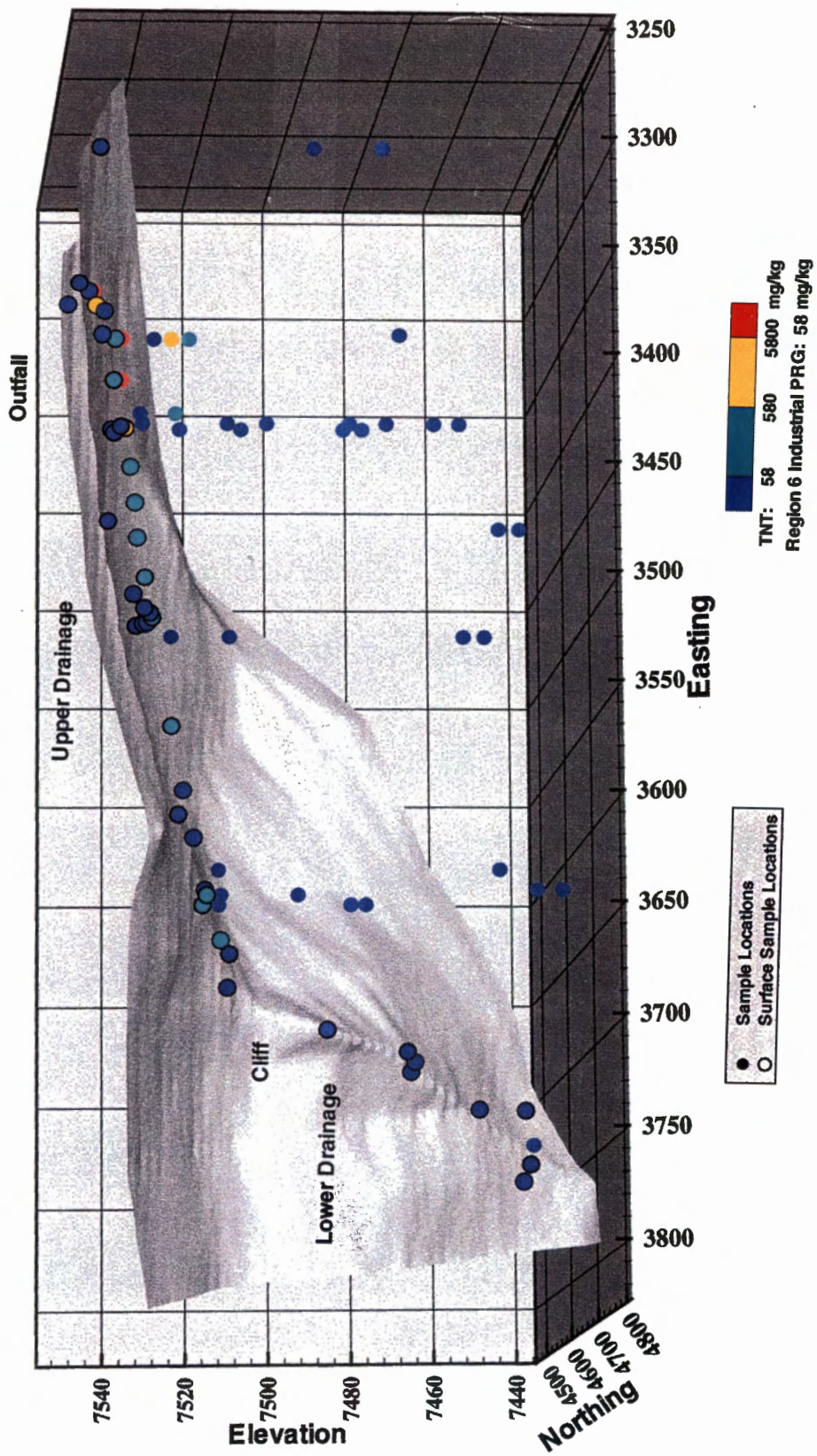


Figure 2.3-6. TNT (mg/kg) contaminant distribution in the 260 drainage

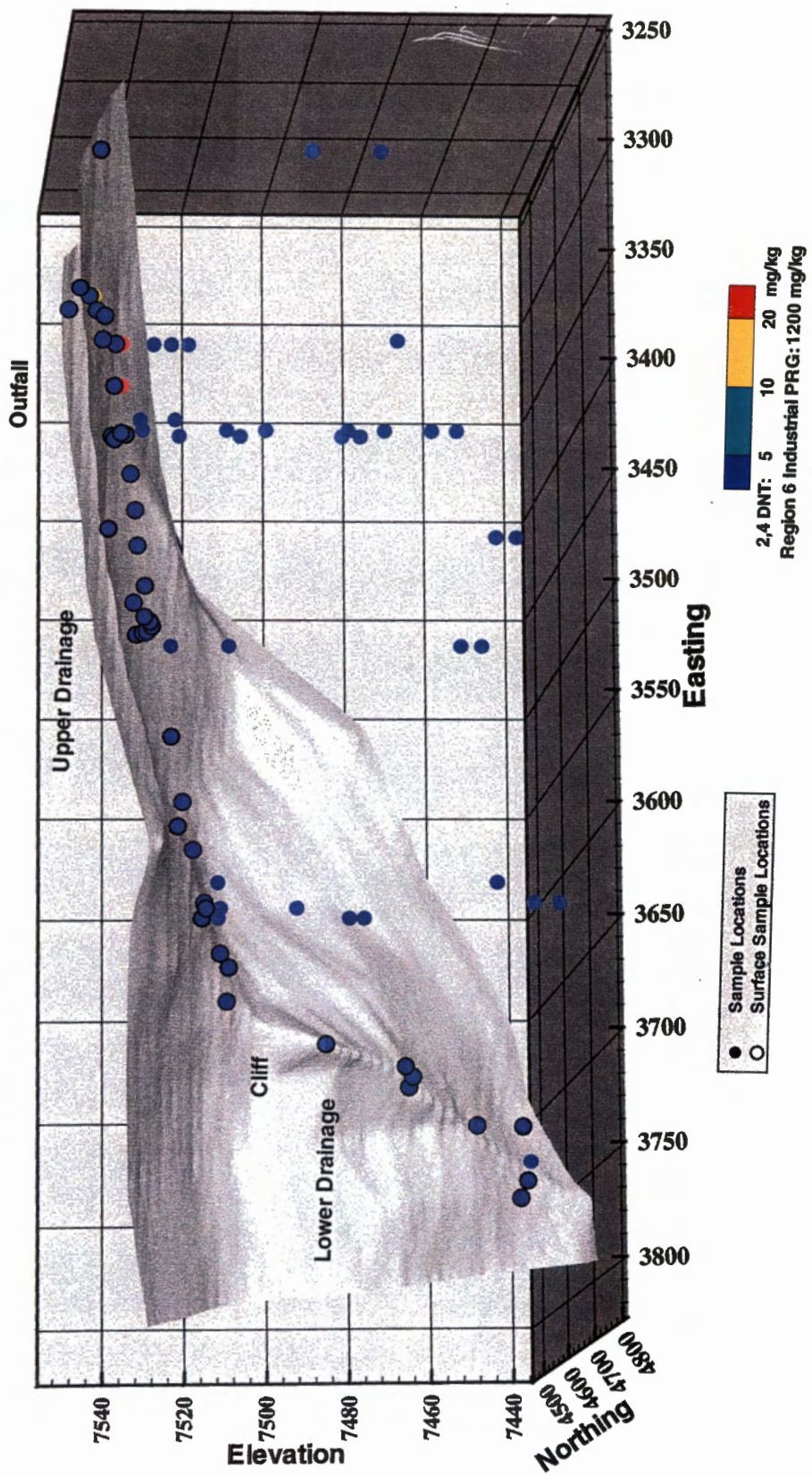


Figure 2.3-7. 2,4-DNT (mg/kg) contaminant distribution in the 260 drainage

Subsurface sampling indicates that contaminant concentrations generally decrease rapidly below the soil/ tuff interface throughout the entire drainage channel. However, sample 0316-96-0252, taken from the surge layer below the pond (location 2700), had a total HE concentration greater than a sample from a layer of overlying tuff (see Figures 2.3-1 through 2.3-7) (LANL 1998, 59891).

Chapter 2 of the Phase II RFI report (LANL 1998, 59891) presents the results of both RFI sampling activities and the pre-RFI sampling. It is included as Attachment A of this plan.

3.0 PROPOSED IM

This section provides an overview of the site conceptual model for consolidated PRS 16-021(c)-99 and how the IM is expected to affect specific elements of the conceptual model. The section also describes, in detail, the implementation of the IM, including supplemental sampling activities, cleanup activities, and site restoration.

Due to operations that are currently performed at TA-16-260, any activities that take place within a 600-ft blast radius behind TA-16-260 [including PRS 16-021(c)-99 activities] will be restricted: they must take place either after 5:00 PM Monday through Thursday or any time Friday through Sunday. In general, IM field activities conducted behind TA-16-260 will be performed Friday through Sunday.

The boundaries of consolidated PRS 16-021(c)-99 have been expanded from those of PRS 16-021(c) to include an area outside and to the north of the drainage channel. The boundary was enlarged to capture terrain contaminated by TA-16-260 operations that was newly identified during the PRS 16-021(c) Phase II RFI subsurface investigations. Staging of contaminated material that is potentially hazardous waste pending treatment or transport to a disposal facility will be confined within the new PRS boundary.

The current revisions of the following ER Project standard operating procedures (SOPs) and quality procedures (QPs) will be strictly adhered to during all aspects of the IM at PRS 16-021(c)-99:

- ER-SOP-1.01, General Instructions for Field Investigations
- ER-SOP-1.02, Sample Container and Preservation
- ER-SOP-1.03, Handling, Packaging and Shipping of Samples
- ER-SOP-1.04, Sample Control and Field Documentation
- ER-SOP-1.05, Field Quality Control Samples
- ER-SOP-1.06, Management of ER Project Wastes
- ER-SOP-1.07, Operational Guidelines for Taking Soil and Water Samples in Explosive Areas
- ER-SOP-1.08, Field Decontamination of Drilling and Sampling Equipment
- ER-SOP-1.10, Waste Characterization
- ER-SOP-1.12, Field Site Closeout Checklist
- ER-SOP-3.01, Land Surveying Procedures
- ER-SOP-3.08, Geomorphic Characterization
- ER-SOP-3.11, Coordination and Evaluating Geodetic Surveys
- ER-SOP-4.01, Drilling Methods and Drill Site Management
- ER-SOP-5.03, Monitor Well and RFI Borehole Abandonment
- ER-SOP-6.09, Spade and Scoop Method for Collection of Soil Samples
- ER-SOP-6.10, Hand Auger and Thin-Wall Tube Sampler
- ER-SOP-6.24, Sample Collection from Split-Spoon Samplers and Shelby Tube Samplers

- ER-SOP-6.26, Core Barrel Sampling for Subsurface Earth Materials
- ER-SOP-10.06, High Explosives Spot Test
- ER-SOP-10.08, Operation of the Field Portable XRF Instrument
- ER-SOP-12.01, Field Logging, Handling, and Documentation of Borehole Materials
- QP-2.1, Documenting Personnel Qualifications
- QP-2.2, Personnel Orientation and Training
- QP-3.4, Reporting and Correcting Nonconformances
- QP-3.5, Peer Review Process
- QP-4.1, Quality Procedure Development
- QP-4.2, Standard Operating Procedure Development
- QP-4.5, Document Control
- QP-5.3, Readiness Planning and Reviews
- QP-5.7, Notebook Documentation for Environmental Restoration Technical Activities
- QP-7.1, Procurement
- QP-7.2, Supplier Evaluation

QP-5.7, Rev. 0, "Notebook Documentation for Environmental Restoration Technical Activities," supersedes ER-SOP-3.12, Rev. 0, "Field and Laboratory Notebook Documentation for Environmental Restoration Earth Science Studies"; therefore, field documents will be prepared as described in QP-5.7, Rev. 0.

Borehole core will be field-logged as described in ER-SOP-12.01, Rev. 3, "Field Logging, Handling, and Documentation of Borehole Materials"; however, core will not be formally archived at the Field Support Facility and activities outlined in the SOP pertaining to core archiving will not be implemented.

Field determination of gravimeteric soil or core moisture content will be conducted in accordance with American Society for Testing and Materials (ASTM) Standard D 4531-86 "Standard Test Method for Bulk Density of Peat and Peat Products"; an ER Project SOP does not exist for the field determination of moisture content.

For vendor-supplied field-screening test kits (e.g., D TECH and EnSys kits for TNT and RDX), the manufacturers' instructions and SOPs will be followed. An SOP is currently in development for high performance liquid chromatography (HPLC) operations. The field team will document any deviations from ER Project SOPs in field notebooks.

3.1 Conceptual Model

A fundamental premise of the PRS 16-021(c)-99 conceptual model is that PRS 16-021(c)-99 is a significant continuing source of contamination identified in the downstream components of the model. The identified contaminant transport mechanisms are expected to produce interactions among the components of the conceptual model; anything that affects one component of the model is also likely to affect other downgradient components.

In this context, the IM should reduce contaminant levels over time in the various downgradient model components, including the TA-16 seeps and springs, the Cañon de Valle alluvial system, the deep subsurface, and the deep perched and regional aquifers observed in regional borehole R-25. Figure 3.1-1 presents the TA-16 site conceptual model.

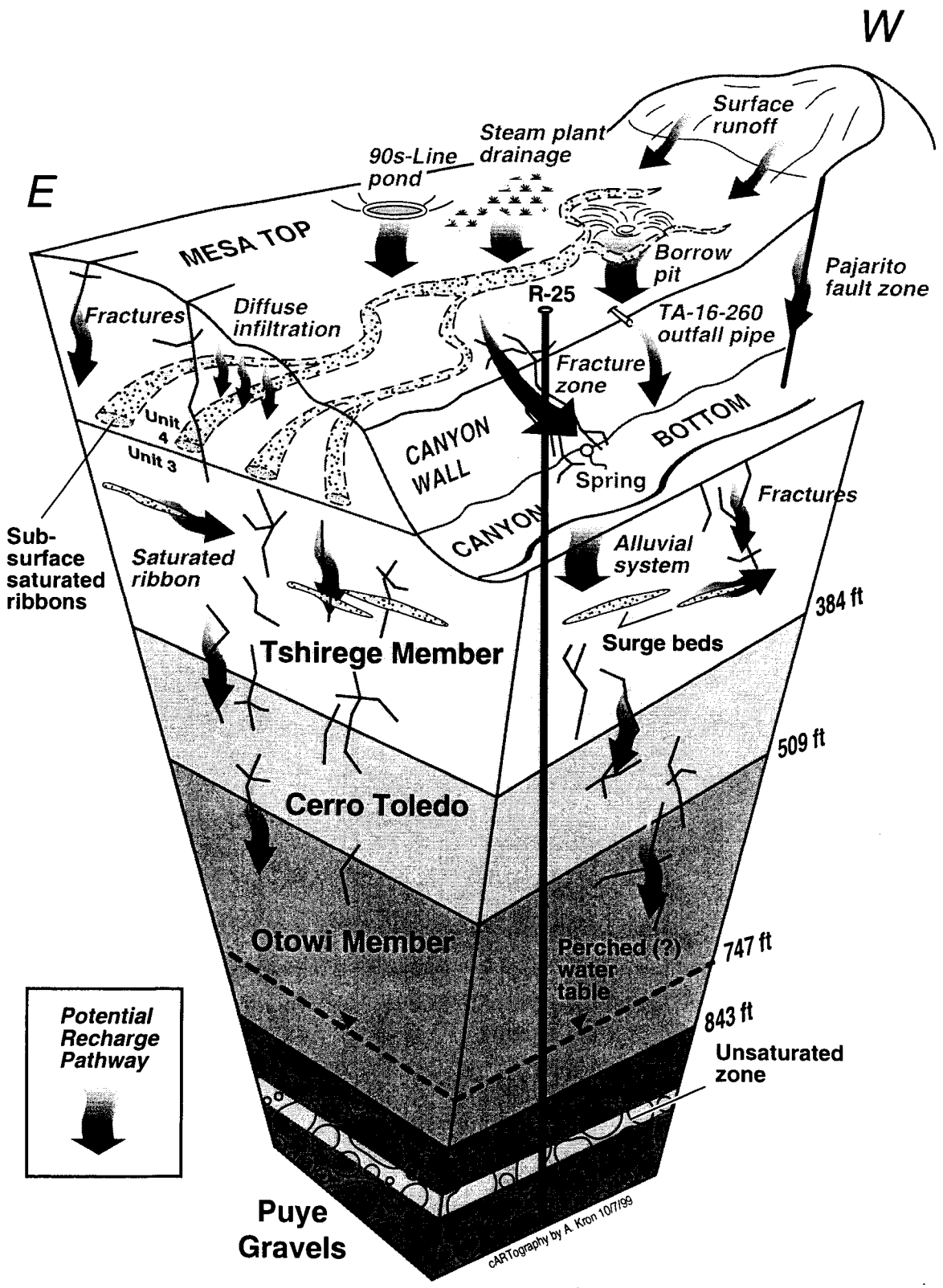


Figure 3.1-1. TA-16 site conceptual model

The TA-16 site conceptual model and the role of PRS 16-021(c)-99 within the framework of the conceptual model are both discussed, in detail, in Section 5 of the Phase II RFI report (LANL 1998, 59891). The conceptual model is also examined in Section 3 of the CMS plan for PRS 16-021(c) (LANL 1998, 59672.3). These two sections are included within this IM plan as Attachments B and C, respectively.

3.2 Supplemental Sampling

In support of the IM, sampling will be conducted in the lower and upper drainage channel and in the pond prior to large-scale excavation activities. During the IM, sampling will also be conducted in support of the CMS. CMS sampling will include (1) pre-excavation sampling of the pond area, and (2) drilling and sampling of a borehole in the pond area, following excavation of the pond. This sampling is discussed, in detail, in Section 6.3.1 of the CMS plan. The CMS sampling must be conducted prior to the blending and removal of the pond sediments. It is intended to support an ongoing bromide tracer study. Data generated by the CMS sampling will neither affect IM operations nor support decisions associated with the IM.

3.2.1 Pre-excavation Screening Sampling of the Lower Drainage Channel

The existing RFI data indicate that isolated sediment accumulation areas in the lower drainage channel contain RDX at concentrations above the Region 6 industrial medium-specific screening level (MSSL) of 16 mg/kg (EPA 1999, 59103). Supplemental screening sampling data will be used to identify additional locations containing greater than 16 mg/kg RDX.

Surface soil screening samples (0–6 in.) will be collected on nominally 10-ft intervals along the center of the lower drainage channel from the base of the cliff to the confluence with Cañon de Valle. Within a 10-ft interval, the exact sample location will be biased to significant sediment accumulation areas. The samples will be field-screened for the presence of HE using the HE spot test kit.

The existing RFI data, supplemental HE spot test data, and geomorphologic information will be used to control initial removals of HE hot spots. Samples will be collected from up- and down-drainage, laterally, and from beneath the spot removals; samples will be field-analyzed for HE using HPLC in order to demonstrate that material contaminated with RDX at concentrations greater than 16 mg/kg has effectively been removed.

Spot removals will be restricted to the sediment profile above the tuff. If screening data demonstrate that RDX-contaminated material (> 16 mg/kg) remains following a spot removal, the removal will be expanded (laterally only) and additional screening samples will be collected.

Analytical laboratory data generated during the post-removal phase of the IM (described in Section 4.0) will allow further evaluation of the effectiveness of HE hot spot removals in the lower drainage channel. Removal of contaminated tuff (if present) from the lower drainage channel is not within the scope of the 260 IM and would require evaluation during the CMS/CMI.

3.2.2 Pre-excavation Screening Sampling of the Upper Drainage Channel

Prior to excavation, a brief screening sampling campaign will be conducted in the upper drainage channel. The screening data will be used in conjunction with existing RFI data to identify locations with high total HE and/or high barium concentrations.

3.2.2.1 HE Screening in Support of Soil Blending and Soil Removals

The existing RFI data indicates that elevated total HE concentrations are associated with sediment accumulation areas. As discussed in Section 5, all sediments within the upper drainage channel that contain

HE at concentrations in excess of 5% will require in-situ blending with less contaminated material to ensure worker safety. The pond area contains the majority of the locations with levels greater than 5% HE; previous RFI sampling identified six locations in the upper drainage with a concentration of more than 5% total HE. Supplemental screening data will be used to identify additional locations containing 5% or greater total HE.

Surface soil screening samples will be collected on nominally 10-ft intervals along the center of the upper drainage channel from the rock dam down drainage to the top of the cliff. Within a 10-ft interval, the exact sample location will be biased to areas of significant sediment accumulation. (Screening samples will not be collected from locations that were sampled during previous campaigns.) The samples will be field analyzed for HE using HPLC.

Locations in the upper drainage channel that require in-situ blending, as identified previously or during the initial IM field-screening effort described above, will be sampled following the blending at all locations that were greater than 5% HE to verify that the blending successfully lowered total HE concentrations to levels below 5%.

HE screening will also be performed in the lower drainage to support the soil removal in that area. Analytical laboratory data generated during the post-removal phase of the IM (described in Section 4.0) will further evaluate the effectiveness of HE removals in the lower drainage channel. Removal of contaminated tuff (if present) from the lower drainage channel is not within the scope of the 260 IM and would require evaluation during the CMS/CMI.

The HPLC field data will be used for screening purposes only. Field HPLC analysis will be based on a modified EPA Method 8330 procedure which is expected to produce high-quality data that is superior to the data from conventional field-screening techniques.

3.2.2.2 Barium Screening and Barium Hot Spot Delineation

The existing RFI data indicate that isolated sediment accumulation areas in the upper drainage channel contain leachable barium at concentrations that exceed 100 mg/L in samples analyzed using the toxicity characterization leaching procedure (TCLP). These levels would require any excavated material to be classified as D005 hazardous waste and would require the stabilization of barium prior to disposal. Based on regression analysis of PRS 16-021(c) RFI laboratory analytical results for barium and TCLP data, soils containing more than 25,000 mg/kg barium (based on fixed-laboratory EPA Method 6010 metals analysis) are likely to be classified as D005 hazardous waste (see also Appendix B). (This is discussed further in Section 5.3.1.1 of this plan.) Supplemental screening data will be used to identify additional locations that contain concentrations of barium greater than 25,000 mg/kg.

Prior to soil blending, surface soil (0–6 in.) screening samples will be collected at nominally 10-ft intervals along the center of the upper drainage channel, from the rock dam down drainage to the top of the cliff. Within the 10-ft intervals, the exact sample location will be biased to significant sediment accumulation areas. Screening samples will not be collected from those locations that were sampled during previous RFI campaigns. Soils known to contain more than 25,000 mg/kg barium that are blended during the initial phases of the IM (due to the presence of 5% total HE) will be assumed to contain more than 25,000 mg/kg of barium following blending and thus will be managed as hazardous waste.

Samples will be field-analyzed for barium using a Spectrace 9000 X-ray fluorescence (XRF) instrument (or equivalent). Because XRF measures total barium and the EPA method measures acid-leachable barium, XRF data are always higher than corresponding EPA Method 6010 data. As a result, LANL will verify the correlation between TCLP and XRF barium results prior to implementing XRF screening.

Tight control of barium hot spot removals will reduce the total volume of potential D005 characteristic hazardous wastes. IM screening data, RFI data, and geomorphologic information will all be used to control initial spot removals of potential hazardous waste (D005 waste) in the upper drainage channel. Samples will be collected from up- and down-drainage, laterally, and from beneath the spot removals; samples will be field-analyzed for barium. If XRF field-screening data demonstrate that high-barium (> 25,000 mg/kg) material remains following a spot removal, the removal will be expanded and additional screening samples will be collected. Individual hot spot removals are anticipated to be less than 1 yd^3 in total volume based on existing contaminant data and geomorphologic information. Material that is potentially D005 waste will be carefully segregated and staged within the AOC boundary pending treatment under Temporary Authorization at the IM treatment pad or off-site disposal.

3.2.3 Post-Blending Pond Screening

The pond, and other blended areas, will be sampled following robotic in-situ soil blending of pond sediments to verify that blending successfully lowered the concentration of total HE in the pond material to less than 5%. Six samples will be collected at random locations within the in-situ pile of blended pond material. Note that the pond has been effectively characterized for HE during previous sampling efforts; therefore no additional pre-blending screening samples will be collected.

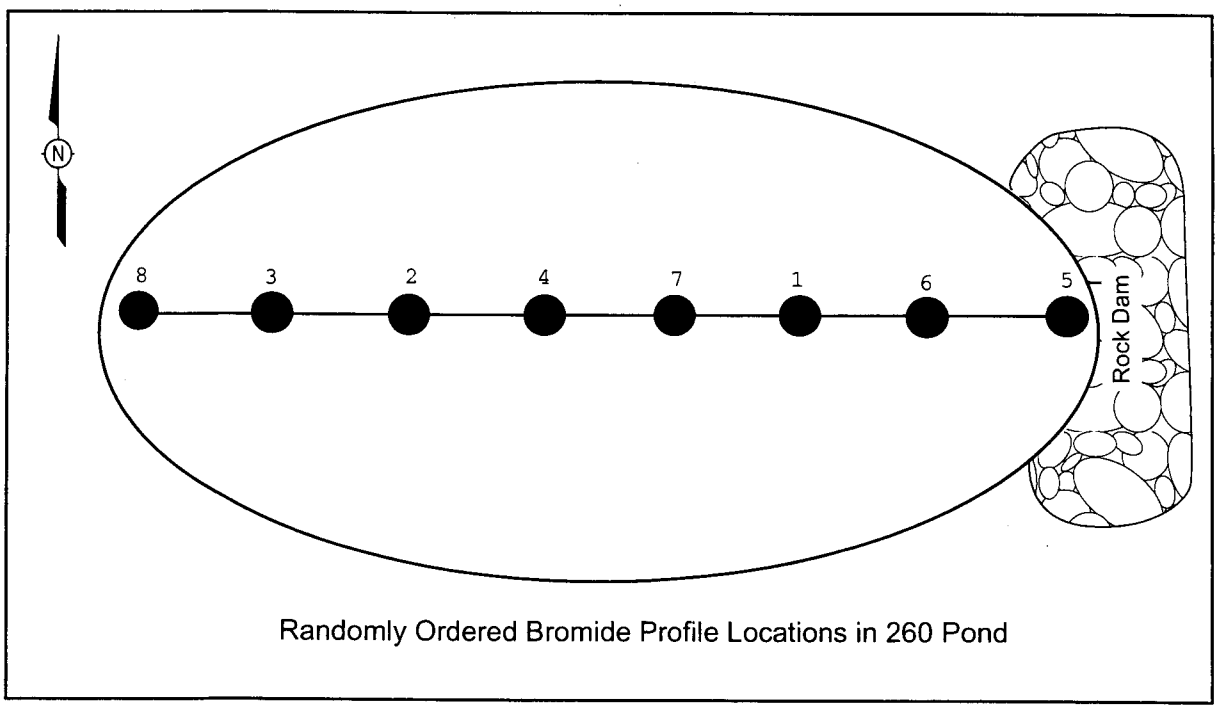
3.2.4 CMS Investigation Sampling: The Bromide Inventory

Bromide inventory sampling, as described in Section 6.3.1 of the CMS plan for PRS 16-021(c), which was approved by NMED, will be implemented during IM activities (LANL 1998, 59672.3). The bromide investigation is designed to determine the amount of bromide tracer remaining in storage in the pond sediments and in the tuff underlying the pond. This information will be used to enhance the understanding of the connection between the suspected HE-contaminant source area (the outfall) and the TA-16 seeps and springs.

A trench will be excavated to the depth of the soil/tuff interface along the center axis of the pond. Eight vertical profile locations will be spaced evenly (approximately 4 ft apart) along the trench. Each profile location will be divided into four equal depth intervals; samples will be collected from the bottom of each interval. This will produce a total of 32 systematic (unbiased) field-screening samples. The samples will be field-analyzed using an ion-specific probe or Hach field-test kit to determine bromide concentration. ASTM methods will be used to determine moisture content.

The ranked-set sampling (RSS) strategy outlined in the CMS plan will be used to select eight samples for fixed-laboratory analysis. The vertical profile locations have been numbered randomly from 1 to 8 (Figure 3.2-1 shows the randomly assigned profile numbers). The four samples from each vertical profile will be ranked from 1 to 4, representing lowest to highest bromide concentration based on the screening data.

Selection of samples for laboratory analysis will begin with the lowest ranked sample in profile 1, the next lowest in profile 2, up to the highest in profile 4, and then again the lowest ranked sample in profile 5 through the highest in profile 8. The fixed-laboratory samples will be analyzed for bromide and moisture content.



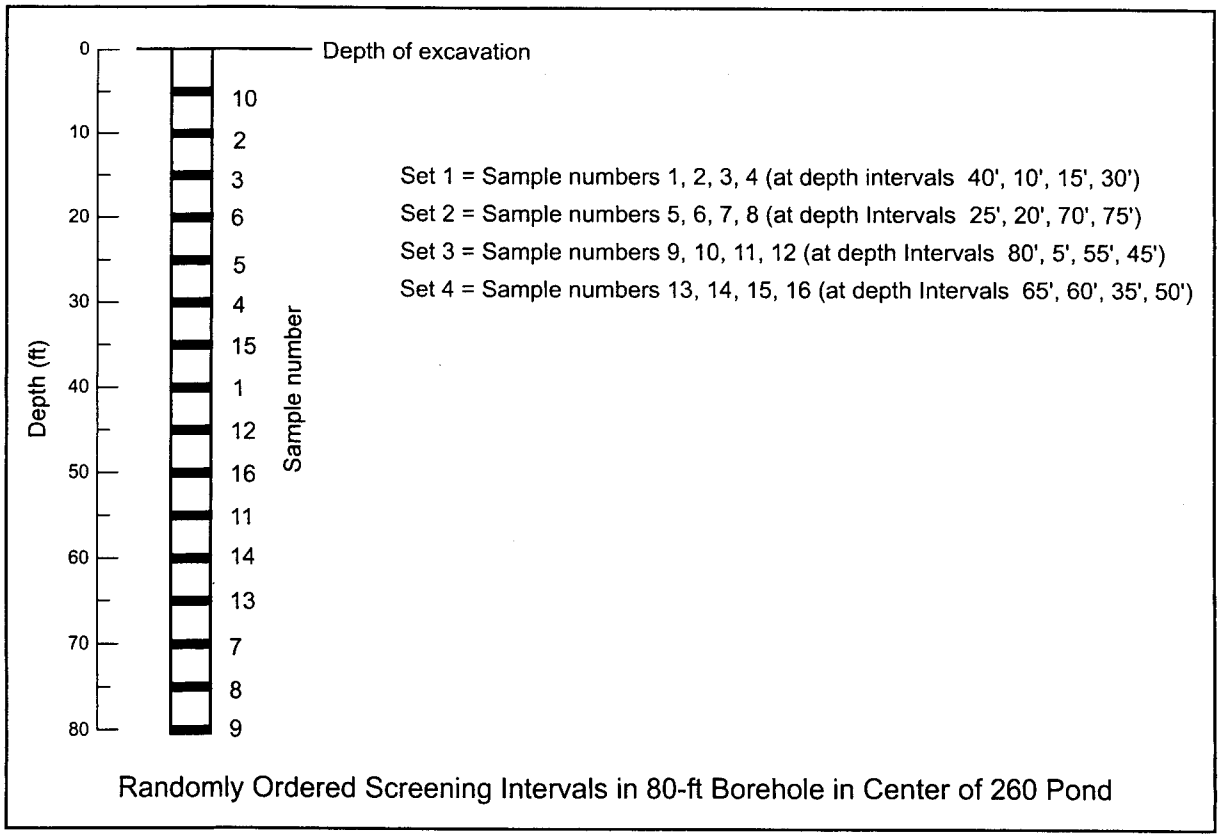


Figure 3.2-1. Randomly ordered bromide sample locations and intervals

After the IM removal of outfall sediments has been completed and the excavation has been sealed and backfilled, an additional borehole, located at the center of the (removed) pond, will be advanced to a total depth of 80 ft bgs. The borehole will be drilled with the Acker ADII drill rig, using a combination of hollow-stem auger and rotary coring methods. Starting from the depth of the pond excavation, the borehole will be continuously cored; samples will be collected from the bottom of each 5-ft interval. This will generate 16 unbiased (systematic) field-screening samples. The core samples will be field-analyzed for percent moisture using an ion-specific probe or Hach field-test kit to determine bromide concentration; using ASTM methods to determine percent moisture; and using field HPLC to determine RDX concentrations.

An RSS strategy will be used again to select 4 of the 16 screening samples for laboratory analysis. The systematic (unbiased) sample intervals have been randomly assigned to 4 subgroups of 4 sample intervals each. (Figure 3.2-1 also shows the randomly assigned interval numbers and sample subgroups.) The screening samples will be ranked 1 through 4 (again based on lowest to highest bromide concentration) within each of the 4 subgroups. Finally, the sample ranked number 1 in the first subgroup, number 2 in the second subgroup, and so on, will be submitted for laboratory analysis. The fixed-laboratory samples will be analyzed for HE by EPA Method 8330 and for bromide and moisture content.

Additional screening samples may be collected to target intervals containing elevated concentrations of RDX and bromide, moist strata, fractures (if any are encountered), or other atypical physical characteristics. These biased samples may be selected (based on physical indicators) from anywhere within the continuous core; the samples will be kept separate from the unbiased samples and will not be used in the RSS estimate of the mean bromide concentration. The selection of biased samples will include

- first, the sample with the highest RDX concentration,
- second, the sample with the highest bromide concentration,
- third, the sample with the highest degree of staining,
- fourth, the sample with the highest apparent moisture content,
- fifth, the sample with the greatest degree of clay development, and
- sixth, the sample with the greatest degree of fracturing.

It will not be necessary to submit all six samples if, as examples, the highest RDX sample will already be submitted as part of the RSS sampling or the highest moisture content sample is also the same sample with the greatest degree of fracturing. The biased samples will be submitted for laboratory analysis of bromide content, moisture content, and HE content, using EPA Method 8330.

3.3 Cleanup Activities

3.3.1 Mobilization

Following the readiness review, equipment will be mobilized and staged at TA-16. Heavy equipment, including excavators, a rolloff truck, a front-end loader, a D7 Caterpillar or equivalent bulldozer, and a water truck, will be stored on the asphalt road adjacent to the field trailers. The screen plant and grizzly (a large-grid, non-mechanized screen) will be mobilized to the pond area. Rolloff containers will be stored along the asphalt roadway behind Building 260. The High Explosives Production Sites (HEPS) Team's field trailers, located near former Building 27, will be used for project administration and for equipment and supply storage. Field analytical equipment, including a field-portable HPLC and XRF, will be set up at the on-site support facility during mobilization.

3.3.2 Infrastructure Installation

IM infrastructure components, including an on-site support facility, a trailer for robotics remote control, an access road, material management facilities and staging areas, a waste treatment area, and a decontamination pad, will be set up and maintained immediately following mobilization.

The BMPs currently installed at the site are sufficient to control stormwater runoff during mobilization, infrastructure installation, and hand excavation and sampling activities; therefore, no new BMPs will be established during the infrastructure installation phase of this project. The stormwater and runoff control measures needed to minimize impacts to Cañon de Valle during the IM are discussed in Section 3.3.3.

The HEPS Team's field trailers (one office trailer, two storage trailers, and one field analysis trailer), located near former Building 27, will be used for site support, field-screening analyses, data management, administrative functions, project coordination, personnel decontamination, and waste treatment support. Use of the HEPS Team trailers will not be affected by HE machining operations because the trailers are outside of Building 260's blast radius.

The mobile control center (MCC) trailer, which contains the base station and controls for the remote excavation system, will be located on the south bank of the drainage, approximately 200 ft below the TA-260 outfall and 100 ft from the center axis of the channel. A 32-ft telescoping mast will be used to raise the base station antennas above most of the local obstructions. A generator will be used to supply electrical power for the MCC.

The work zone and all site postings will be established at the time of site mobilization. Any additional required waste storage areas (90-day hazardous waste accumulation and/or satellite waste accumulation areas) will also be established at that time. The satellite waste accumulation area in the HEPS Team field trailers will be maintained to support field analysis activities.

A decontamination pad, a staging area, and an excavated materials management area will be established within the AOC boundary. A temporary decontamination pad for the heavy equipment and excavated cobbles will be located in the northeast portion of the AOC boundary. The pad will only be installed if it is needed to support site operations. The decontamination pad will be constructed of a double HDPE liner laid over a bermed sand bed 6-in.deep. Excavated material piles will be staged on bermed HDPE liners or in rolloffs.

An access road for heavy equipment will be established on the north side of the drainage channel, leading from the northeastern corner of TA-16-260 to the staging area up-drainage from the mesa edge. Using the north side of the drainage channel will enhance site access and will minimize tree removal. If possible, tree thinning for road construction will be coordinated with scheduled LANL fire protection operations. The lower drainage channel is currently accessible via the SWSC-cut access road and open space south of the drainage channel. [Figure 3.3-1 presents a schematic of the site setup at PRS 16-021(c)-99 for IM operations.]

The existing BMP at the drainage channel's cliff edge will be improved in order to limit erosional impacts to Cañon de Valle during drilling and excavation activities. The existing straw bale and rock dam BMPs within the drainage will be maintained until it is necessary to remove them for soil excavation activities.

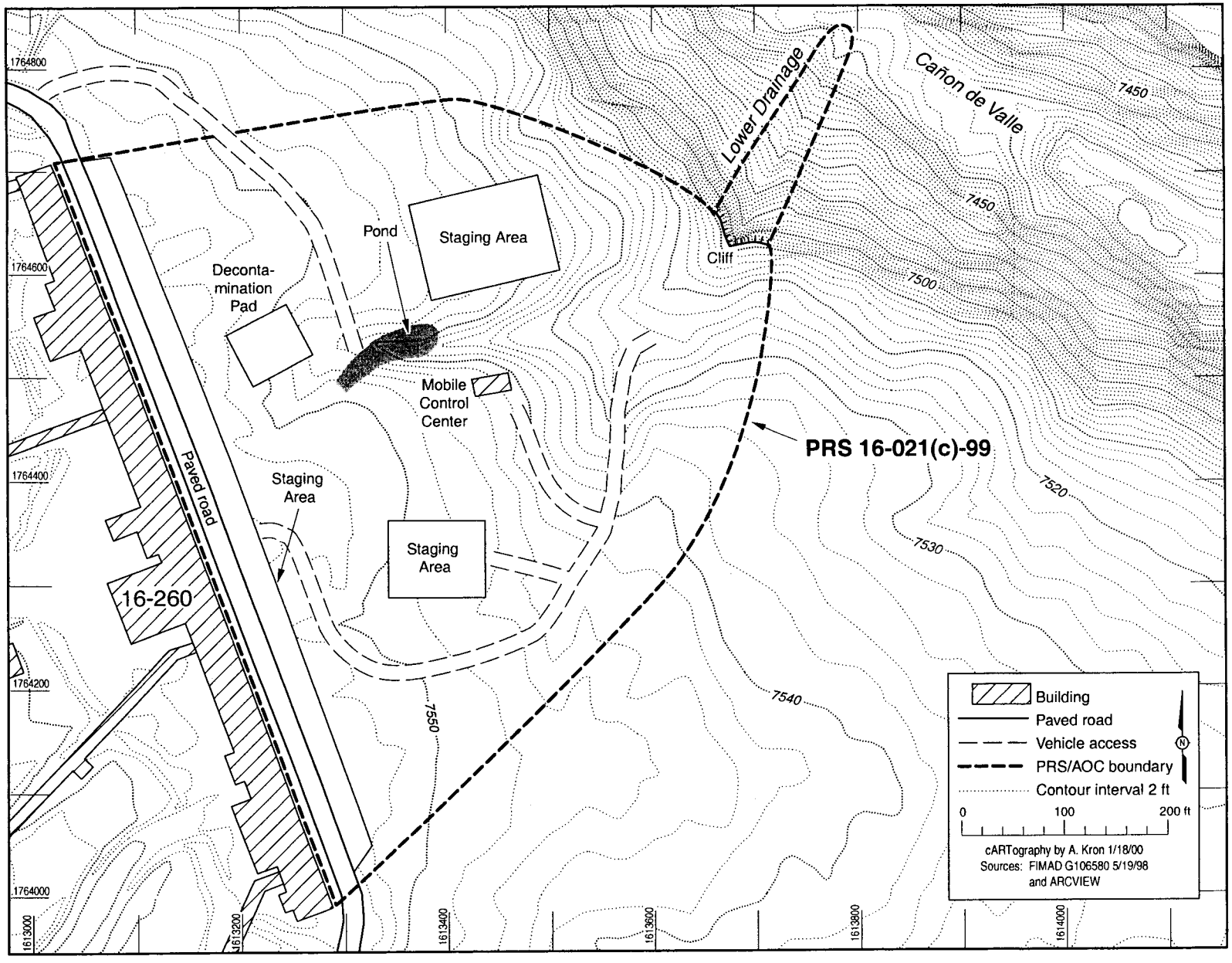


Figure 3.3-1. Schematic of the site setup at PRS 16-021(c)-99 for IM operations

3.3.3 IM Stormwater Control Practices and BMPs

During large-scale excavation and soil size-separation activities, surface water discharges will be prevented from entering the lower drainage channel. This will be accomplished by constructing an earthen berm and swale, which will be lined with HDPE (or equivalent), immediately up-drainage from the cliff's edge. The earthen berm and swale will be constructed in accordance with LANL's "Stormwater/Surface Water Pollution Prevention Best Management Practices (BMPs) Guidance Document" (LANL 1998, 62458).

The berm and swale will be constructed during the initial phases of upper drainage channel excavation. The area immediately up-drainage from the cliff's edge will be scraped clean of contaminated sediments with a conventional excavator. A depression will then be excavated and lined. The earth berm will be constructed immediately down-drainage from the swale and will slightly overlap the swale liner. Figure 3.3-2 presents a schematic of the zero-discharge BMP at the cliff's edge.

The swale will be pumped periodically (as necessary) to prevent discharge into the lower drainage channel. Any water removed from the swale will be managed similarly to other IM-produced and containerized water. Sediments that settle out into the swale will also be removed periodically and managed with other IM excavation materials.

No additional BMPs in the upper drainage channel are anticipated to be necessary to maintain zero discharge into the lower drainage channel. The existing BMPs in the lower drainage channel should be sufficient to control runoff and erosional effects during the relatively low-impact excavation and sampling activities in the lower drainage channel. Site access routes will be managed to prevent increased erosion and runoff, if necessary. Existing site access routes are not anticipated to require significant enhancement, and construction of BMPs is unlikely to be necessary. Post-IM BMPs are discussed in Section 3.4. Additional detail about both IM and post-IM BMPs is presented in the HEPS TA-16 Stormwater Pollution Prevention Plan, which is included with this document as Attachment D.

3.3.4 Excavation

Robotic excavation, conventional mechanized excavation, soil vacuuming, and hand excavation techniques will be used to execute the IM cleanup. Specific methods, or a combination of methods, will be used at different locations in the PRS. Method selection will be based on total HE concentrations and operating group requirements.

The excavation has been broken down into three distinct activities: (1) excavation of the lower drainage channel, (2) excavation of the upper drainage channel below the pond, and (3) excavation of the pond area.

Excavated material will be processed through a screen plant equipped with a grizzly to separate the dacite gravels, cobbles, and boulders (aggregate material) greater than 3 in. in diameter from finer material. The composting and most other treatments that are being considered cannot process material containing aggregates greater than approximately 3 in. in diameter. The grizzly will divert larger aggregates (greater than 6 in. in diameter) from the screen plant where the intermediate size aggregates (3 to 6 in. in diameter) are removed.

The contamination of aggregates in the outfall drainage channel is expected to be predominantly surficial. This material (greater than 3 in. in diameter) will be washed with water to remove any contaminated fine material that has adhered to the aggregate surfaces. This will be accomplished by pressure washing the aggregates removed via the grizzly and by equipping the screen plant with spray bars to wash the intermediate size aggregates.

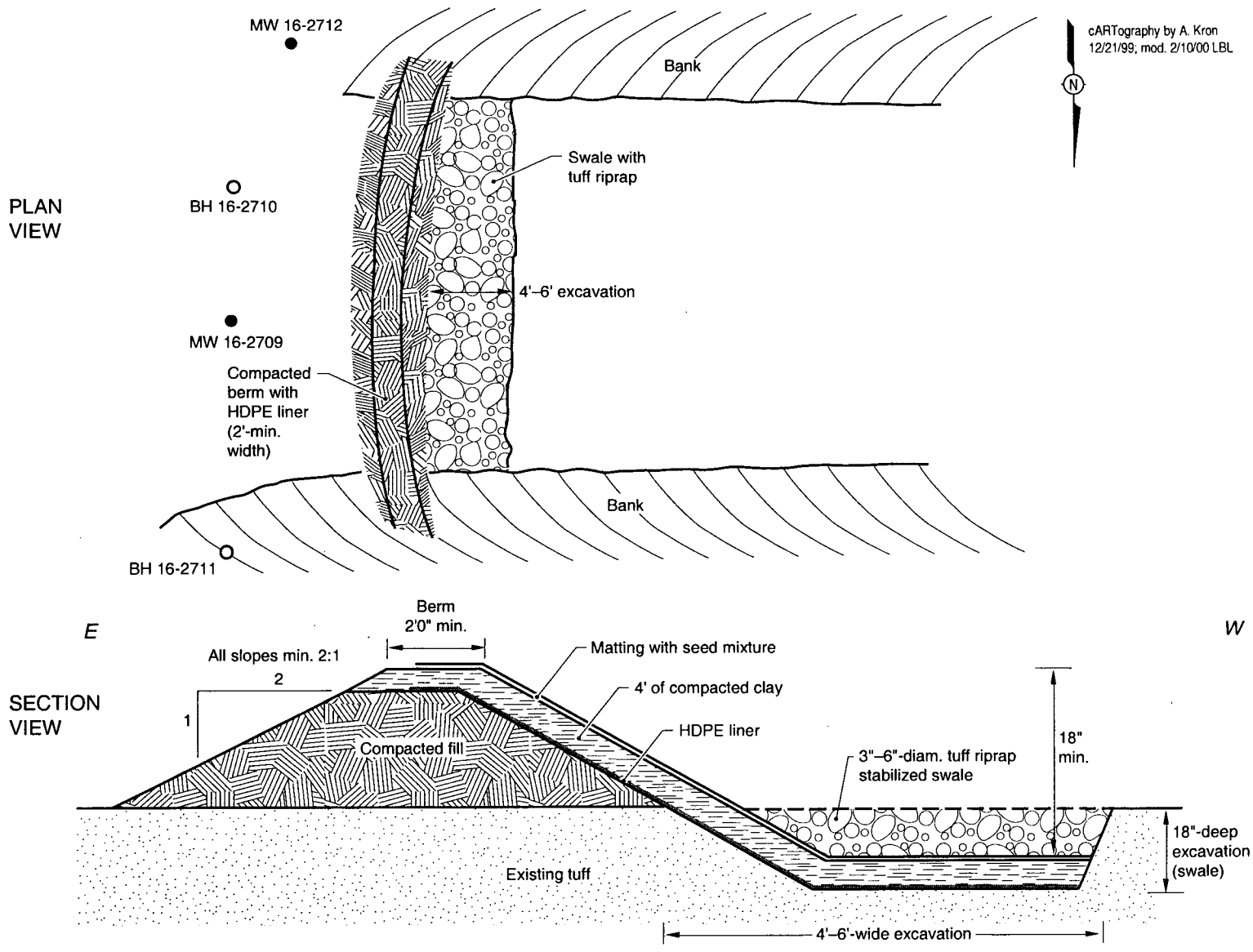


Figure 3.3-2. Schematic of zero-discharge BMP

Segregation of fine material from aggregates will be performed in watertight rolloffs or tanks within the AOC boundary. The captured water will be allowed to settle. The fine material recovered following settling will be collected and managed with the bulk material removed from the corresponding area of the PRS.

The wash water will be staged in tanks within the AOC boundary and will be reused for primary decontamination of equipment and oversized aggregates, for dust suppression within contaminated areas, and for soil wetting during soil treatment. Any excess water will be sampled and disposed of at the HE liquid waste treatment plant at TA-16. The segregated aggregates will be staged on-site. They will be used later to establish new BMPs as part of site-restoration activities.

3.3.4.1 Lower Drainage Channel Excavation

A combination of hand excavation and soil vacuuming methods will be used to remove HE hot spots in the lower drainage channel. The excavated material will be processed and treated similarly to upper drainage channel excavated material. Soil blending is not expected to be required in the lower drainage channel.

3.3.4.2 Upper Drainage Channel Excavation

Excavation of the upper drainage channel between the rock dam and the cliff's edge will proceed after the soil blending. It will be performed with a conventional excavator and front-end loader. Sediment removal in this area will be limited to the material above the sediment/tuff interface.

In the initial phase of the upper drainage channel excavation, barium hot spots (greater than 25,000 mg/kg barium, potential D005 waste) will be removed and managed. Following the removal of hot spots, the excavator will be used to scrape sediments into a pile at the wide flat area approximately 400 ft down drainage from the outfall. This will establish a relatively uncontaminated and stable surface for siting the screen plant.

Once the screen plant has been sited, the excavator will continue the contaminated soil removal by working progressively up drainage from lowest to highest contamination. Contaminated material will be scraped into a pile within the drainage channel; spoils piles will be processed through the screen plant in batches based on the size of the spoils pile. The screen plant will be moved up drainage behind the excavator as necessary to maintain efficient excavation and processing of material.

A 3- or 4-yd front-end loader (Caterpillar 940 or equivalent) will be used to capture the large fractions cast off from the end of the screen plant. The material processed through the size separator will be accumulated on the ground beneath the screen plant. This material will be transported to staging piles, as necessary. Oversized fractions from the screen plant and rubble screened out by the grizzly will be transferred by front-end loader to a rubble pile or to the watertight rolloffs and/or tanks for further size separation (Figure 3.3-3).

At this time, construction of the BMP at the cliff's edge, including the construction of a lined swale, will be made (see Section 3.3.3).

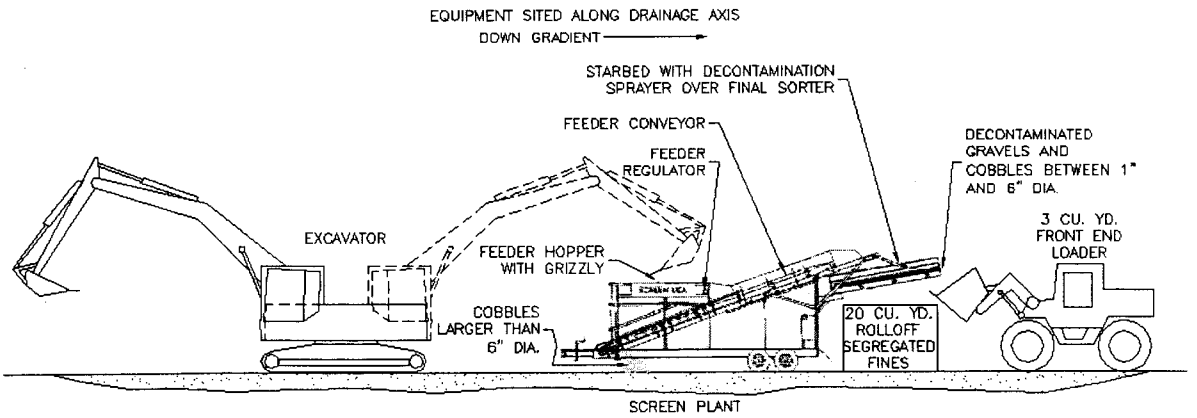


Figure 3.3-3. Schematic of material processing within the drainage channel, using the screen plant to sort size fractions

3.3.4.3 Pond Excavation

Near-surface sediments in the pond area (from the rock dam up-drainage to approximately 30 ft below the outfall) are potentially reactive. They will be blended and excavated robotically to ensure personnel safety.

The robotic system is comprised of two major components: the remote excavator and the MCC. A radio link exists between the excavator and the MCC.

The remote excavation system integrates preprogrammable, repeatable robotic controls with a remotely operated excavator. The remote excavator uses a 32-ft arm capable of reaching 20 ft below the base of the trackhoe. The standard human interfaces (e.g., seat, control sticks and pedals, operators, cab) have been replaced with on-board computing systems.

The MCC houses the operator and control console. This console incorporates multiple video and computer monitors which display all information to the operator and allow the operator to guide the excavator and view progress via several cameras aimed at the excavation.

Because the average total HE concentration in the pond is 4.7% (47,000 mg/kg) (see Table 5.1-1), in-situ blending of the approximately 67 yd^3 of pond sediments (based on pond dimensions of 20 ft wide, 50 ft long, and 3 ft deep) is expected to meet the safety requirement criteria of 5% total HE in the excavated waste. As discussed in Section 3.2.3, the pond material will be screened after the robotic blending.

If a significant amount of rock is intermixed with the blended pond sediments, the excavated material will be processed through the screen plant and captured directly in rolloffs. If screening is not required, the excavated material will be placed directly into rolloffs. Rolloffs will be placed in a staging area within the AOC boundary. When analytical results have been received that verify that the excavated material no longer contains potentially detonable concentrations of HE, the material will be moved into staging piles, transported off-site for disposal, or transported to the treatment pad.

The tuff and surge bed underlying the pond will be excavated conventionally, if it is mechanically feasible. In the field, it will be determined if standard excavation techniques can effectively remove the tuff overlying the surge bed. The surge bed will be removed from only the area immediately underlying the footprint of

the pond. The CMS/CMI will evaluate alternatives if the surge bed extends laterally beyond the pond footprint. The excavated material will be processed through the screen plant and treated similarly to the upper drainage channel sediments. Tuff rubble will be handled as all other oversized material.

3.3.5 Decontamination and Demobilization of Equipment

Equipment will be moved from areas of low contamination to areas of higher contamination and will operate from remediated areas, whenever operational logistics allow. Equipment for transferring excavated soil from the drainage to the material staging areas will be operated from remediated areas and will contact contaminated material only with buckets or scoops.

Front-end loader scoops and backhoe loads will be leveled. Before soil is transferred out of the drainage, loose soils will be removed from the bucket or scoop over the contaminated area. The tires of the earth-moving equipment will be monitored periodically with the HE spot-test kit and will undergo dry decontamination as necessary to ensure that HE contamination is not spread to clean areas.

The heavy excavation equipment and the screen plant will remain in the drainage until the equipment is no longer needed. Before removing this equipment and the drill rig from the drainage, the equipment will undergo an extensive dry decontamination process to remove all residual soils adhering to the equipment.

Following sampling, excavation, and soil treatment activities, all potentially contaminated equipment will undergo a two-stage decontamination: residual dry soil adhering to equipment will be removed, followed by a high-pressure Alconox/water wash within the AOC (within the drainage channel or at a decontamination pad) or at Building 400. Decontamination fluids from the pad will be collected and used for soil wetting during the soil treatment process. Any excess fluids will be sampled and disposed of at the HE liquid waste treatment plant. The air filters from equipment operating in the exclusion zone will be considered contaminated and will be properly disposed of before the equipment leaves the site.

Vehicles hauling excavated material from the site, and all potentially contaminated equipment, will be checked with the HE spot-test kit before leaving the AOC. All equipment and materials will receive HE decontamination slips from TA-16 Facility Management prior to release from the HE area.

3.4 Site Restoration

When excavation and confirmatory sampling is complete, hydrologic barriers will be installed at the bottom of the excavated pond and at the depth of the soil/tuff interface. This will minimize the migration of residual HE in the overlying soil profile and the surrounding surge bed, fractures, and tuff pore space. The first hydrologic barrier will be installed at a depth that corresponds to the top of the tuff; the soil/tuff interface is anticipated to be at a depth of approximately 5 ft beneath the pond. The second hydrologic barrier will be located directly on top of and overlapping the surge bed located at approximately 17 ft below pre-excavation grade. The hydrologic barriers will consist of crushed tuff amended with bentonite. Bentonite will be added to the crushed tuff at a rate of 2.5% (by weight) dry bentonite and 1.5% wet bentonite, via an 8% bentonite-water slurry. The minimum compacted thickness of each layer will be 18 in. The saturated permeability of the barriers is estimated to be less than 1×10^{-7} cm/s.

Between and above the hydrologic barriers, the excavation will be backfilled with clean crushed tuff that has been ASTM D2487–certified. The fill will be placed in 8-in. lifts and compacted to the required 90% maximum dry density. During placement, compaction will be determined in accordance with the modified proctor ASTM D1557, method A or D.

The pond and other areas of extensive soil removal will be regraded to prevent ponding, reduce erosion, and reduce the sediment load contribution to Cañon de Valle. The lower reaches of the drainage that have

been excavated to tuff but that are within 2 ft of the original contours will not be backfilled and recontoured. After recontouring, approximately 3–5 in. of loose topsoil will be applied to disturbed areas outside the drainage channel (including the treatment area), along the channel banks, and on the pond area, in preparation for permanent seeding.

At this point, a series of check dams will be installed in the upper drainage channel. Check dams will be constructed of 2- to 15-in. aggregate rock, stacked to a maximum height of 2 ft. Decontaminated rocks from the excavation will be used to construct the rock dams. The center of the dams will be at least 6 in. lower than the outer edges. The check dams will be spaced such that the toe of the upstream dam is at the same elevation as the top of the downstream dam. To prevent the development of a hydraulic head over the excavated pond area, the first check dam will be located approximately 25 ft downgradient from the existing pond dam.

All disturbed areas with soil will be reseeded with the seed mixture and application rate specified in Section 222.7 of the LANL Architectural Standards Manual, Volume 4, and as approved by LANL's Water Quality and Hydrology Group (ESH-18) and LANL's Ecology Group (ESH-20). If reseeding occurs after September 15th, a dormant seed will be applied by broadcast spreading; water will be applied at the discretion of ESH-18 and ESH-20. If reseeding occurs during the spring or summer (before September 15th), the approved mixture will be applied with a hydroseeder.

The reseeded areas will be covered with approximately 2 in. of mulch obtained from the Los Alamos County landfill. In the event that long-term staging of excavated soils is required, excavated material management areas will be set up in the interim to prevent erosion. All staging areas will be reseeded after removal of staged excavated material.

To enhance soil stability and to improve the rate of revegetation, reseeded areas along the drainage channel banks and the pond area will be covered with jute matting instead of mulch: the matting will be unrolled in the direction of water flow and will be anchored with wood stakes at the toe of the slope. On the up-drainage side, the matting will be anchored in a trench that is 6 in. wide and 6 in. deep. On the down-drainage side, the matting will be anchored in a trench that is 6 in. wide and 12 in. deep. The channel bottom in the upper and lower drainages will be left as bare tuff and will not be reseeded

4.0 CONFIRMATORY SAMPLING

An RSS strategy will be used to estimate the residual contamination remaining in the drainage channel following excavation (Patil et al. 1994, 59113). The confirmatory sampling has been designed to support a risk assessment of the contamination that remains in the 260 outfall following excavation. The RSS strategy will allow a more accurate estimate of the mean residual contaminant concentrations while requiring fewer fixed-laboratory samples.

The outfall will be divided into three distinct strata (A, B, and C) based on geology and pre-excavation contaminant levels. The three strata are described below:

- A—Surface material from the excavated drainage channel between the outfall and the edge of the cliff. The floor is expected to be mostly tuff; the drainage channel banks may be partially soil. The area is expected to be fairly homogeneous because excavation in this area will be performed using heavy equipment.
- B—Surface material from the drainage channel between the base of the cliff and the drainage channel's confluence with Cañon de Valle. Post-IM sampling may include unexcavated areas as well as excavated areas. This stratum is expected to be more heterogeneous than A.

- C—Subsurface material (expected depth of 1 to 2 ft) from the center of the drainage channel between the outfall and the cliff. This stratum is expected to have the least variability in contaminant concentrations and to be the most homogenous geologically; therefore, fewer samples will be necessary to characterize this stratum.

A total of 18 screening samples will be collected from each of the first two strata; 9 screening samples will be collected from the third. The samples will then be field-analyzed for HE constituents using HPLC and field-analyzed for barium using XRF.

The 18 screening samples from stratum A will be collected along 6 transects spaced evenly (approximately every 65 ft) from the outfall down-drainage to the cliff. Three screening samples will be collected from each transect: one sample from the center of the channel, one sample approximately 15 ft perpendicular to the center line of the channel in one direction, and one sample 15 ft perpendicular to the center line in the opposite direction.

The 18 screening samples from stratum B will be collected along 6 transects spaced evenly (approximately every 50 ft) from the cliff down-drainage to the confluence of the drainage channel with Cañon de Valle. Three screening samples will be collected from each transect: one sample from the center of the channel, one sample approximately 10 ft perpendicular to the center line of the channel in one direction, and one sample 10 ft perpendicular to the center line in the opposite direction.

The 9 screening samples from stratum C will be collected from 9 evenly spaced locations (approximately every 45 ft) down the center of the drainage channel.

The RSS strategy described below will be used to select samples for fixed-laboratory analysis. Six samples will be taken from strata A and B, and three samples will be taken from stratum C. The laboratory samples will be analyzed using the standard TA-16 suite of analyses. This suite includes metals analysis by EPA Method 6010, extended HE analysis by EPA Method 8330, semivolatile organic compound (SVOC) analysis by EPA Method 8270, volatile organic compound (VOC) analysis by EPA Method 8260 using En Core samplers (or sealed sampling sleeves in tuff), and total uranium analysis by inductively coupled plasma mass spectrometry. Analysis of total uranium is adequate because correlation data for total uranium to isotopic uranium is available (AQ Safety 2000, 64945).

In strata A and B, transects will be numbered randomly from 1 to 6; the three screening samples from each transect will be considered 1 sample group. In stratum C, the screening samples will be assigned randomly to 3 groups of 3 samples. Figure 4.0-1 depicts the screening sample locations in all three strata and presents the random number assignments to transects (strata A and B) and sample locations (stratum C). Within each group, samples will be ranked from lowest to highest concentration based on field RDX concentrations.

From strata A and B, the following samples will be submitted for laboratory analysis: the lowest ranked sample from group 1 and from group 4, the middle ranked sample from group 2 and from group 5, and the highest ranked sample from group 3 and from group 6. From stratum C, the following samples will be submitted for laboratory analysis: the lowest ranked sample from group 1, the middle ranked sample from group 2, and the highest ranked sample from group 3.

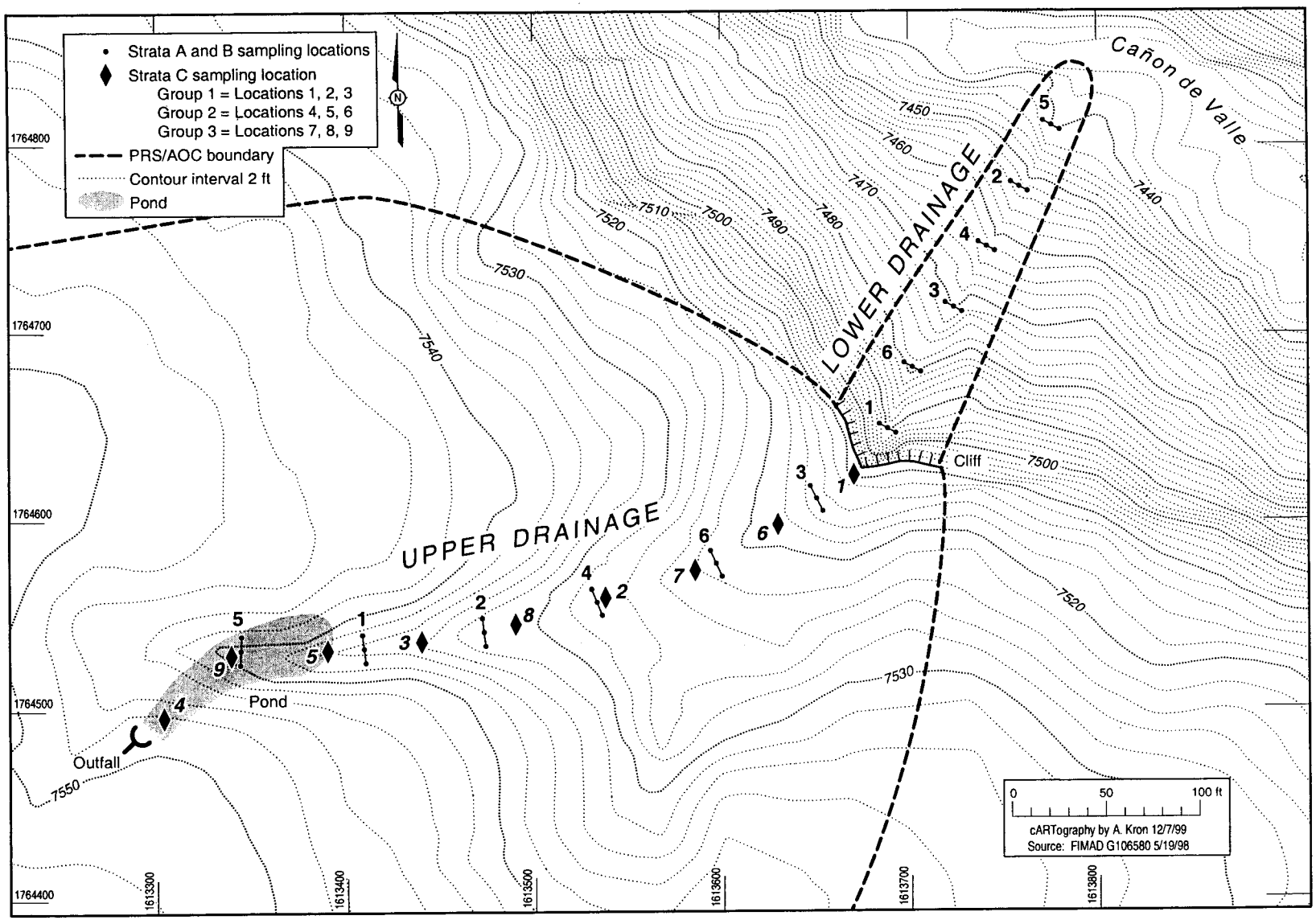


Figure 4.0-1. Confirmatory sampling locations in the three strata

An anomalous sample (e.g., a sample with an unusually high barium or HE concentration) can be selected for laboratory analysis in place of a sample that would have been selected using the RSS strategy. In this event, the sample's ranking within a group should be noted and an appropriately ranked sample from another group should be selected. This will preserve the low/middle/high selection of samples from the sample groups. As an example, the middle ranked sample (based on RDX concentration) from stratum A in group 1 is anomalous and should be selected for laboratory analysis; therefore, the lowest ranked sample from group 2 should be selected for analysis in place of the middle ranked sample. The result: the lowest ranked samples in strata A would be derived from groups 2 and 4, the middle ranked samples would be derived from groups 1 and 5; the highest ranked samples, derived from groups 3 and 6, would not be affected.

QA samples will also be run by HPLC to ensure the reliability of field HPLC data. HE-spiked performance evaluation samples will be run each day that the instrument is used. In addition, duplicate samples will be field-analyzed at the rate of 1 per 10 screening samples.

5.0 WASTE MANAGEMENT

The potentially contaminated wastes to be generated during the IM will include excavated soil/sediment/ tuff (excavated waste) and investigation-derived wastes (IDW). Figure 5.0-1 depicts the waste decision process to be used for segregating and treating wastes. Before excavated wastes are generated, locations to be excavated will be screened for total HE concentration (Section 3.2). To protect the safety of IM site workers, if the screening results indicate a concentration greater than 5% total HE, material containing less than 5% total HE within the IM area will be blended with the greater than 5% material (in situ) until the HE concentration of the resulting mixture is less than 5%.

Locations suspected to contain concentrations of barium that would cause the material, when generated as waste, to be classified as hazardous D005 waste (hot spots with greater than 25,000 mg/kg barium) will be identified. These locations will be selected based on existing data and geomorphic examination as described in Section 3.2.2.2. Samples of material from these locations will be screened for barium using an XRF. As explained in Section 3.2.2.2, a screening criterion of 25,000 mg/kg barium in the excavated material will be used to identify material to be removed.

Material removed from areas that were blended, and all D005 wastes, may require a temporary authorization permit before on-site waste treatment. If a temporary authorization permit is not obtained, this waste will be staged, and a permit application will be submitted or it will be shipped directly for disposal at an appropriate waste disposal facility.

Excavated waste (except blended waste if a temporary authorization permit is not obtained) will be treated to reduce the total HE content (as described in Section 5.3.1.2) to meet the waste acceptance criteria of the selected treatment, storage, and disposal (TSD) facility. If any waste derived from soil blending or from barium hot spot removals contains underlying hazardous constituents (UHCs), as described in 40 CFR §268.40(e), that exceed the universal treatment standards (UTSs) as listed in 40 CFR §268.48, it will be treated to meet UTS requirements before disposal (as described in Section 5.3.1.3). Treatment may either be on-site or off-site at an appropriately permitted facility.

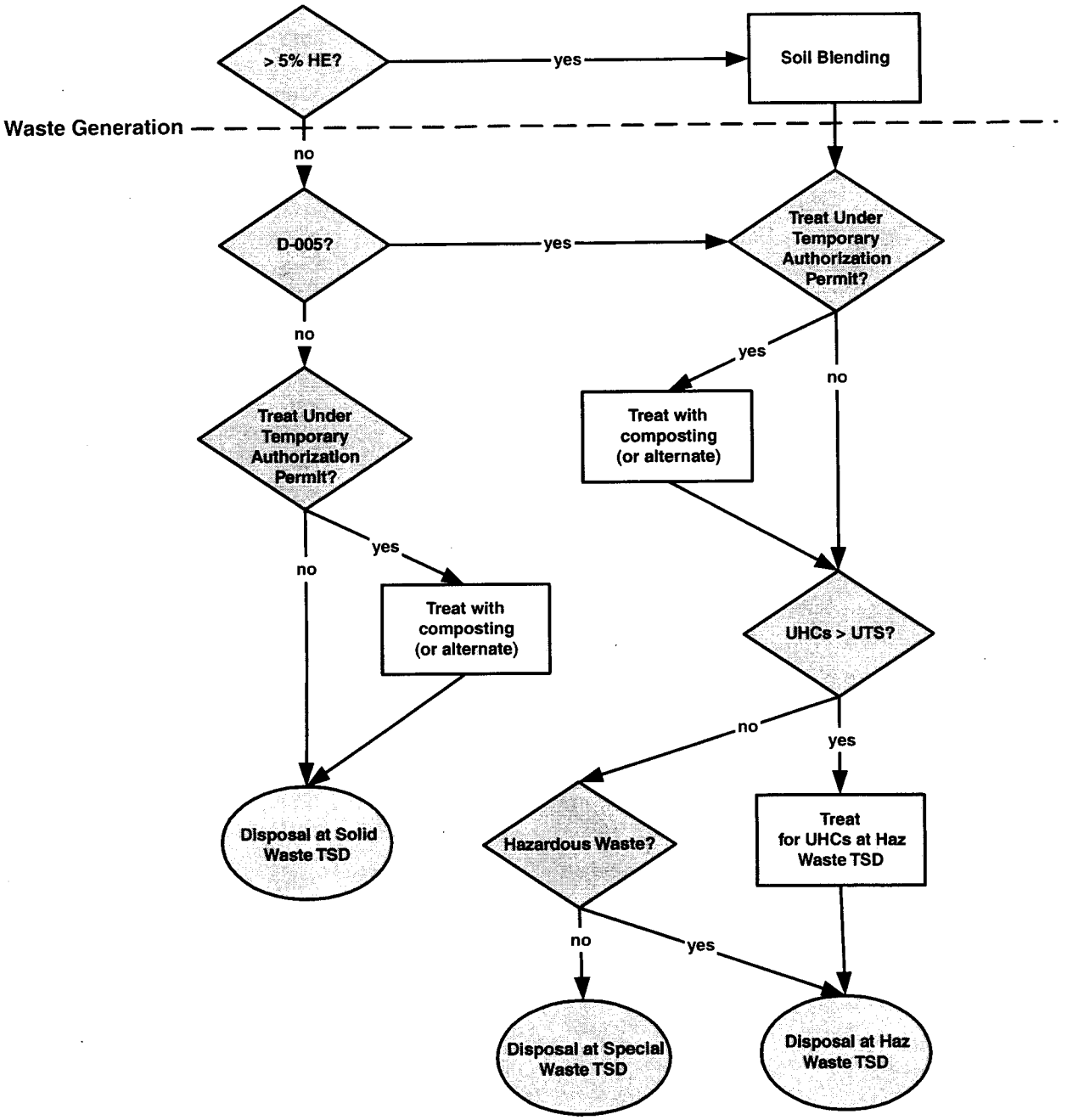


Figure 5.0-1. Treatment and disposal paths for excavated wastes

The disposal paths for IDW will be determined based on the characterization of the excavated material contained in (or on) the IDW and the intrinsic characteristics of the IDW as described in Section 5.1.

5.1 Waste Characterization

Characterization of wastes will be based on a combination of acceptable knowledge, existing laboratory analytical results, and new laboratory analytical results. Excavated rock greater than 3 in. in diameter that is free of potentially contaminated fines will not be considered as waste but will be beneficially used for ero-

sion control purposes (see Section 3.4). Wastes that have not come into contact with potentially contaminated material will be disposed of as administrative or municipal waste. IDW and equipment that were exposed to contaminated material or equipment will be decontaminated as appropriate and characterized as solid waste.

The goal of waste characterization sampling is to ensure: (1) that wastes are handled in compliance with all applicable regulations; (2) that treatment goals for HE and barium are achieved; and (3) that the waste acceptance criteria for the applicable TSD are met. Treatment goals for HE are not proposed in this plan. These goals will be developed, in consultation with NMED, following completion of treatment pilot studies and after a decision that on-site treatment is a viable option.

There are two distinct waste sample protocols: (1) for barium hot spot wastes and wastes from areas that were blended before excavation; and (2) for wastes that were never classified as hazardous and were not blended. However, all wastes will be characterized for radiological contaminants based on analytical laboratory data collected for the naturally occurring radioactive material (NORM) determination described in Section 5.1.3.

Barium hot spot and blended wastes will be characterized based upon existing analytical data and direct samples of the waste following composting (or alternate process) treatment. Material that is identified as likely to be nonhazardous (based on existing data) will be characterized based on data generated prior to treatment. These data will ensure that these materials are not hazardous wastes.

Characterization will be based on analytical laboratory data of samples collected from either pre- or post-treatment waste (see above). Samples will be collected at a rate of one composite sample for each 100 yd^3 (except for VOC organic compound samples which will be collected as grab samples). This sampling frequency will be adequate for the material which has been homogenized by the composting process (or alternate process). This sampling methodology and frequency is consistent with the waste sampling strategy at MDA P, which is far more heterogeneous. These samples will be analyzed for metals (TCLP), HE (EPA Method 8330), VOCs (EPA Method 8260), and SVOCs (EPA Method 8270). TCLP organics analysis will be added to the analyte suite whenever the 2,4-DNT results from the 8330 analysis exceed 20 times the TCLP limit. Characterization for all other constituents will be based on analytical laboratory data from the Phase I and Phase II investigations.

Waste water will be characterized based on analytical laboratory results. At least one sample will be submitted from each container (tank). These samples will be submitted for HE (EPA Method 8330), inorganics (EPA Method 6010), VOCs (EPA Method 8260), and water quality parameter analyses as stipulated by the HE water treatment facility waste acceptance criteria.

The contamination in or on IDW, the decontamination liquid, and the field analytical residue wastes will be characterized based on contaminant concentrations in the excavated wastes using a conservative estimate of the amount of excavated waste contained in (or on) these wastes. The type and concentration of solvents in the waste will also be considered when characterizing field analytical residue wastes.

5.1.1 Listed Hazardous Waste Characterization

Excavated wastes from the IM are not expected to be classified as listed hazardous waste. Interviews conducted with current and former managers of Building 260 identified that acetone, toluene, and trichloroethene were used within the building as solvents (Kidman 1998, 64703). Acetone and toluene have been detected in samples from the outfall and drainage area. Trichloroethene has been detected in samples from Cañon de Valle springs but not in samples from the area covered by this IM. Other F-listed constituents were observed in the 260 outfall data, but they are not known to have been used in a listed process.

For the area included in this IM, toluene was detected in 2 out of 12 samples reported in the Phase II RFI report (LANL 1998, 59891). It was detected at 0.003 mg/kg in one sample of the surge material underlying the pond and at 0.002 mg/kg in one sample of the material in the upper drainage. Acetone was detected in 43 out of 64 samples, with a maximum concentration of 0.43 mg/kg.

LANL requested that the New Mexico Environment Department's (NMED) Hazardous and Radioactive Materials Bureau issue a "no-longer-contained-in" determination for environmental media generated during the IM that contains detected concentrations of acetone, toluene, and trichloroethene below EPA's Region 6 Medium-Specific Screening Levels (MSSLs) for an industrial receptor. NMED approved the request for a "no-longer-contained-in" determination. Wastes containing these three constituents at concentrations less than "no-longer-contained-in" concentrations agreed upon by LANL and NMED will be properly disposed of in a Subtitle D engineered facility. Those wastes with concentrations of these three constituents that exceed such agreed-upon levels will be properly disposed of in a Subtitle C engineered facility as hazardous waste.

The liquid analytical residue waste generated during sample screening analyses may contain listed hazardous waste constituents that would cause the waste to be F-listed hazardous waste. This waste will be characterized based on knowledge of the processes and concentrations of chemicals listed in the Material Safety Data Sheets for the materials used in the analyses. Hazardous field analytical residue waste will be treated at the TA-16 open burn (OB) hazardous waste treatment unit (if they contain HE) or disposed of in a Subtitle C engineered facility as hazardous waste.

5.1.2 Potential Classification as Characteristic Hazardous Waste

Based on existing data, the constituents that could most likely cause waste to be classified as "characteristic hazardous waste" are HE; 2,4-DNT; and barium. Excavated wastes with a total HE concentration of greater than 10% would cause the waste to exhibit the hazardous waste characteristic of reactivity (hazardous waste code D003). Excavated wastes with a 2,4-DNT concentration of greater than 0.13 mg/L in a TCLP extract would cause the waste to exhibit the hazardous waste toxicity characteristic (TC) for 2,4-DNT (hazardous waste code D030). Excavated wastes with a barium concentration of greater than 100 mg/L in a TCLP extract would cause the waste to exhibit the TC for barium (hazardous waste code D005).

The average and maximum concentrations of the three constituents found during the Phase II RFI (LANL 1998, 59891) for three areas covered by this IM are listed in Table 5.1-1. Characterization for these characteristics will be based on the direct waste samples, as described in Section 5.1.

5.1.2.1 Reactivity

Excavated wastes from the IM are not expected to exhibit the hazardous waste characteristic of reactivity following in-situ blending.

As explained in Section 5.0, any areas containing a total HE concentration of greater than 5% will be blended with other excavated material until the resulting total HE concentration is below 5%. The 5% blending level is an extremely conservative level required by the operating group under the Laboratory's Integrated Safety Management system. However, for the purpose of this IM, only waste containing a total HE concentration greater than 10% will be characterized as exhibiting the hazardous waste characteristic of reactivity. This level is consistent with levels used by Department of Defense (DOD) personnel (EPA 1993, 64704; USATHAMA 1987, 64706) and with site-specific reactivity data (Scott 1998, 64702). However, all wastes generated from areas that were blended prior to removal will be subject to all Land Disposal Restriction requirements.

Table 5.1-1
Detected Constituent Concentrations

Location	Contaminant	Number of Samples	Number of Detections	Average Concentration*	Maximum Concentration*
Pond (surface to tuff)	HE	16	16	4.7%	14.6%
	2,4-DNT	16	4	3.3 mg/kg	24.1 mg/kg
	Barium	16	14	7903 mg/kg	18,200 mg/kg
Pond (tuff to surge bed)	HE	3	3	0.41%	0.97%
	2,4-DNT	3	2	0.2 mg/kg	0.23 mg/kg
	Barium	3	3	498 mg/kg	600 mg/kg
Upper and lower drainage	HE	36	36	1.9%	14.7%
	2,4-DNT	33	14	0.84 mg/kg	3.99 mg/kg
	Barium	30	22	9416 mg/kg	33,300 mg/kg

* Average and maximum of sample results from within the area of the IM using method detection limit values for nondetects.

Samples from excavated wastes will be analyzed for HE constituents either before or after treatment (see Section 5.1). All HE constituent concentrations from each direct sample of the waste will be summed to calculate the total HE concentration. These totals will be used to classify the waste for the hazardous waste characteristic of reactivity. Note that the operating group requires the HE level to be less than 5% (50,000 mg/kg) in order to ship the waste off-site as a non-explosive material.

5.1.2.2 D030

Excavated wastes from the IM are not expected to exhibit the hazardous waste TC for 2,4-DNT (hazardous waste code D030). Concentrations of 2,4-DNT in the excavated waste are not expected to exceed the toxicity characteristic criteria of 0.13 mg/L in the TCLP extract because this constituent is not readily soluble. A few locations contain total 2,4-DNT concentrations more than 20 times this TC concentration (2.6 mg/L). This constituent has not readily migrated, as the highest concentrations are limited to the near surface of the pond (see Figure 2.3-7).

Samples from excavated wastes will be analyzed for 2,4-DNT using EPA Method 8330. Any sample that contains a 2,4-DNT concentration greater than 2.6 mg/kg (the minimum concentration that could theoretically produce a TCLP concentration of 0.13 mg/L) will be submitted for TCLP organics analyses either before or after treatment (see Section 5.1). The waste will then be characterized for this hazardous waste characteristic based on the TCLP analytical results.

5.1.2.3 D005

Excavated wastes generated from areas identified as barium hot spots may exhibit the hazardous waste TC for barium (hazardous waste code D005). Concentrations of barium in the remaining (the non–hot spot) excavated waste are not expected to exceed the TC criteria (100 mg/L in the TCLP extract) before treatment. The barium hot spots will be removed based on the hot spot screening criteria of 25,000 mg/kg.

The screening criteria is based on results from site-specific split samples that were analyzed using both TCLP (extractable) metals and metals (laboratory) analytical methods. A comparison of split-sample results for barium is presented in Appendix B. The average ratio between laboratory barium concentration and TCLP results is approximately 283 mg/kg (laboratory) to 1 mg/L (TCLP). Only two points lie outside one standard deviation of the average ratio, and all ratios are within two standard deviations of the average.

The average ratio predicts that a sample which would produce a TCLP extract barium concentration of 100 mg/L would also produce a laboratory analytical barium concentration of 28,300 mg/kg. The more conservative use of 25,000 mg/kg as an indicator that waste may be D005 hazardous waste will only be used as a screening tool for segregating wastes. All final determinations for this hazardous waste characteristic will be based on results from representative samples of the waste submitted for TCLP metals analyses.

Seven locations in the upper drainage have been identified as hot spots for barium. Additional hot spots may be identified and removed for treatment based on the screening criteria described above and on the procedure described in Section 3.2.2.2. Treatment of barium hot spot waste is described in Section 5.3.1.1.

5.1.3 Radioactivity

Excavated wastes from the IM are not expected to be characterized as radioactive.

Of the 29 samples that were taken during the 1995 RFI from the TA-16-260 outfall drainage and analyzed for total uranium, 13 were above established LANL background levels for uranium. However, sample isotopic uranium analytical results demonstrate that all U-234/U-238 activity ratios for the 260 drainage samples fall within the range established for natural uranium. Natural uranium has never been used or processed at Building 260. These elevated levels may have resulted from the evaporation of effluent municipal water concentrating uranium at the evaporative surface and the sorption of uranium in solution onto soils and sediments. Therefore, excavated wastes will be characterized as containing NORM.

5.2 Anticipated Waste Types and Volumes of Waste

5.2.1 Excavated Wastes

Potential and expected waste types for soil/tuff wastes, and their associated volumes, are listed in Table 5.2-1.

Estimations of the potential "worst case" waste volumes are based on all of the following assumptions:

- All volumes are on the high end of volume estimates.
- Blending will not take place prior to waste generation.
- The 2,4-DNT concentrations will cause waste to exhibit the D030 waste characteristic.
- A treatment permit is not granted.

Estimations of the expected waste volumes are based on the successful implementation of the IM as described in this plan.

Table 5.2-1
Potential and Expected Excavation Waste Types and Volumes

Location	Potential[a]		Expected[b]	
	RCRA Codes[c,d]	Volume[e]	Waste Types	Volume[e]
Blended material	D003, D030, D005	500 yd^3	NM special	220 yd^3
Pond[f] (tuff to surge bed)	None	800 yd^3	Solid waste	100 yd^3
Drainage (to tuff below pond)	D003, D005	1000 yd^3	Solid waste	300 yd^3
Barium hot spot waste	D005	20 yd^3	NM special	2 yd^3
Total	D003, D030, D005	2320 yd^3	Solid waste	400 yd^3
			NM special	222 yd^3

[a] Potential waste volumes and codes represent "worst case" estimates.

[b] Following treatment; not including any bulking due to composting.

[c] Multiple RCRA codes indicate that waste could be characterized as one or more of the codes.

[d] The health-based "contained-in" determination has been approved.

[e] Waste volume is an in-situ estimate; composting may increase these volumes by a factor of 1.8.

[f] Rock removed from this area is media that will be replaced, not generated as waste.

5.2.2 Investigation-Derived Waste

Table 5.2-2 lists the expected IDW types and volumes from excavation and sampling activities.

Table 5.2-2
Anticipated IDW Types and Volumes

Description	Waste Types	Volume
Analytical residues	D003, D030, D001, F003, F005	30 gal.
Decontamination liquids	HE-contaminated	500 gal.
Drainage water	HE-contaminated	5000 gal.
Contaminated IDW solids	Solid waste	1 yd^3
Uncontaminated IDW solids	Municipal	2 yd^3

Analytical residues from field analytical measurements will be comprised of residual sample material and spent solvents used in the extraction of HE constituents.

Decontamination liquids will be generated only as required to complete decontamination following dry decontamination.

Any water in the drainage from IM operations will be pumped into holding tanks as close to the source as possible. This waste will be used beneficially for dust suppression of contaminated material (e.g., moisture control during excavation of the pond and moisture control of the composting or alternate treatment described in Section 5.3.1.2).

IDW solid wastes generated from excavation and sampling activities will be comprised mainly of inner disposable gloves and empty sample containers.

Uncontaminated IDW will include all IDW that have been decontaminated or that have not come into contact with potentially contaminated media or equipment.

5.3 Method of Management and Disposal

It is currently assumed that generated wastes will require on-site treatment for HE and barium using a technology such as composting. However, if a cost-effective, off-site, treatment and disposal facility is identified, or if on-site permitting is difficult, then direct shipment to an appropriate off-site treatment and disposal facility will be used.

5.3.1 Waste Treatment

It is currently assumed that excavated wastes will be treated with composting (or similar technology) to reduce the concentration of total HE. Wastes that were blended before generation, or were formerly characterized with a D-listed hazardous waste code, will also be treated, if necessary, for underlying hazardous constituents as defined in §268.2(l) to comply with the UTSs as listed in 40 CFR §268.48.

5.3.1.1 Treatment of D005 Hazardous Waste

Excavated soils with barium concentrations in screening samples greater than 25,000 mg/kg (barium hot spots as described in Section 5.1.2) will be managed as D005 hazardous waste and treated to remove this hazardous waste characteristic under a temporary authorization to treat hazardous waste or at an off-site facility. Upon generation, these wastes will be transported to the treatment pad that will be created during site preparation. The treatment pad, sand base, and containment system are described in Sections 3.3.2 and 5.3.1.2.

An amendment containing sulfate will be added to the waste and thoroughly mixed to reduce the solubility of the barium in the waste. Following treatment, waste characterization samples will be submitted for TCLP metals analysis (see Section 5.1.2.3) to confirm that treatment goals (barium TCLP land disposal restrictions) have been met. If the goals have not been met, the waste will receive additional treatment or be characterized as D005 hazardous waste and await further treatment and disposal at a hazardous waste treatment and disposal facility.

5.3.1.2 Composting of HE Constituents

Depending upon the successful completion of the composting pilot study, excavated wastes will be treated using composting or another similar (alternate) technology such as zero valent iron reduction. Waste material to be treated with composting will be placed in sequential windrows along the length of the sand base on the treatment pad that will be prepared during site preparation. Hazardous, formerly hazardous, and solid wastes will be maintained in separate piles during treatment. Care will be taken to not cross-contaminate these different wastes.

The treatment pad, sand base, and containment system are described in Section 3.3.2. An engineering drawing of the proposed construction is provided in Figure 5.3-1. The waste will be placed on the sand base in a manner that will provide a windrow approximately 6-ft tall and 16-ft wide at the base.

All amendments will be placed directly on the top of the windrows and blended into the waste using two passes with the compost turner. The waste will be adjusted to, and maintained at, approximately 35% moisture content (by weight) throughout treatment. Results from the composting pilot study will be used to guide the timing and type of the amendments as well as the timing of additional mixes. Analytical results from representative samples will be used to determine if treatment has been successfully completed.

5.3.1.3 Treatment of Underlying Hazardous Constituents for Treated Formerly Characteristic Hazardous Waste

Excavated wastes that were blended prior to generation or treated to remove the D005 hazardous waste code will be evaluated for conformance with underlying hazardous constituent requirements as described in 40 CFR §268.40(e). Blended and formerly D005 wastes will be managed separately from other wastes during any waste treatment or shipment for disposal until it has been determined that the waste complies with the UTSs listed in 40 CFR §268.48.

If one or more underlying hazardous constituents exceed the UTSs, it will be determined if a feasible and appropriate on-site treatment can be applied to the waste. If treatment at LANL is not feasible or appropriate, the waste will be shipped for treatment and disposal to a suitable off-site facility.

5.3.2 Waste Minimization

Generation of hazardous excavated waste will be minimized by implementing the pre-excavation screening described in Section 3.2.1. This will limit excavated hot-spot removal volumes of hazardous wastes within the drainage channel.

Excavated wastes will be limited to sediment, soil, and material smaller than 3 in. in diameter. Fines will be removed as waste from rock greater than 3 in. in diameter. The rock will then be used beneficially for erosion control in the drainage and will not be considered generated waste.

Nonhazardous decontamination liquids and run-off from the composting soil treatment piles will be collected and used to maintain moisture levels in treatment piles and in rolloff waste containers. Use of these liquids for moisture and dust control will be constrained such that no free liquids will be present following application. Because all runoff will be contained and no liquid will be released to ground surfaces, a notice of intent to discharge will not be required.

5.3.3 Waste Staging and Documentation

All hazardous wastes will be staged and handled in accordance with 20 NMAC 4.1, Subpart III, Part 262, Standards Applicable to Generators of Hazardous Waste.

A 90-day hazardous waste accumulation area, under the control of the operator, will be established near the HE Production Sites Team's TA-16 field trailers for all hazardous waste streams with volumes greater than 55 gal. An established satellite accumulation area inside the HEPS Team's field trailer will be used for all hazardous waste streams with volumes less than 55 gal. until they are sent for appropriate off-site disposal or moved to the 90-day hazardous waste accumulation area.

Field personnel that are trained in waste management will affix and maintain all required postings, labels, and signs. Waste forms will be completed and submitted in a timely manner such that hazardous excavated wastes will be shipped before expiration of the 90-day hazardous waste storage limit. These hazardous waste accumulation areas will be registered with ESH-19. Inspections and documentation of the inspections of 90-day hazardous waste accumulation areas and satellite accumulation areas will be conducted according to guidance criteria established by ESH-19. All wastes that (1) are appropriate and approved for the particular waste types, (2) meet transportation requirements, and (3) meet the waste-acceptance criteria of the receiving TSD facility, will be staged in enclosed containers

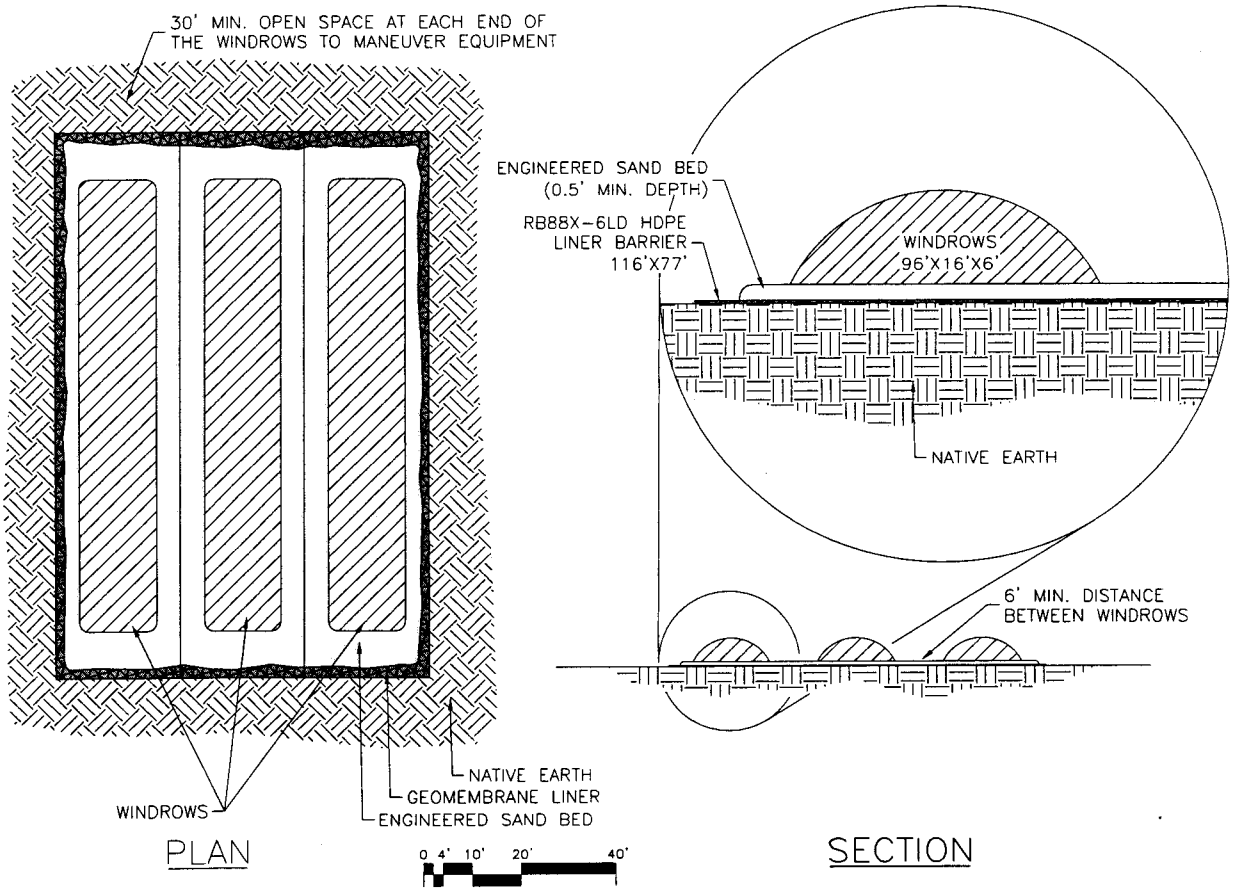


Figure 5.3-1. Proposed construction of soil treatment pad

Excavated material that is potentially hazardous waste will be managed in closed containers within the AOC boundary (in accordance with the EPA's concept of AOC) until it is processed, treated, or shipped off-site.

Treated, formerly characteristic hazardous wastes are New Mexico special (NM special) wastes. These wastes will be managed in accordance with the New Mexico solid waste management regulations.

5.3.4 Waste Transport and Disposal

Selection of disposal facilities for excavated wastes will be limited to those that are pre-approved by LANL and are eligible to accept wastes containing NORM. Wastes will be disposed of only at facilities where the waste meets the waste-acceptance criteria and the appropriate state regulations governing the TSD.

Excess decontamination liquids that are not used in the composting process (it is likely that such liquids will be of minimal volume) are expected to be disposed of at the HE waste water treatment facility located at TA-16. Non-contaminated IDW and personal protective equipment wastes will be disposed of at the Los Alamos County landfill. The analytical residue wastes resulting from field analytical measurements will be treated at the RCRA-permitted TA-16 OB unit and disposed of appropriately off-site.

6.0 PROPOSED SCHEDULE AND UNCERTAINTIES

The proposed 260 IM project schedule and a summary of uncertainties that could affect the project cost and schedule are presented in the following sections.

6.1 Project Schedule

The current 260 IM project schedule is presented graphically in Figure 6.1-1. The schedule is based on the assumption that field operations behind Building 260 will be conducted only on Fridays, Saturdays, and Sundays.

Following are some key milestone activities and dates:

- Readiness review scheduled for January 14, 2000
- Mobilization scheduled to begin February 10, 2000
- Completion of excavation activities anticipated by June 30, 2000
- Completion of soil treatment anticipated by December 2000
- Completion of the IM report anticipated by March 2001

6.2 Logistical Uncertainties

Excavation of the tuff beneath the pond (discussed in Section 3.3.4.3) may be difficult or not feasible using the proposed excavation methods. The decision to proceed with the removal of the tuff and underlying surge deposit will be based on an evaluation of tuff excavation rates during operations.

The robotic equipment necessary to remove the pond sediments (discussed in Section 3.3.4.3) may not be available by the planned start date for robotic activities. The robotic excavator is currently being used to support the MDA P closure; therefore, the 260 IM is subject to uncertainties from the MDA P closure schedule.

Weather could significantly affect the project schedule. Heavy snow would create new site-management requirements and would reduce operational efficiency. Freezing temperatures would also impede operations, particularly those operations that require the use of water (e.g. soil wetting, sediment-rock segregation, and equipment decontamination as discussed in Sections 3.3.4 and 3.3.5). Lower temperatures would reduce the soil treatment rate, resulting in longer soil staging times and increased treatment periods. Composting is discussed in Section 5.3.1.2 of this document.

6.3 Administrative, Technical, and Regulatory Uncertainties

The classification and final disposition of generated wastes could also significantly affect project costs. The anticipated waste classifications and the planned disposal paths are discussed in Section 5.0 of this document. Table 5.2-1 presents the variability associated with potential and expected excavation waste types and volumes.

It is also anticipated that soil blending of areas which contain potential D003 wastes will be allowed, in order to mitigate risk to IM site workers before the waste is generated. However, a final determination of the acceptability of soil blending has not yet been made. If it is determined that soil blending cannot be done, these wastes will need to be shipped to an off-site hazardous waste TSD facility for treatment and disposal. This would result in a significant increase in waste management, transportation, treatment, and disposal costs.

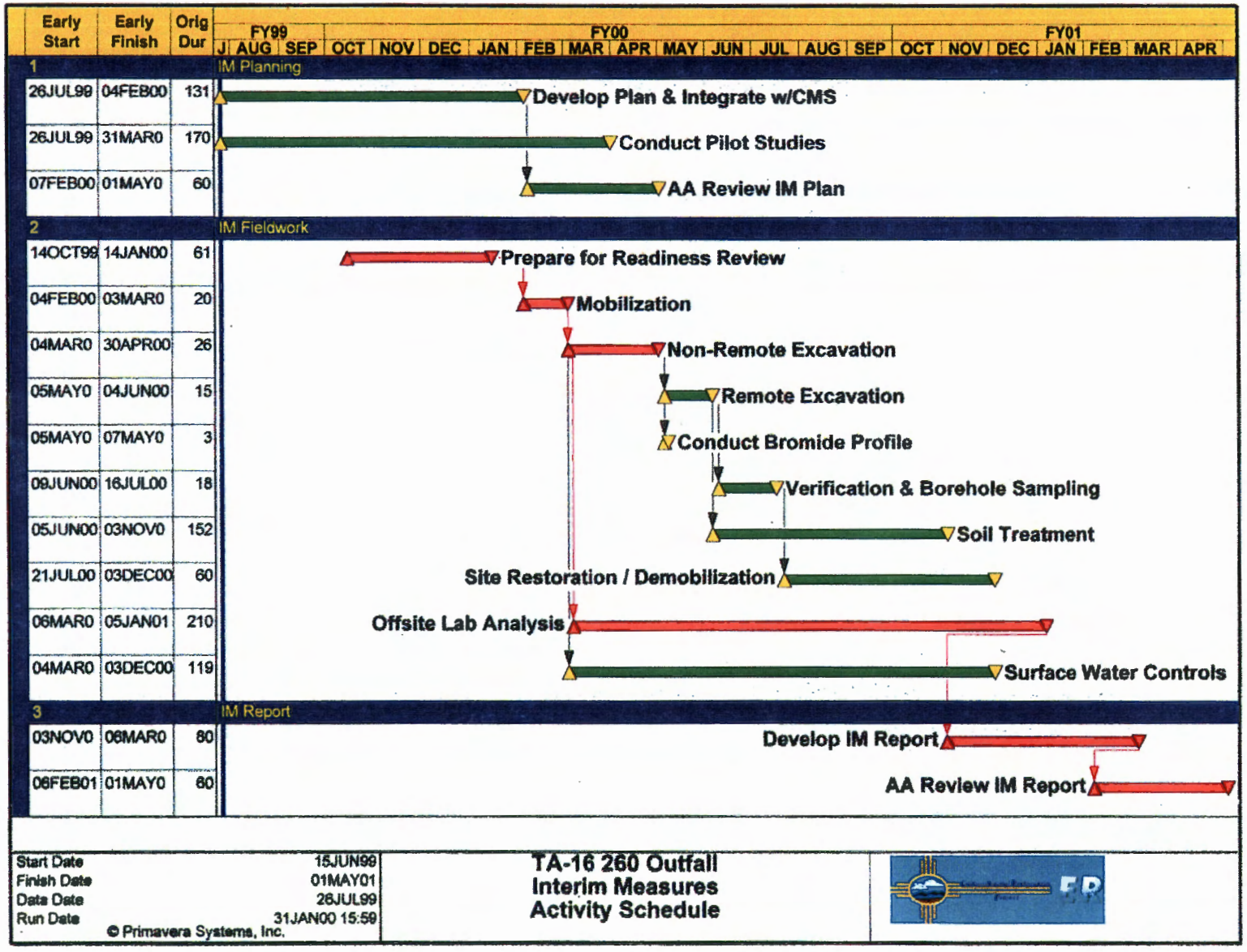


Figure 6.1-1. Proposed 260 IM schedule

It is also anticipated that above-background concentrations of natural uranium in IM wastes are due to the presence of NORM. These wastes, therefore, will not be classified as radioactive. If the NORM determination is not validated, much of the IM waste will be classified as radioactive or mixed, resulting in a significant increase in waste management, transportation, treatment, and disposal costs. In addition, there may be no path forward for this waste if it is classified as radioactive or mixed waste. Such a determination would likely require stopping work on the IM.

It is also anticipated that composting will be used to treat HE-contaminated and barium-contaminated soils. A pilot treatment study is currently being conducted to evaluate the applicability of this technology for the IM. Should this technology prove to be ineffective, alternative treatment technologies may need to be evaluated.

These uncertainties could significantly affect project duration and cost. Some of these could result in significant delays to the project until alternatives are identified.

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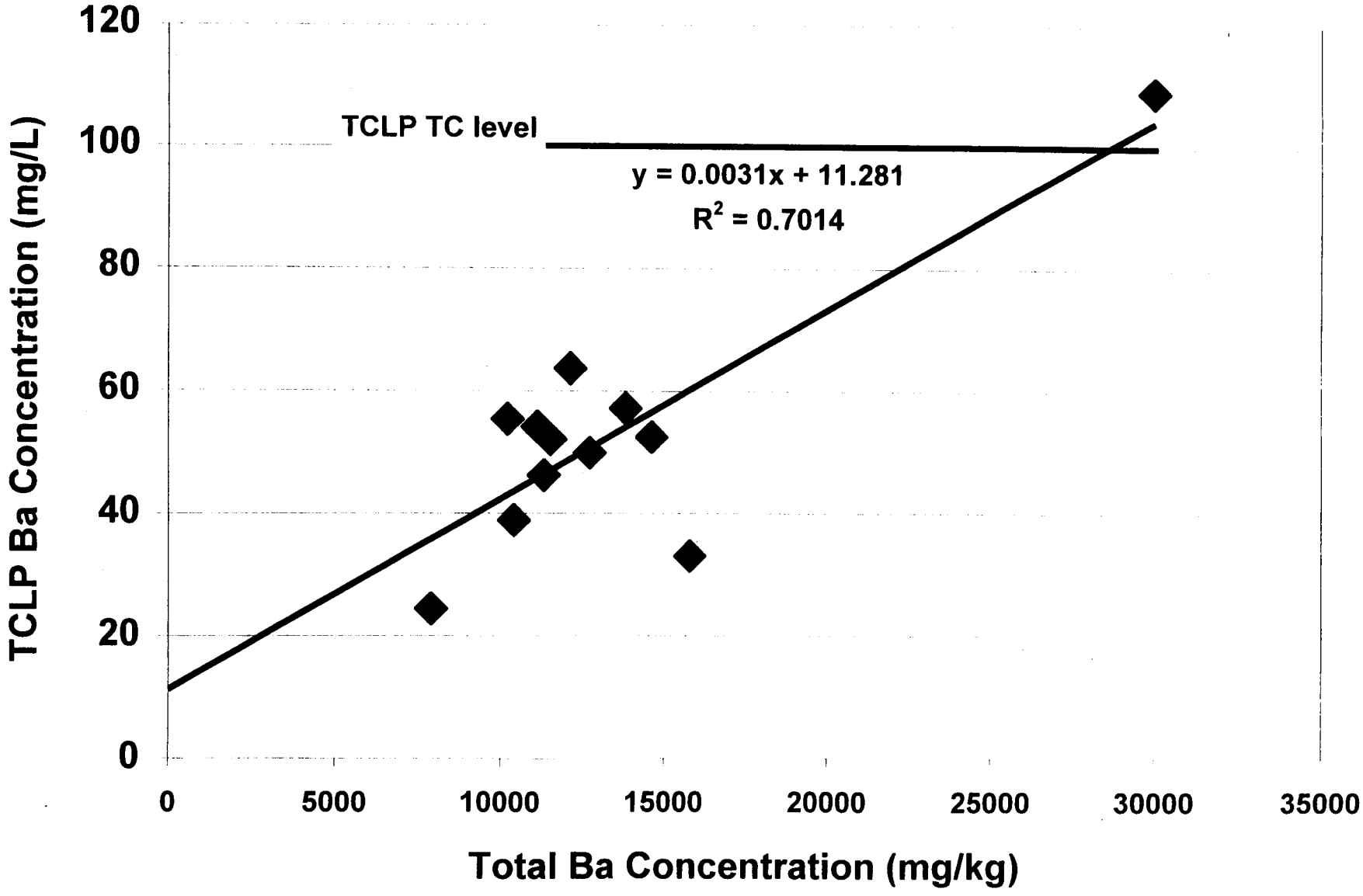
Appendix A

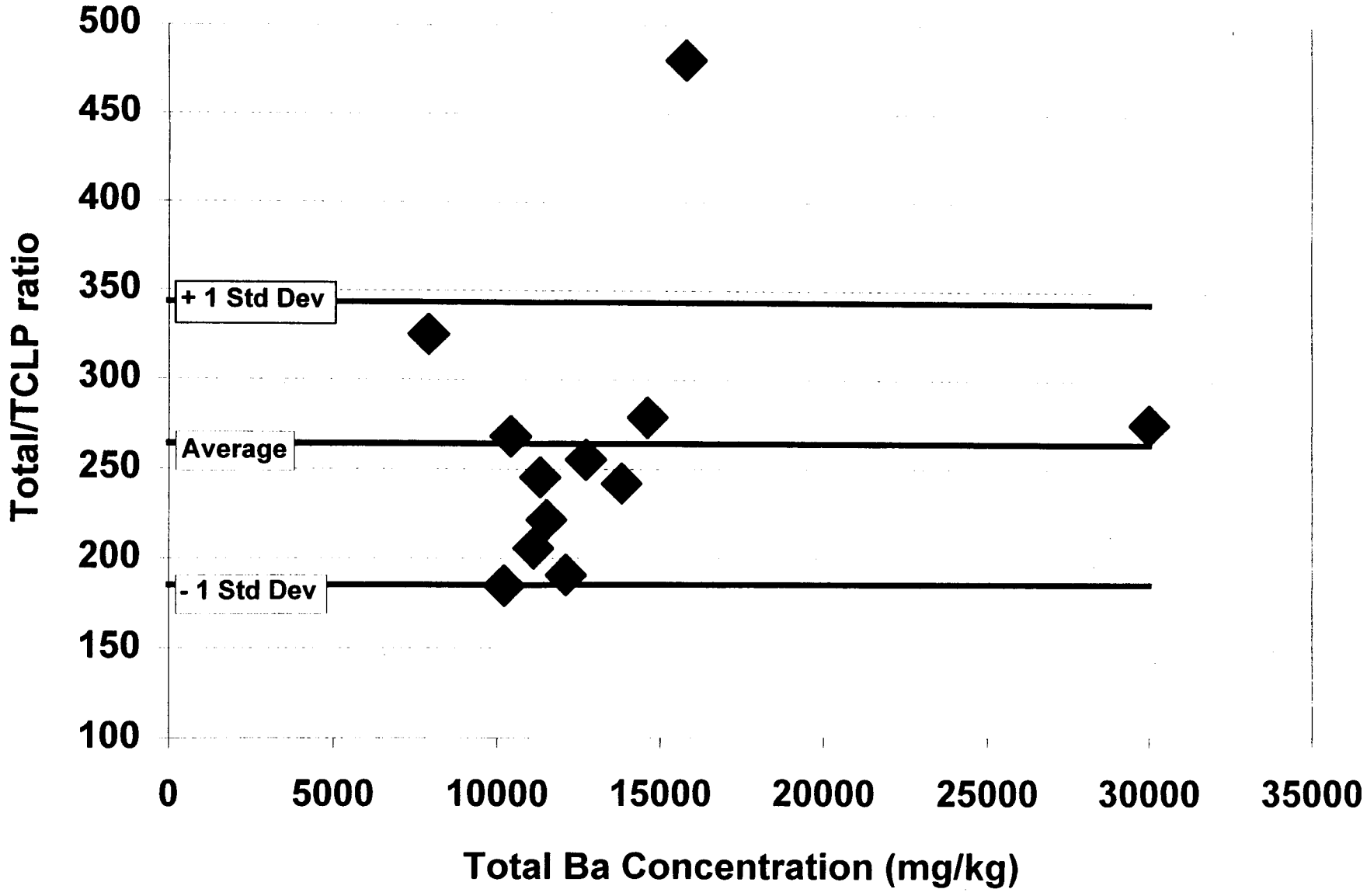
Acronyms and Abbreviations

AOC	area of contamination
ASTM	American Society for Testing and Materials
bgs	below ground surface
BMP	best management practice
CFR	code of Federal regulations
CMS	corrective measures study
CMI	corrective measures implementation
DNT	dinitrotoluene
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
ER	environmental restoration
ESH-18	Water Quality and Hydrology Group
ESH-19	Hazardous and Solid Waste Group
ESH-20	Ecology Group
HDPE	high density polyethylene
HE	high explosive
HEPS	high explosives production sites
HMX	1,3,5,7-tetranitro-1,3,5,7-tetrazacyclooctane
HPLC	high performance liquid chromatography
IDW	investigation-derived waste
IM	interim measure
LANL	Los Alamos National Laboratory
MCC	mobile control center
MDA	material disposal area
MSSL	medium-specific screening level
NMED	New Mexico Environment Department
NORM	naturally occurring radioactive material
NPDES	National Pollutant Discharge Elimination System
OB	open burn
PRS	potential release site
QA	quality assurance
QP	quality procedure
RCRA	Resource Conservation and Recovery Act
RDX	cyclonite, or 1,3,5-trinitro-1,3,5-triazacyclohexane
RFA	RCRA facility assessment
RFI	RCRA facility investigation
RSS	ranked-set sampling
SOP	standard operating procedure
SVOC	semivolatile organic compound
SWSC	sanitary waste system consolidation
TA	technical area
TC	toxicity characterization
TCLP	toxicity characterization leaching procedure
TNB	1,3,5-trinitrobenzene
TNT	2,4,6-trinitrotoluene
TSD	treatment, storage, and disposal
UHC	underlying hazardous constituent
UTS	universal treatment standard
VOCs	volatile organic compounds
XRF	x-ray fluorescence

Appendix B

Comparison of TCLP to Laboratory Barium


TCLP TC level
y = 0.0031x + 11.281
R² = 0.7014
TCLP Ba Concentration (mg/L)
Total Ba Concentration (mg/kg)
0
20
40
60
80
100
120
0
5000
10000
15000
20000
25000
30000
35000


500
450
400
350
300
250
200
150
100
Total/TCLP ratio
+ 1 Std Dev
Average
- 1 Std Dev
0
5000
10000
15000
20000
25000
30000
35000
Total Ba Concentration (mg/kg)

Attachment A

Section 2 of the RFI Report for PRS 16-021(c)

2.0 SOURCE AREA INVESTIGATION

2.1 Summary

The source area of PRS 16-021(c), the outfall from the TA-16-260 machining building, encompasses the drainage from the outfall to the base of the colluvial slope in Cañon de Valle (an area 650 ft long and 15–30 ft wide) and the underlying soil and tuff. Phase I investigations sampled surficial materials within the drainage. During Phase II, additional surface and near-surface samples were collected at a limited number of locations in order to bound the lateral extent of contamination. Thirteen boreholes (BHs), drilled to depths between 17 and 115 ft in and near the drainage, were also sampled during Phase II. Phase II investigations included extensive field screening using immunoassay methods for RDX and TNT as well as laboratory sampling for HE and other chemicals.

Taken together, Phase I and Phase II data provide a much clearer picture of the nature and extent of contamination at the outfall than was available at the conclusion of the Phase I investigation. High levels of HE and barium are observed within the drainage, from the surface to the soil/tuff interface. Soil depths are about 5.5 ft in the former pond area which occupies the drainage from about 40 to 95 ft below the outfall, but only about 1 ft nearer the edge of the mesa (300 to 400 ft from the outfall). Phase II surface sampling confirmed the results of Phase I by demonstrating that surface contamination does not extend laterally beyond the reasonably well-defined drainage. Downgradient within the drainage, concentrations of the major contaminants (barium and the HEs HMX, RDX, and TNT) decrease rapidly beyond the ponded area, although significant levels of HMX and barium do continue to the base of the colluvial slope in Cañon de Valle.

Subsurface sampling indicates that concentrations also decrease rapidly below the soil/tuff interface. However, there is significant subsurface contamination, up to 1000 mg/kg of HE in tuff, within the uppermost tuff unit (Unit 5 of the Tshirege Member of the Bandelier Tuff, Qbt_5) beneath the upper part of the drainage, including the former pond area. Even higher levels—a total of almost 1% HE—were reported in a sample of saturated material from the surge bed that separates Unit 5 from Unit 4, which was encountered at a depth of about 16 ft beneath the pond. Below the level of this surge bed, HE is observed only sporadically and at much lower concentrations (less than 5 mg/kg). As discussed in Section 2.4.4, there is some evidence for stratigraphic control of both concentration levels and lateral migration in the subsurface.

HE and barium are the principal contaminants at the TA-16-260 outfall, although several other metals, including cadmium, chromium, copper, lead, nickel, vanadium, and zinc, are consistently observed above background levels in the drainage. Other organic compounds, particularly anthracene and phthalates, are also detected in several samples. Data from all analytical suites are reviewed in this section.

An IM to remove material from the drainage is proposed for 1999. Approximately 90% of the source term, including the major contaminants as well as the additional organic and inorganic chemicals mentioned above, can be removed by excavating to the soil/tuff interface within the drainage to the edge of the mesa. Most of the remaining RDX/TNT source term can be captured by removing material, to a depth of approximately 20 ft, from below the ponded area and from the next 50–100 ft of the drainage. A significant portion of the remaining HMX and barium is found in surface material between the edge of the mesa and

the bottom of Cañon de Valle. Residual contamination (that is, contamination at greater depths or outside the drainage) is at low levels and cannot be located reliably.

2.2 Phase II Data Needs and Objectives

Prior to the beginning of the RFI investigation of PRS 16-021(c), the TA-16-260 outfall had been extensively sampled for HE only. Levels up to 27 wt % of HMX and RDX had been documented in the area of the former pond. The data showed HE contamination extending from the discharge point to Cañon de Valle. These data are summarized in Table 2.2-1. All samples in Table 2.2-1 are surface (0–6 in.) soil samples taken from the drainage centerline, unless otherwise indicated. Distances from the outfall are approximate, and distances from the centerline were not always recorded. Data are from Baytos (1992, 57082) and King (1971, 05913; 1972, 04953; and 1976, 05920).

Table 2.2-1
HE in the TA-16-260 Drainage Channel, Pre-RFI Data

Collection Date	Sample Location	HE	Result (mg/kg)	EQL[a]
3/11/60	Pond center	RDX	85 000	NA[b]
3/11/60	Pond center	RDX	35 000	NA
3/11/60	Pond center	TNT	13 000	NA
3/11/60	Pond center	TNT	13 000	NA
3/11/60	20 ft below dam	RDX	43 000	NA
3/11/60	20 ft below dam	TNT	17 000	NA
3/11/60	30 ft below dam	RDX	33 000	NA
3/11/60	30 ft below dam	TNT	7000	NA
3/11/60	100 ft below dam	RDX	27 000	NA
3/11/60	100 ft below dam	TNT	400	NA
3/11/60	150 ft below dam	RDX	5000	NA
3/11/60	150 ft below dam	TNT	200	NA
4/29/70	Outfall	HMX/RDX[c]	70 000	NA
4/29/70	Outfall	TNT	0	NA
4/29/70	Pond center	HMX/RDX	205 000	NA
4/29/70	Pond center	TNT	37 000	NA
4/29/70	1 ft below dam	HMX/RDX	48 000	NA
4/29/70	1 ft below dam	TNT	700	NA
4/29/70	Between dam and cliff	HMX/RDX	129 000	NA
4/29/70	Between dam and cliff	TNT	1200	NA
4/29/70	Cliff	HMX/RDX	39 000	NA
4/29/70	Cliff	TNT	1000	NA
11/18/70	10 ft from outfall	HMX/RDX	32 000	NA
11/18/70	10 ft from outfall	TNT	0	NA
11/18/70	Inlet to pond	HMX/RDX	141 000	NA
11/18/70	Inlet to pond	TNT	1000	NA

Table 2.2-1 (continued)

Collection Date	Sample Location	HE	Result (mg/kg)	EQL[a]
11/18/70	10 ft above dam	HMX/RDX	221 000	NA
11/18/70	10 ft above dam	TNT	5000	NA
11/18/70	5 ft below dam	HMX/RDX	145 000	NA
11/18/70	5 ft below dam	TNT	2000	NA
11/5/71	10 ft from outfall	HMX/RDX	29 000	NA
11/5/71	10 ft from outfall	TNT	0	NA
11/5/71	Pond inlet	HMX/RDX	108 000	NA
11/5/71	Pond inlet	TNT	0	NA
11/5/71	10 ft above dam	HMX/RDX	257 000	NA
11/5/71	10 ft above dam	TNT	0	NA
11/5/71	10 ft below dam	HMX/RDX	225 000	NA
11/5/71	10 ft below dam	TNT	0	NA
8/22/73	10 ft from outfall	HMX/RDX	13 000	NA
8/22/73	10 ft from outfall	TNT	0	NA
11/14/74	Outfall	HMX/RDX	17 000	NA
11/14/74	Outfall	TNT	0	NA
11/14/74	1 ft above dam	HMX/RDX	171 000	NA
11/14/74	1 ft above dam	TNT	1000	NA
11/14/74	50 ft below dam	HMX/RDX	137 000	NA
11/14/74	50 ft below dam	TNT	2000	NA
12/5/75	10 ft from outfall	HMX/RDX	2000	NA
12/5/75	10 ft from outfall	TNT	0	NA
12/5/75	1 ft above dam	HMX/RDX	92 000	NA
12/5/75	1 ft above dam	TNT	0	NA
11/19/76	10 ft from outfall	HMX/RDX	2000	NA
11/19/76	10 ft from outfall	TNT	0	NA
11/19/76	50 ft from outfall	HMX/RDX	30 000	NA
11/19/76	50 ft from outfall	TNT	1000	NA
11/19/76	65 ft from outfall	HMX/RDX	267 000	NA
11/19/76	65 ft from outfall	TNT	3000	NA
11/19/76	250 ft from outfall	HMX/RDX	173 000	NA
11/19/76	250 ft from outfall	TNT	3000	NA
7/18/84	3 ft from outfall	HMX/RDX	3000	NA
7/18/84	3 ft from outfall	TNT	0	NA
7/18/84	30 ft from outfall	HMX/RDX	104 000	NA
7/18/84	30 ft from outfall	TNT	9000	NA
7/18/84	50 ft from outfall	HMX/RDX	167 000	NA
7/18/84	50 ft from outfall	TNT	23 000	NA
9/12/85	30 ft from outfall	HMX/RDX	20 000	NA
9/12/85	30 ft from outfall	TNT	1000	NA

Table 2.2-1 (continued)

Collection Date	Sample Location	HE	Result (mg/kg)	EQL[a]
9/12/85	110 ft from outfall	HMX/RDX	266 000	NA
9/12/85	110 ft from outfall	TNT	48 000	NA
9/12/85	230 ft from outfall	HMX/RDX	17 000	NA
9/12/85	230 ft from outfall	TNT	1000	NA
7/21/91	1 ft from outfall	HMX	26 400	NA
7/21/91	1 ft from outfall	RDX	8000	100
7/21/91	1 ft from outfall	TNT	700	100
7/21/91	20 ft from outfall	HMX	4000	NA
7/21/91	20 ft from outfall	RDX	14 000	100
7/21/91	20 ft from outfall	TNT	10 000	100
7/21/91	40 ft from outfall	HMX	1000	NA
7/21/91	40 ft from outfall	RDX	100	100
7/21/91	40 ft from outfall	TNT	< 100	100
7/21/91	45 ft from outfall	HMX	29 400	NA
7/21/91	45 ft from outfall	RDX	< 100	100
7/21/91	45 ft from outfall	TNT	< 1 00	100
7/21/91	50 ft from outfall, center pool	HMX	43 800	NA
7/21/91	50 ft from outfall, center pool	RDX	5000	100
7/21/91	50 ft from outfall, center pool	TNT	< 100	100
7/21/91	60 ft from outfall, center pool	HMX	40 000	NA
7/21/91	60 ft from outfall, center pool	RDX	24 000	100
7/21/91	60 ft from outfall, center pool	TNT	< 100	100
7/21/91	60 ft from outfall, north edge of pond	HMX	5000	NA
7/21/91	60 ft from outfall, north edge of pond	RDX	400	100
7/21/91	60 ft from outfall, north edge of pond	TNT	< 100	100
7/21/91	70 ft from outfall	HMX	39 000	NA
7/21/91	70 ft from outfall	RDX	51 800	100
7/21/91	70 ft from outfall	TNT	6000	100
7/21/91	70 ft from outfall, north edge of pond	HMX	90 000	NA
7/21/91	70 ft from outfall, north edge of pond	RDX	100 000	100
7/21/91	70 ft from outfall, north edge of pond	TNT	20 000	100
7/21/91	80 ft from outfall	HMX	97 000	NA
7/21/91	80 ft from outfall	RDX	126 000	100
7/21/91	80 ft from outfall	TNT	30 000	100
7/21/91	90 ft from outfall	HMX	13 250	NA
7/21/91	90 ft from outfall	RDX	134 700	100
7/21/91	90 ft from outfall	TNT	20 000	100
7/21/91	90 ft from outfall, north edge of pond	HMX	23 000	NA
7/21/91	90 ft from outfall, north edge of pond	RDX	340 000	100
7/21/91	90 ft from outfall, north edge of pond	TNT	71 000	100

Table 2.2-1 (concluded)

Collection Date	Sample Location	HE	Result (mg/kg)	EQL[a]
7/21/91	110 ft from outfall	HMX	62 000	NA
7/21/91	110 ft from outfall	RDX	14 000	100
7/21/91	110 ft from outfall	TNT	3000	100
11/15/91	90 ft from outfall, 12 in. from north edge	HMX	56 300	NA
11/15/91	90 ft from outfall, 12 in. from north edge	RDX	19 700	100
11/15/91	91 ft from outfall	HMX	29 100	NA
11/15/91	91 ft from outfall	RDX	700	100
11/15/91	91 ft from outfall	TNT	300	100
11/15/91	91 ft from outfall, 2 in. deep	HMX	66 800	NA
11/15/91	91 ft from outfall, 2 in. deep	RDX	9600	100
11/15/91	91 ft from outfall, 2 in. deep	TNT	< 100	100
11/15/91	91 ft from outfall, 8 in. deep	HMX	54 100	NA
11/15/91	91 ft from outfall, 8 in. deep	RDX	7100	100
11/15/91	91 ft from outfall, 8 in. deep	TNT	2200	100
11/15/91	91 ft from outfall, 13 in. deep	HMX	96 000	NA
11/15/91	91 ft from outfall, 13 in. deep	RDX	38 900	100
11/15/91	91 ft from outfall, 13 in. deep	TNT	4200	100
11/15/91	91 ft from outfall, 8 in. from edge, 13 in. deep	HMX	92 400	NA
11/15/91	91 ft from outfall, 8 in. from edge, 13 in. deep	RDX	155 200	100
11/15/91	91 ft from outfall, 8 in. from edge, 13 in. deep	TNT	93 400	100
11/15/91	91 ft from outfall, 12 in. from edge, 13 in. deep	HMX	106 300	NA
11/15/91	91 ft from outfall, 12 in. from edge, 13 in. deep	RDX	171 800	100
11/15/91	91 ft from outfall, 12 in. from edge, 13 in. deep	TNT	9700	100
11/15/91	135 ft from outfall	HMX	20 900	NA
11/15/91	135 ft from outfall	RDX	1900	100
11/15/91	135 ft from outfall	TNT	300	100
11/15/91	210 ft from outfall	HMX	37 300	NA
11/15/91	210 ft from outfall	RDX	6300	100
11/15/91	210 ft from outfall	TNT	100	100

[a] Estimated from minimum reported values.

[b] NA = Not available.

[c] Early HE determinations were made by ultraviolet spectrophotometric methods, which did not quantitatively distinguish HMX from RDX.

RFI investigations conducted during 1995 at PRS 16-021(c), and reported in the Phase I RFI Report (LANL 1996, 55077), confirmed the existence of very high levels of HE contamination in the surface and near-surface soils and sediments within 600 ft of the outfall. Strongly decreasing trends downgradient from the pond were established, but the extent of contamination was not completely bounded either laterally or down the drainage. Phase I sampling included no samples from a depth of more than 2 ft, and almost all samples were 0- to 6-in. surface sediment samples.

Additional contaminants were identified by the Phase I investigation: barium (a constituent of some HE) at levels up to 3 wt %, several other metals at levels slightly above background, and generally low levels of organics. Of these additional contaminants, only barium and bis(2-ethylhexyl)phthalate, a plasticizer used in explosives, exceeded the human health SAL in any sample.

Nearby springs emerge approximately 100 ft below the mesa top, into Cañon de Valle and into a tributary of Water Canyon. Preliminary sampling indicates the presence of HE in groundwaters that feed these springs. The hydrology of TA-16, and in particular the connectivity between mesa-top release sites such as the TA-16-260 outfall and these springs, is not well understood. There are other potential sources of HE for these waters at TA-16, but the levels of contamination resident at PRS 16-021(c) make it one of the prime candidates for the source of spring contamination.

The following Phase II objectives for source area sampling in the TA-16-260 outfall drainage and immediately adjacent media were identified in the Phase I RFI Report (LANL 1996, 55077, p. 60):

1. to bound the lateral extent of surface contamination, particularly at those points where Phase I transects across the drainage failed to bound HE contamination,

2. to determine the depth of the very high levels of contamination in the ponded area of the outfall as well as the lower parts of the drainage, and

3. to investigate the migration of contamination into the underlying bedrock and characterize subsurface pathways in the immediate vicinity of the outfall in order to generate hypotheses about transport to springs and groundwater.

The SAP included in the Phase I RFI Report for PRS 16-021(c) (LANL 1996, 55077) proposed to accomplish these objectives by

1. surface and near-surface sampling along two transects perpendicular to the main axis of the drainage and located 200 ft and 600 ft, respectively, below the outfall. The six transects included in Phase I were spaced at 100-ft intervals below the outfall. Of the six, the 200- and 600-ft trausects were the two where contamination did not appear to be adequately bounded by samples collected between 5 and 12 ft from the axis of the drainage (see Figure 5.2.9-1 in LANL 1996, 55077).

2. sampling in 12 BHs to be drilled in or near the outfall drainage to a depth of approximately 70 ft. In particular, BHs drilled in the drainage itself were to provide deeper sediment samples or soil/tuff interface samples as well as data from the underlying bedrock. Section 2.3 describes the implementation of this Phase II program. The results of the Phase II sampling, combined with those of Phase I, are presented in Section 2.4.

2.3 Scope of Sampling and Analysis

2.3.1 Summary

The domain of the Phase II field investigation conducted during 1997 at the PRS 16-021(c) source area included the Bandelier Tuff and groundwater (if present) down to a maximum depth of approximately 100 ft in the area beneath and around the TA-16-260 outfall drainage channel. The majority of samples generated during the investigation were subsurface tuff samples collected using either hollow-stem auger or wet-coring drilling methods. The investigation also included some surface and shallow subsurface sediments within and adjacent to the drainage channel. These samples were collected using hand sampling methods.

Resistivity profiling surveys were conducted to identify possible zones of increased subsurface moisture and fracture zones (see Section 4.4.1.2.) These results were used to bias BH locations. BH locations were selected both within and outside low resistivity zones, as shown on Figure 2.3-1. Monitoring wells were installed in the four BHs judged most likely to produce water, including the two in which water was observed during drilling.

All Phase II samples were field screened for HE using DTech immunoassay/colorimetric methods. Screening data were used to bound the extent of contamination both laterally and vertically in the field; confirmatory laboratory samples were selected at the ends of lateral transects and at the bottom of vertical BHs from segments for which the DTech results were nondetects. The screening data also provided more complete coverage of the subsurface than could be obtained from the laboratory samples alone. The accuracy and precision of the DTech screening methods are evaluated in Appendix E.

Phase II laboratory samples were analyzed for HE, inorganic chemicals, and VOCs and SVOCs. Although above-background levels of uranium were reported in some Phase I samples, no uranium analyses were required by the Phase II sampling and analysis plan for the source area. However, uranium was analyzed for in Phase II sediment and water samples collected in Cañon de Valle (see Section 3).

2.3.2 Field Investigation

Fifteen BHs were drilled during the Phase II source area investigation of PRS 16-021(c), including two that were drilled as continuations of adjacent abandoned BHs. Screening samples were collected every 5 ft for the entire drilled length of each BH. A minimum of two analytical samples were collected from each BH; these were selected based on screening results and/or lithology. Surface and near-surface samples were collected along two transects across the drainage channel as well as at two BH locations within the channel (16-2709 and 16-2710). All sampling locations, including Phase I sampling locations, are shown in Figure 2.3-1.

A total of 209 screening samples (187 from the BHs and the remainder from the transects) and 57 analytical laboratory samples were collected in the source area during the Phase II investigation. The laboratory samples include two collocated subsurface samples. All but one of the Phase II laboratory samples were analyzed for HE, VOCs, SVOCs, and inorganics; sample 0316-96-0282 from BH 16-2705 was analyzed only for VOCs. Table 2.3-1 lists the 37 Phase I samples (those with location IDs up to 16-1409) as well as the 57 Phase II laboratory samples by location and depth. It provides the analytical laboratory request numbers for each sample. Additional information, including the sample collection date, the analysis date, and the analytical laboratory for each sample, is provided in Appendix I.

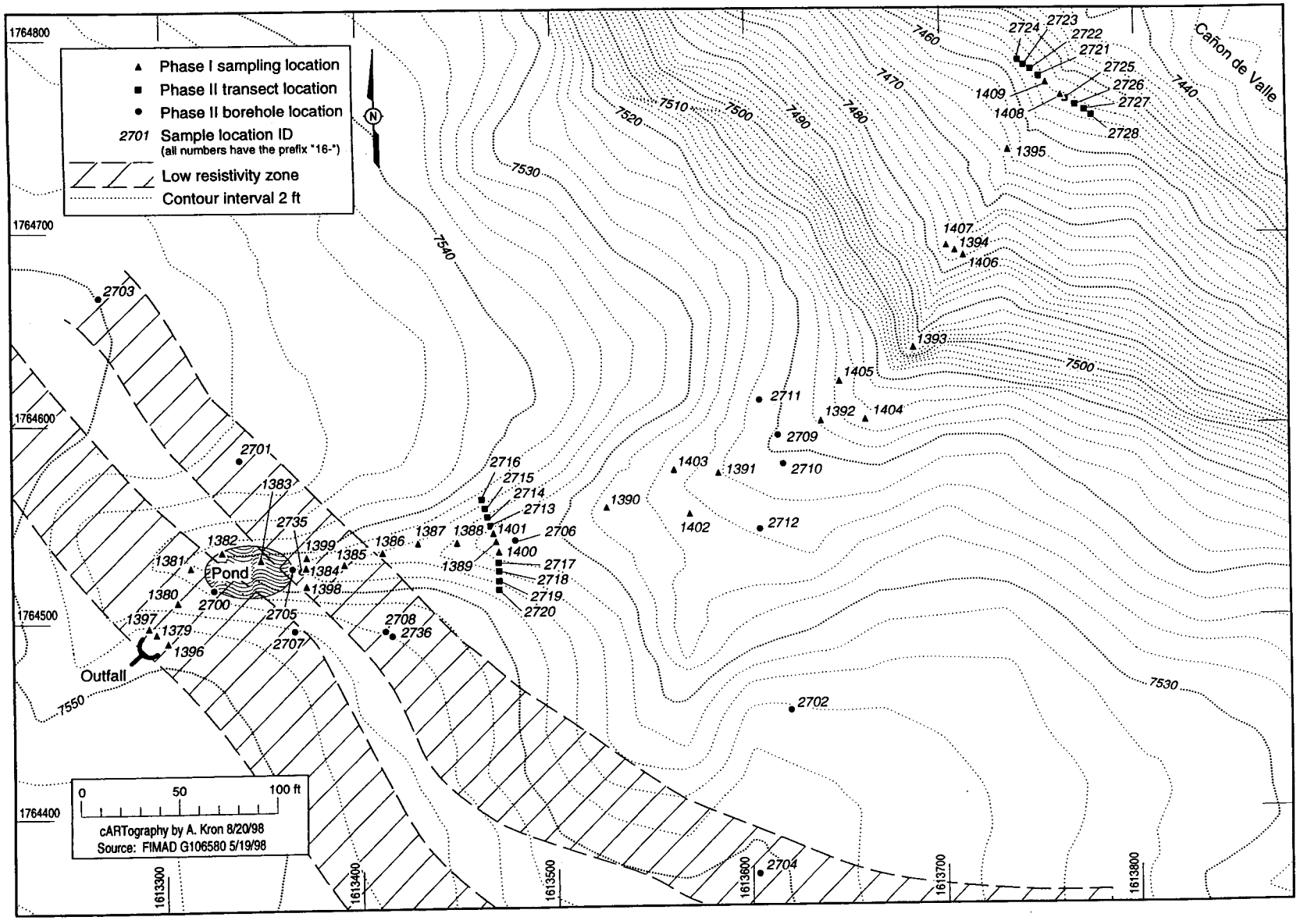


Figure 2.3-1. Phase I and Phase II sampling locations for the TA-16-260 outfall source area

Table 2.3-1

Summary of Phase I and Phase II Samples Collected for Fixed Laboratory Analysis at the TA-16-260 Outfall Source Area

Location ID	Sample ID	Sample Type	Depth (ft)	Media	VOCs	SVOCs	HE	Inorganic Chemicals	Total Uranium
16-1379	0316-95-0027	Grab	0–0.5	SED[a]	NA[b]	1268	1268	1269	1270
16-1379	0316-95-0044	Grab	1–1.5	SED	1173	1173	1173	1174	1175
16-1379	0316-95-2015	Grab, split	1–1.5	SED	1173	1173	1173	1174	1175
16-1380	0316-95-0028	Grab	0–0.5	SED	NA	1268	1268	1269	1270
16-1381	0316-95-0029	Grab	0–0.5	SED	NA	563	563	564	565
16-1382	0316-95-0030	Grab	0–0.5	SED	NA	563	563	564	565
16-1382	0316-95-2012	Grab, collocated	0–0.5	SED	NA	563	563	564	565
16-1382	0316-95-0045	Grab	1.5–1.9	SED	1173	1173	1173	1174	1175
16-1383	0316-95-0031	Grab	0–0.5	SED	NA	563	563	564	565
16-1383	0316-95-2013	Grab, collocated	0–0.5	SED	NA	563	563	564	565
16-1383	0316-95-0046	Grab	1.7–2.2	SED	1173	1173	1173	1174	1175
16-1384	0316-95-0032	Grab	0–0.5	SED	NA	1268	1268	1269	1270
16-1385	0316-95-0033	Grab	0–0.5	SED	NA	563	563	564	565
16-1386	0316-95-0034	Grab	0–0.5	SED	NA	563	563	564	565
16-1387	0316-95-0035	Grab	0–0.5	SED	NA	563	563	564	565
16-1388	0316-95-0036	Grab	0–0.5	SED	NA	563	563	564	565
16-1389	0316-95-0037	Grab	0–0.5	SED	NA	563	563	564	565
16-1390	0316-95-0038	Grab	0–0.5	SED	NA	1268	1268	1269	1270
16-1391	0316-95-0039	Grab	0–0.5	SED	NA	1268	1268	1269	1270
16-1392	0316-95-0040	Grab	0–0.5	SED	NA	1268	1268	1269	1270
16-1393	0316-95-0041	Grab	0–0.5	SED	NA	1268	1268	1269	1270
16-1394	0316-95-0042	Grab	0–0.5	SED	NA	1268	1268	1269	1270
16-1395	0316-95-0043	Grab	0–0.5	SED	NA	1268	1268	1269	1270
16-1396	0316-95-0014	Grab	0–0.5	SED	NA	972	972	978	979
16-1397	0316-95-0013	Grab	0–0.5	SED	NA	972	972	978	979
16-1398	0316-95-0016	Grab	0–0.5	SED	NA	972	972	978	979
16-1399	0316-95-0015	Grab	0–0.5	SED	NA	972	972	978	979
16-1400	0316-95-0018	Grab	0–0.5	SED	NA	972	972	978	979
16-1401	0316-95-0017	Grab	0–0.5	SED	NA	972	972	978	979
16-1402	0316-95-0020	Grab	0–0.5	SED	NA	972	972	978	979
16-1403	0316-95-0019	Grab	0–0.5	SED	NA	972	972	978	979
16-1404	0316-95-0022	Grab	0–0.2	SED	NA	972	972	978	979
16-1405	0316-95-0021	Grab	0–0.5	SED	NA	972	972	978	979
16-1406	0316-95-0024	Grab	0–0.5	SED	NA	1222	1222	1223	1224
16-1407	0316-95-0023	Grab	0–0.5	SED	NA	1222	1222	1223	1224

Table 2.3-1 (continued)

Location ID	Sample ID	Sample Type	Depth (ft)	Media	VOCs	SVOCs	HE	Inorganic Chemicals	Total Uranium
16-1408	0316-95-0026	Grab	0–0.5	SED	NA	1222	1222	1223	1224
16-1409	0316-95-0025	Grab	0–0.5	SED	NA	1222	1222	1223	1224
16-2700	0316-96-0252	Grab	16.2–17.5	Surge	2818	2818	2820	2819	NA
16-2700	0316-96-0250	Grab	7–8	Qbt_5	2778	2778	2780	2779	NA
16-2700	0316-96-0254	Grab	15.5–16.5	Qbt_5	2809	2809	2811	2810	NA
16-2701	0316-97-0256	Grab	3.5–4.5	SED	3774R[c]	3774R	3775R	3776R	NA
16-2701	0316-97-0257	Grab	74–75	Qbt_4	3827R	3827R	3828R	3829R	NA
16-2702	0316-97-0262	Grab	3–4	SED	3857R	3857R	3859R	3858R	NA
16-2702	0316-97-0264	Grab	29–30	Qbt_4	3879R	3879R	3880R	3881R	NA
16-2702	0316-97-0263	Grab	69–70	Qbt_4	3879R	3879R	3880R	3881R	NA
16-2703	0316-97-0268	Grab	3.5–4.5	SED	3902R	3902R	3903R	3904R	NA
16-2703	0316-97-0270	Grab	53–54	Qbt_4	3902R	3902R	3903R	3904R	NA
16-2703	0316-97-0269	Grab	69–70	Qbt_4	3902R	3902R	3903R	3904R	NA
16-2704	0316-97-0274	Grab	4–5	SED	3827R	3827R	3828R	3829R	NA
16-2704	0316-97-0276	Grab	23–24	Qbt_4	3860R	3860R	3861R	3862R	NA
16-2704	0316-97-0277	Grab	28–29	Qbt_4	3860R	3860R	3861R	3862R	NA
16-2704	0316-97-0275	Grab	69–70	Qbt_4	3827R	3827R	3828R	3829R	NA
16-2705	0316-96-0280	Grab	4–5	Qbt_5	2821	2821	2823	2822	NA
16-2705	0316-96-0282	Grab	8.5–9.5	Qbt_5	2850	NA	NA	NA	NA
16-2705	0316-96-0281	Grab	12.5–13.5	Qbt_5	2850	2850	2853	2849	NA
16-2706	0316-97-0286	Grab	4–5	Qbt_5	3517R	3517R	3518R	3519R	NA
16-2706	0316-97-2020	Grab, collocated	4–5	Qbt_5	3517R	3517R	3518R	3519R	NA
16-2706	0316-97-0289	Grab	18–19	Qbt_5	3579R	3579R	3580R	3581R	NA
16-2706	0316-97-0288	Grab	74–75	Qbt_4	3539R	3539R	3540R	3541R	NA
16-2706	0316-97-0287	Grab	79–80	Qbt_4	3539R	3539R	3540R	3541R	NA
16-2707	0316-96-0292	Grab	7.5–8.5	Qbt_5	2762	2762	2764	2763	NA
16-2707	0316-96-0293	Grab	24–25	Qbt_5	2762	2762	2764	2763	NA
16-2707	0316-96-0296	Grab	39–40	Qbt_4	2762	2762	2764	2763	NA
16-2707	0316-96-0294	Grab	64–65	Qbt_4	2778	2778	2780	2779	NA
16-2707	0316-96-0295	Grab	68.5–69.5	Qbt_4	2778	2778	2780	2779	NA
16-2708	0316-97-0298	Grab	4–5	SED	3215R	3215R	3216R	3217R	NA
16-2709	0316-97-0389	Grab	0.5–1	SED	3621R	3621R	3622R	3623R	NA
16-2709	0316-97-0304	Grab	3.5–4.5	Qbt_5	3612R	3612R	3613R	3614R	NA
16-2709	0316-97-0305	Grab	21.5–22.5	Qbt_5	3644R	3644R	3645R	3646R	NA
16-2710	0316-97-0388	Grab	0.5–1	SED	3621R	3621R	3622R	3623R	NA
16-2710	0316-97-0310	Grab	4–5	Qbt_5	3621R	3621R	3622R	3623R	NA
16-2710	0316-97-0312	Grab	35–36	Qbt_4	3652R	3652R	3653R	3654R	NA
16-2710	0316-97-0311	Grab	38.5–39.5	Qbt_4	3652R	3652R	3653R	3654R	NA
16-2711	0316-97-0316	Grab	3.5–4.5	Qbt_5	3757R	3757R	3758R	3759R	NA

Table 2.3-1 (concluded)

Location ID	Sample ID	Sample Type	Depth (ft)	Media	VOCs	SVOCs	HE	Inorganic Chemicals	Total Uranium
16-2711	0316-97-0317	Grab	69–70	Qbt_4	3757R	3757R	3758R	3759R	NA
16-2712	0316-97-0322	Grab	4–5	Qbt_5	3706R	3706R	3707R	3708R	NA
16-2712	0316-97-0324	Grab	83–83.8	Qbt_4	3737R	3737R	3739R	3738R	NA
16-2712	0316-97-0323	Grab	89–90	Qbt_4	3737R	3737R	3739R	3738R	NA
16-2713	0316-97-0328	Grab	0–0.5	SED	3827R	3827R	3828R	3829R	NA
16-2716	0316-97-0330	Grab	2–2.8	SED	3827R	3827R	3828R	3829R	NA
16-2717	0316-97-0329	Grab	0–0.5	SED	3827R	3827R	3828R	3829R	NA
16-2718	0316-97-0331	Grab	2–2.8	SED	3827R	3827R	3828R	3829R	NA
16-2718	0316-97-2021	Grab, collocated	2–2.8	SED	3827R	3827R	3828R	3829R	NA
16-2724	0316-97-0332	Grab	0–0.5	SED	3879R	3879R	3880R	3881R	NA
16-2726	0316-97-0333	Grab	0–0.5	SED	3879R	3879R	3880R	3881R	NA
16-2735	0316-97-0280	Grab	4–5	Qbt_5	3388R	3388R	3389R	3390R	NA
16-2735	0316-97-0282	Grab	24.7–25.3	Qbt_4	3461R	3461R	3462R	3463R	NA
16-2735	0316-97-0283	Grab	34–35	Qbt_4	3461R	3461R	3462R	3463R	NA
16-2735	0316-97-0390	Grab	54–55	Qbt_4	3478R	3478R	3479R	3480R	NA
16-2735	0316-97-0391	Grab	63–63.8	Qbt_4	3478R	3478R	3479R	3480R	NA
16-2735	0316-97-0392	Grab	74.4–75.4	Qbt_4	3478R	3478R	3479R	3480R	NA
16-2735	0316-97-0393	Grab	80.5–81.5	Qbt_4	3478R	3478R	3479R	3480R	NA
16-2736	0316-97-0300	Grab	99–100	Qbt_3	3344R	3344R	3346R	3345R	NA
16-2736	0316-97-0299	Grab	104–105	Qbt_3	3330R	3330R	3332R	3331R	NA

[a] SED = Sediment.
Qbt# = Tuff Unit #
[b] NA = Analysis was not performed for this sample.

HE field screening consisted of the HE spot test (LANL ER SOP 10.06), which was performed at the site immediately following sample collection, and RDX- and TNT-sensitive immunoassay/colorimetric screening performed at the field trailer located near former building TA-16-027 using DTech kits. Daily quality assurance/quality control (QA/QC) evaluations of the DTech method were performed using RDX- and TNT-spiked performance evaluation (PE) samples (see Appendix E). The minimum detection limit of the DTech Explosive Test Kits for RDX and TNT is 0.5 mg/kg (ppm) in soil. Transect samples were also field-screened for VOCs with a photoionization detector (PID). The approximate detection limit for the PID is 1 ppm.

Spot test, immunoassay, and PID screening results are provided in Table 2.3-2, which also identifies the corresponding laboratory samples. In general, the laboratory samples are either splits of the screening sample or collected from the same 1-ft core interval, but, in a few cases, the laboratory sample was taken from an adjacent segment of core.

Table 2.3-2
Summary of Phase II Screening Samples Collected at the TA-16-260 Outfall Source Area

Location ID	Screening Sample ID	Depth (ft)	Media	HE Spot Test Result	DTech Results RDX/TNT (ppm)	Laboratory Sample ID
16-2700	0316-96-1550	7.0–8.0	Qbt_5	Positive	1.29/NT[a]	0316-96-0250
16-2700	0316-96-1551	9.0–10.0	Qbt_5	Positive	150/NT	None
16-2700	0316-96-1552	14–15	Qbt_5	Positive	61/NT	None
16-2700	0316-96-1553	15.5–16.5	Qbt_5, Surge bed	Positive	533/NT	0316-96-0254
16-2700	None	NA	Surge bed water/slurry	NT	NT	0316-96-0252
16-2701	0316-97-1566	3.5–4.5	Soil	Negative	<0.5/<0.5	0316-97-0256
16-2701	0316-97-1567	7.5–8.5	Qbt_5	Negative	<0.5/<0.5	None
16-2701	0316-97-1568	14.0–15.0	Qbt_5	Negative	1.5/<0.5	None
16-2701	0316-97-1569	18.5–19.5	Qbt_5	Negative	<0.5/<0.5	None
16-2701	0316-97-1570	24.0–25.0	Qbt_4	Negative	<0.5/<0.5	None
16-2701	0316-97-1571	28.5–29.5	Qbt_4	Negative	(1.56&3.6)/ <0.5	None
16-2701	0316-97-1572	34.0–35.0	Qbt_4	Negative	<0.5/<0.5	None
16-2701	0316-97-1573	38.5–39.5	Qbt_4	Negative	<0.5/<0.5	None
16-2701	0316-97-1574	44.0–45.0	Qbt_4	Negative	<0.5/<0.5	None
16-2701	0316-97-1575	48.5–49.5	Qbt_4/surge bed	Negative	<0.5/<0.5	None
16-2701	0316-97-1576	54.0–55.0	Qbt_4/surge bed	NT	<0.5/<0.5	None
16-2701	0316-97-1577	58.0–59.0	Qbt_4/surge bed	NT	2.28/<0.5	None
16-2701	0316-97-1578	64.0–65.0	Qbt_4	NT	<0.5/<0.5	None
16-2701	0316-97-1579	69.25–69.75	Qbt_4	Negative	2.4/<0.5	None
16-2701	0316-97-1580	74.0–75.0	Qbt_4	Negative	<0.5/<0.5	0316-97-0257
16-2701	0316-97-1581	79.0–80.0	Qbt_4	Negative	<0.5/<0.5	None
16-2701	0316-97-1806	84.0–85.0	Qbt_4	Negative	<0.5/<0.5	None
16-2702	0316-97-1582	3.0–4.0	Qbt_5	Negative	<0.5/<0.5	0316-97-0262
16-2702	0316-97-1584	14.0–15.0	Qbt_5	Negative	<0.5/<0.5	None
16-2702	0316-97-1585	19.0–20.0	Qbt_5	Negative	<0.5/<0.5	None
16-2702	0316-97-1586	24.0–25.0	Qbt_5	Negative	<0.5/<0.5	None
16-2702	0316-97-1587	29.0–30.0	Qbt_4	Negative	<0.5/0.71	0316-97-0264
16-2702	0316-97-1588	34.0–35.0	Qbt_4	Negative	<0.5/<0.5	None
16-2702	0316-97-1589	38.5–39.5	Qbt_4	Negative	<0.5/<0.5	None
16-2702	0316-97-1590	43.5–44.5	Qbt_4	Negative	<0.5/<0.5	None
16-2702	0316-97-1591	48.5–49.5	Qbt_4	Negative	<0.5/<0.5	None
16-2702	0316-97-1592	53.5–54.5	Qbt_4	Negative	<0.5/<0.5	None
16-2702	0316-97-1593	58.5–59.5	Qbt_4/non-welded	Negative	<0.5/<0.5	None
16-2702	0316-97-1594	64.0–65.0	Qbt_4/surge bed	Negative	<0.5/<0.5	None
16-2702	0316-97-1595	69.0–70.0	Qbt_4	Negative	<0.5/<0.5	0316-97-0263

Table 2.3-2 (continued)

Location ID	Screening Sample ID	Depth (ft)	Media	HE Spot Test Result	DTech Results RDX/TNT (ppm)	Laboratory Sample ID
16-2703	0316-97-1600	3.5–4.5	Soil/cobbles	Negative	<0.5/<0.5	0316-97-0268
16-2703	0316-97-1602	13.5–14.5	Qbt_5	Negative	<0.5/<0.5	None
16-2703	0316-97-1603	18.5–19.5	Qbt_5	Negative	<0.5/<0.5	None
16-2703	0316-97-1604	23.75–24.75	Qbt_4	Negative	<0.5/<0.5	None
16-2703	0316-97-1605	28.0–29.0	Qbt_4	Negative	<0.5/<0.5	None
16-2703	0316-97-1606	33.25–34.25	Qbt_4	Negative	<0.5/<0.5	None
16-2703	0316-97-1607	38.5–39.5	Qbt_4	Negative	<0.5/<0.5	None
16-2703	0316-97-1608	43.5–44.5	Qbt_4	Negative	<0.5/<0.5	None
16-2703	0316-97-1609	48.0–49.0	Qbt_4/non-welded	Negative	<0.5/<0.5	None
16-2703	0316-97-1610	53.0–54.0	Qbt_4/non-welded	Negative	<0.5/1.8	0316-97-0270
16-2703	0316-97-1611	57.5–57.75	Qbt_4/non-welded	Negative	<0.5/<0.5	None
16-2703	0316-97-1612	63.5–64.5	Qbt_4	Negative	<0.5/<0.5	None
16-2703	0316-97-1613	69.0–70.0	Qbt_4	Negative	<0.5/<0.5	0316-97-0269
16-2704	0316-97-1616	4.0–5.0	Soil/Qbt_5 interface	Negative	<0.5/<0.5	0316-97-0274
16-2704	0316-97-1617	9.0–10.0	Qbt_5	Negative	<0.5/<0.5	None
16-2704	0316-97-1618	14.0–15.0	Qbt_4	Negative	<0.5/<0.5	None
16-2704	0316-97-1619	19.0–20.0	Qbt_4	Negative	<0.5/<0.5	None
16-2704	None	23.0–24.0	Qbt_4	NT	NT	0316-97-0276
16-2704	0316-97-1620	24.0–25.0	Qbt_4	Negative	2.40/0.71	None
16-2704	None	28.0–29.0	Qbt_4	NT	NT	0316-97-0277
16-2704	0316-97-1621	29.0–30.0	Qbt_4	Negative	<0.5/0.79	None
16-2704	0316-97-1622	34.0–35.0	Qbt_4	Negative	<0.5/<0.5	None
16-2704	0316-97-1623	39.0–40.0	Qbt_4	Negative	<0.5/<0.5	None
16-2704	0316-97-1624	44.0–45.0	Qbt_4	Negative	<0.5/<0.5	None
16-2704	0316-97-1625	49.0–50.0	Qbt_4	Negative	<0.5/<0.5	None
16-2704	0316-97-1626	53.2–54.2	Qbt_4/non-welded	Negative	<0.5/<0.5	None
16-2704	0316-97-1627	58.5–59.5	Qbt_4/non-welded	Negative	<0.5/<0.5	None
16-2704	0316-97-1628	63.3–64.3	Qbt_4/non-welded	Negative	<0.5/<0.5	None
16-2704	0316-97-1629	69.0–70.0	Qbt_4	Negative	<0.5/<0.5	0316-97-0275
16-2705	0316-96-1632	4.0–5.0	Qbt_5	Negative	3.9/NT	0316-96-0280
16-2705	0316-96-1633	8.5–9.5	Qbt_5	Negative	1.8/NT	0316-96-0282
16-2705	0316-96-1634	12.5–13.5	Qbt_5	Negative	2.7/NT	0316-96-0281

Table 2.3-2 (continued)

Location ID	Screening Sample ID	Depth (ft)	Media	HE Spot Test Result	DTech Results RDX/TNT (ppm)	Laboratory Sample ID
16-2706	0316-97-1648	4.0–5.0	Qbt_5	Positive	1.62/<0.5	0316-97-0286 0316-97-2020
16-2706	0316-97-1649	18.0–19.0	Qbt_5/surge bed	Positive	<0.5/<0.5	0316-97-0289
16-2706	0316-97-1650	23.0–24.0	Qbt_4	Positive	<0.5/<0.5	None
16-2706	0316-97-1651	28.0–29.0	Qbt_4	Negative	3.60/<0.5	None
16-2706	0316-97-1652	34.5–35.5	Qbt_4	Negative	NT/<0.5	None
16-2706	0316-97-1653	39.0–40.0	Qbt_4	Negative	<0.5/<0.5	None
16-2706	0316-97-1654	43.5–44.5	Qbt_4	Negative	<0.5/<0.5	None
16-2706	0316-97-1655	48.5–49.5	Qbt_4	Negative	<0.5/<0.5	None
16-2706	0316-97-1656	53.5–54.5	Qbt_4	Negative	<0.5/<0.5	None
16-2706	0316-97-1657	59.0–60.0	Qbt_4	Negative	<0.5/0.57	None
16-2706	0316-97-1658	63.83–64.83	Qbt_4	Positive	2.64/<0.5	None
16-2706	0316-97-1659	69.0–70.0	Qbt_4	Positive	<0.5/<0.5	None
16-2706	0316-97-1660	74.0–75.0	Qbt_4	Positive	<0.5/<0.5	0316-97-0288
16-2706	0316-97-1661	79.0–80.0	Qbt_4	Negative	<0.5/<0.5	None
16-2706	0316-97-1662	83.0–84.0	Qbt_4	Negative	<0.5/<0.5	None
16-2706	0316-97-1663	89.0–90.0	Qbt_4	Negative	<0.5/<0.5	0316-97-0287
16-2707	0316-96-1665	7.5–8.5	Qbt_5	Negative	<0.5/NT	0316-96-0292
16-2707	0316-96-1666	14–15	Qbt_5	Negative	<0.5/NT	None
16-2707	0316-96-1667	18.5–19.5	Qbt_5	Negative	0.71/NT	None
16-2707	0316-96-1668	24–25	Qbt_5	Negative	0.87/NT	0316-96-0293
16-2707	0316-96-1669	28–29	Qbt_4	Negative	0.76/NT	None
16-2707	0316-96-1670	34–35	Qbt_4	Negative	<0.5/NT	None
16-2707	0316-96-1671	39–40	Qbt_4	Negative	1.08/NT	0316-96-0296
16-2707	0316-96-1672	44–45	Qbt_4	Negative	<0.5/NT	None
16-2707	0316-96-1673	49–50	Qbt_4	Negative	<0.5/NT	None
16-2707	0316-96-1674	54–55	Qbt_4	NT	1.5/NT	None
16-2707	0316-96-1675	58–59	Qbt_4	Negative	2.4/NT	None
16-2707	0316-96-1676	64–65	Qbt_4	Negative	3.8/NT	0316-96-0294
16-2707	0316-96-1677	68.5–69.5	Qbt_4, surge bed	Negative	3.1/NT	0316-96-0295
16-2708	0316-97-1680	4.0–5.0	Qbt_5	Negative	4.5/1.29	0316-97-0298
16-2708	0316-97-1681	7.5–8.5	Qbt_5	Negative	1.98/<0.5	None
16-2708	0316-97-1682	13.5–14.5	Qbt_5	Negative	2.28/NT	None
16-2708	0316-97-1683	18.75–19.75	Qbt_5	Negative	1.5/NT	None
16-2708	0316-97-1684	24.0–25.0	Qbt_4	Negative	<0.5/NT	None
16-2708	0316-97-1685	29.0–30.0	Qbt_4	Negative	2.1/NT	None
16-2708	0316-97-1694	30.75–31.5	Qbt_4/fracture plane	Negative	<0.5/NT	None
16-2708	0316-97-1686	34.0–35.0	Qbt_4	Negative	4.1/NT	None

Table 2.3-2 (continued)

Location ID	Screening Sample ID	Depth (ft)	Media	HE Spot Test Result	DTech Results RDX/TNT (ppm)	Laboratory Sample ID
16-2708	0316-97-1687	39.0–40.0	Qbt_4	Negative	1.74/NT	None
16-2708	0316-97-1688	44.0–45.0	Qbt_4	Negative	0.61/NT	None
16-2709	0316-97-1704	0.5–1.0	Soil	Positive	5.40/ (5<TNT<50)	0316-97-0389
16-2709	0316-97-1696	3.5–4.5	Qbt_5	Positive	1.56/1.07	0316-97-0304
16-2709	0316-97-1697	9.17–9.67	Qbt_5	Positive	2.88/0.71	None
16-2709	0316-97-1698	13.25–14.25	Qbt_5/surge bed	Positive	2.04/<0.5	None
16-2709	0316-97-1699	21.5–22.5	Qbt_5	Negative	<0.5/0.5	0316-97-0305
16-2709	0316-97-1700	24.0–25.0	Qbt_5	Negative	<0.5/<0.5	None
16-2709	0316-97-1701	29.0–30.0	Qbt_4	Negative	<0.5/<0.5	None
16-2709	0316-97-1702	33.0–34.0	Qbt_4	Negative	<0.5/<0.5	None
16-2710	0316-97-1726	0.5–1.0	Soil	Positive	5.48/4.47	0316-97-0388
16-2710	0316-97-1712	4.0–5.0	Qbt_5	Positive	1.08/<0.5	0316-97-0310
16-2710	0316-97-1713	9.17–10.0	Qbt_5	Positive	<0.5/1.07	None
16-2710	0316-97-1714	14.0–15.0	Qbt_5	Negative	<0.5/<0.5	None
16-2710	0316-97-1715	19.0–20.0	Qbt_5	Negative	<0.5/<0.5	None
16-2710	0316-97-1716	24.0–25.0	Qbt_5	Positive	1.45/<0.5	None
16-2710	0316-97-1717	29.0–30.0	Qbt_4	Negative	<0.5/<0.5	None
16-2710	0316-97-1718	35.0–36.0	Qbt_4	Positive	<0.5/<0.5	0316-97-0312
16-2710	0316-97-1719	38.5–39.5	Qbt_4	Negative	<0.5/<0.5	0316-97-0311
16-2710	0316-97-1720	44.0–45.0	Qbt_4	Negative	<0.5/<0.5	None
16-2710	0316-97-1721	49.0–49.33	Qbt_4	Negative	<0.5/<0.5	None
16-2711	0316-97-1728	3.5–4.5	Qbt_5	Negative	<0.5/<0.5	0316-97-0316
16-2711	0316-97-1729	9.0–10.0	Qbt_5	Negative	2.70/<0.5	None
16-2711	0316-97-1730	14.0–15.0	Qbt_5	Negative	<0.5/<0.5	None
16-2711	0316-97-1731	19.0–20.0	Qbt_5	Negative	1.03/<0.5	None
16-2711	0316-97-1732	24.0–25.0	Qbt_5/surge bed	Negative	<0.5/<0.5	None
16-2711	0316-97-1733	29.0–30.0	Qbt_4/surge bed	Negative	<0.5/<0.5	None
16-2711	0316-97-1734	34.0–35.0	Qbt_4/surge bed	Negative	<0.5/<0.5	None
16-2711	0316-97-1735	39.0–40.0	Qbt_4/surge bed	Negative	<0.5/<0.5	None
16-2711	0316-97-1736	43.5–44.5	Qbt_4/surge bed	Negative	<0.5/<0.5	None
16-2711	0316-97-1737	49.0–50.0	Qbt_4/surge bed	Negative	<0.5/<0.5	None
16-2711	0316-97-1738	53.75–54.75	Qbt_4	Negative	<0.5/<0.5	None
16-2711	0316-97-1739	59.0–60.0	Qbt_4	Negative	<0.5/<0.5	None
16-2711	0316-97-1740	64.0–65.0	Qbt_4	Negative	<0.5/<0.5	None
16-2711	0316-97-1741	69.0–70.0	Qbt_4	Negative	<0.5/<0.5	0316-97-0317
16-2712	0316-97-1744	4.0–5.0	Qbt_5	Positive	<0.5/<0.5	0316-97-0322
16-2712	0316-97-1745	9.0–10.0	Qbt_5	Negative	<0.5/<0.5	None
16-2712	0316-97-1746	14.0–15.0	Qbt_5	Negative	<0.5/<0.5	None

Table 2.3-2 (continued)

Location ID	Screening Sample ID	Depth (ft)	Media	HE Spot Test Result	DTech Results RDX/TNT (ppm)	Laboratory Sample ID
16-2712	0316-97-1747	18.0–19.0	Qbt_5	Negative	<0.5/<0.5	None
16-2712	0316-97-1748	24.0–25.0	Qbt_5	Negative	<0.5/<0.5	None
16-2712	0316-97-1749	29.0–30.0	Qbt_4	Negative	<0.5/<0.5	None
16-2712	0316-97-1750	30.0–30.17	Qbt_4	Negative	<0.5/<0.5	None
16-2712	0316-97-1751	39.0–40.0	Qbt_4	Negative	<0.5/<0.5	None
16-2712	0316-97-1752	44.0–45.0	Qbt_4	Negative	1.08/<0.5	None
16-2712	0316-97-1753	48.0–49.0	Qbt_4	Negative	<0.5/<0.5	None
16-2712	0316-97-1754	61.0–62.0	Qbt_4	Negative	<0.5/<0.5	None
16-2712	0316-97-1755	64.0–65.0	Qbt_4	Negative	<0.5/<0.5	None
16-2712	0316-97-1756	68.5–69.17	Qbt_4	Negative	0.61/<0.5	None
16-2712	0316-97-1757	74.0–75.0	Qbt_4	Negative	<0.5/<0.5	None
16-2712	0316-97-1758	79.0–80.0	Qbt_4	Negative	<0.5/<0.5	None
16-2712	0316-97-1759	83.0–83.83	Qbt_4	Negative	3.50/<0.5	0316-97-0324
16-2712	0316-97-1803	89.0–90.0	Qbt_4	Negative	<0.5/<0.5	0316-97-0323
16-2712	0316-97-1804	94.0–95.0	Qbt_4	Negative	<0.5/<0.5	None
16-2712	0316-97-1805	99.0–100.0	Qbt_3	Negative	<0.5/<0.5	None
16-2713	0316-97-1760	0.0–0.5	Soil/tuff gravels	Negative	<0.5/<0.5	0316-97-0328
16-2714	0316-97-1761	0.0–0.5	Soil/tuff gravels	Negative	<0.5/<0.5	None
16-2714	0316-97-1768	2.0–2.75	Soil/tuff gravels	Negative	1.98/<0.5	None
16-2715	0316-97-1762	0.0–0.5	Soil/tuff gravels	Negative	<0.5/<0.5	None
16-2716	0316-97-1763	0.0–0.5	Soil/tuff gravels	Negative	<0.5/<0.5	None
16-2716	0316-97-1769	2.0–2.75	Soil/tuff gravels	Negative	<0.5/<0.5	0316-97-0330
16-2717	0316-97-1764	0.0–0.5	Soil/tuff gravels	Negative	<0.5/<0.5	0316-97-0329
16-2718	0316-97-1765	0.0–0.5	Soil/tuff gravels	Negative	<0.5/<0.5	None
16-2718	0316-97-1770	2.0–2.75	Soil/dacite cobbles	Negative	<0.5/<0.5	0316-97-0331 0316-97-2021
16-2719	0316-97-1766	0.0–0.5	Soil/tuff gravels	Negative	<0.5/<0.5	None
16-2720	0316-97-1767	0.0–0.5	Soil/tuff gravels	Negative	<0.5/<0.5	None
16-2721	0316-97-1772	0.0–0.5	Soil/tuff gravels	Negative	5.25/<0.5	None
16-2722	0316-97-1773	0.0–0.5	Soil/tuff gravels	Negative	3.5/<0.5	None
16-2723	0316-97-1774	0.0–0.5	Soil/tuff gravels	Negative	1.5/<0.5	None
16-2724	0316-97-1775	0.0–0.5	Soil/tuff gravels	Negative	<0.5/<0.5	0316-97-0332
16-2725	0316-97-1776	0.0–0.5	Soil/tuff gravels	Negative	2.94/3.67	None
16-2726	0316-97-1777	0.0–0.5	Soil/tuff gravels	Negative	<0.5/<0.5	0316-97-0333
16-2727	0316-97-1778	0.0–0.5	Soil/tuff gravels	Negative	<0.5/<0.5	None
16-2728	0316-97-1779	0.0–0.5	Soil/tuff gravels	Negative	<0.5/<0.5	None
16-2735	0316-97-1632	4.0–5.0	Soil/Qbt_5 interface	Positive	5.7/1.90	0316-97-0280
16-2735	0316-97-1633	8.5–9.5	Qbt_5	Positive	4.1/1.34	None

Table 2.3-2 (concluded)

Location ID	Screening Sample ID	Depth (ft)	Media	HE Spot Test Result	DTech Results RDX/TNT (ppm)	Laboratory Sample ID
16-2735	0316-97-1634	13.0–14.0	Qbt_5	Positive	2.64/<0.5	None
16-2735	0316-97-1635	16.67–16.83	Qbt_5	Positive	2.1/<0.5	None
16-2735	0316-97-1636	24.67–25.33	Qbt_4	Negative	0.55/NT	0316-97-0282
16-2735	0316-97-1638	34.0–35.0	Qbt_4	Negative	1.45/NT	0316-97-0283
16-2735	0316-97-1639	38.0–38.5	Qbt_4	Negative	0.82/<0.5	None
16-2735	0316-97-1641	49.0–49.5	Qbt_4	Negative	<0.5/<0.5	None
16-2735	0316-97-1642	54.0–55.0	Qbt_4/surge bed	Negative	2.58/<0.5	0316-97-0390
16-2735	0316-97-1643	60.0–60.25	Qbt_4	Negative	<0.5/<0.5	None
16-2735	0316-97-1644	62.0–63.0	Qbt_4	Negative	<0.5/<0.5	None
16-2735	0316-97-1645	63.0–63.83	Qbt_4	Negative	4.0/<0.5	0316-97-0391
16-2735	0316-97-1646	67.33–68.33	Qbt_4	Negative	<0.5/<0.5	None
16-2735	0316-97-1647	72.0–73.0	Qbt_4	Negative	2.22/NT	None
16-2735	0316-97-1799	74.42–75.42	Qbt_4	Negative	4.20/NT	0316-97-0392
16-2735	0316-97-1801	80.5–81.5	Qbt_4	Negative	<0.5/NT	0316-97-0393
16-2735	0316-97-1800	84.5–85.5	Qbt_4	Negative	<0.5/NT	None
16-2735	0316-97-1802	90.0–91.0	Qbt_4	Negative	<0.5/NT	None
16-2736	0316-97-1689	49.0–50.0	Qbt_4	Negative	<0.5/NT	None
16-2736	0316-97-1690	53.0–54.0	Qbt_4/surge bed	Negative	<0.5/NT	None
16-2736	0316-97-1691	57.5–58.5	Qbt_4/surge bed	Negative	1.18/NT	None
16-2736	0316-97-1692	64.0–65.0	Qbt_4/surge bed	Negative	1.92/NT	None
16-2736	0316-97-1693	69.0–70.0	Qbt_4	Negative	1.86/NT	None
16-2736	0316-97-1790	74.0–75.0	Qbt_4	Negative	1.24/NT	None
16-2736	0316-97-1791	79.0–80.0	Qbt_4	Negative	2.64/NT	None
16-2736	0316-97-1792	84.0–85.0	Qbt_4	Negative	1.03/NT	None
16-2736	0316-97-1793	89.0–90.0	Qbt_4	Negative	0.5/NT	None
16-2736	0316-97-1794	94.0–95.0	Qbt_3	Negative	<0.5/NT	None
16-2736	0316-97-1795	99.0–100.0	Qbt_3	Negative	1.56/NT	0316-97-0300
16-2736	0316-97-1796	104.0–105.0	Qbt_3	Negative	<0.5/NT	0316-97-0299
16-2736	0316-97-1797	108.0–109.0	Qbt_3	Negative	<0.5/NT	None
16-2736	0316-97-1798	113.05–114.5	Qbt_3	Negative	<0.5/NT	None

[a] NT = Test not performed.

Initial Phase II field activities at PRS 16-021(c) began on November 1, 1996, and ran through December 23, 1996. BHs 16-2700 and 16-2705 (in the drainage) and 16-2707 (south of the drainage) were drilled during this period (see Figure 2.3-1). Activities resumed in May of 1997 and the remaining BHs, as well as the transect sampling, were completed by November 9, 1997. Field operations were conducted during evenings and/or weekends (Friday through Sunday) due to site access restrictions associated with HE machining operations at TA-16-260. ICF Kaiser and LANL personnel implemented all field operations.

The climatic conditions encountered during sampling covered the four seasons typical of the Pajarito Plateau. Temperatures ranged from near 0°F to over 90°F. Precipitation events included the summer monsoon thunderstorms and winter blizzards. Wind velocity ranged from flat calm to powerful gusts over 35 mph. Sampling activities were occasionally curtailed during intense lightning storms. Severe winter temperatures and snow accumulation reduced sampling efficiency due to increased site set-up and tear-down work (primarily associated with managing drilling fluids and work-site access).

Sample collection and handling conformed to the following procedures:

- SAP from the RFI Report for PRSs at TA-16 and (LANL 1996, 55077), except for deviations discussed in more detail below.
- Site-Specific Health and Safety Plan
- OU 1082 Waste Management Plan
- OU 1082 Quality Assurance Plan
- LANL LP 116-1.0, Stop Work and Restart
- LANL ER-SOP-1.01, General Instructions for Field Investigations
- LANL ER-SOP-1.02, Sample Containers and Preservation
- LANL ER-SOP-1.03, Handling, Packaging, and Shipping Samples
- LANL ER-SOP-1.04, Sample Control and Field Documentation
- LANL ER-SOP-1.05, Field Quality Control Samples
- LANL ER-SOP-1.06, Management of RFI-Generated Waste
- LANL ER-SOP-1.07, Operational Guidelines for Taking Soil and Water Samples in Explosive Areas
- LANL ER-SOP-1.08, Field Decontamination of Drilling and Sampling Equipment
- LANL ER-SOP-4.01, Drilling Methods and Drill Site Management
- LANL ER-SOP-4.04, General Borehole Logging
- LANL ER-SOP-5.01, Monitor Well Construction
- LANL ER-SOP-5.02, Well Development
- LANL ER-SOP-5.03, Management of ER Program Wastes
- LANL ER-SOP-6.09, Spade and Scoop Method for Collection of Soil Samples
- LANL ER-SOP-6.10, Hand Auger and Thin-Wall Tube Sampler

- LANL ER-SOP-6.24, Sample Collection from Split-Spoon Samplers and Shelby Tube Samplers
- LANL ER-SOP 10.06, High Explosives Spot Test
- LANL ER-SOP-12.01, Field Logging, Handling, and Documentation of Borehole Samples
- LANL ER-SOP-12.02, Transportation, Receipt, and Admittance of Borehole Samples for the Sample Management Facility
- LANL ER-SOP-12.03, Acceptance of Non-borehole Samples by the Sample Management Facility
- LANL Administrative Requirement 8-2, Hearing Conservation
- LANL Administrative Requirement 12-1, Personal Protective Equipment
- LANL Administrative Requirement 15-1, Field Work
- LANL ER-QAPjP-06, Sampling Procedures
- LANL ER-QAPjP-07, Sample Custody
- LANL ER-QAPjP-08, Calibration Procedures and Frequency

2.3.2.1 BH Drilling and Logging

All drilling operations were performed remotely with an Acker™ AD2 drill rig. Water was used continuously throughout all drilling operations to wet the subsurface and, when coring, to recover cuttings from the BH. BHs were advanced to refusal with 4.25-in. hollow-stem augers equipped with stainless-steel, split-spoon samplers. Following auger refusal, the drill system was switched over to an NQ/NW wireline wet-coring system. A casing advancer was also used to advance the drill string through unconsolidated material. Continuous coring cannot be performed with the casing advancer. Therefore, a drive sampler was used to recover core once the target interval was reached with the casing advancer. Drilling water was supplied to the drill string with a regulated pump (20 gpm/700 psi) powered by an 11hp gas motor. Return drilling fluids were collected in a trough, moved to a settling trough with an electric pump, then transferred to 850-gal. storage containers with a gas-powered trash pump. Drill cuttings were collected in a trough, then transferred into labeled 55-gal. drums.

HE field screening was performed on the deepest 1-ft segment of each 5-ft core interval greater than 24 in., and on the surface and subsurface transect samples.

All BHs were completely logged in the field (see Appendix G). The core was measured to the nearest 0.1 ft and photographed. The core description included the degree of weathering and welding; percentages of lithics, phenocrysts, and pumice; obvious mineralization or alteration features; degree of fracturing; moisture content; and formation color. In addition, the core log included the run number, depth, HE spot test results, and sample and core run photograph numbers. The core was placed in plastic tubing, labeled with BH site ID and core depth, and placed in labeled core boxes. All segments of missing core were marked with a placeholder noting the missing depth and the reason material was missing. The plastic

tubing was then sealed and the core boxes were placed in a storage trailer. Following the drilling activities, the core was released from the HE Corridor by the facilities management group in charge of the investigation area (ESA-FM) and transported to the Sample Management Office (SMO) for more detailed lithologic logging. Detailed geologic logs and stratigraphic interpretations were prepared by Ken Wohletz of the Laboratory's geology and geochemistry group (EES-1) at the SMO. These logs and interpretations are described in Section 4 and Appendix G.

2.3.2.2 Transect Sampling

Surface and subsurface (12–36 in. below grade) samples were collected along transects located at 200 ft (adjacent to site IDs 16-1400 and 16-1401) and 600 ft (adjacent to site IDs 16-1408 and 16-1409) downgradient from the outfall. See Figure 2.3-1. The surface samples were collected at 5-ft lateral intervals; the subsurface samples were collected at 10-ft intervals to define the lateral extent of contamination in the drainage channel. The samples were collected at their specified intervals until HE spot test and DTech field screening results were negative for HE contamination. Laboratory samples were then selected at the ends of the transects.

Field screening of the 200-ft transect found no HE contamination in the surface samples collected up to 20 ft north and south of 16-1401 and 16-1400, respectively. However, DTech field screening showed levels of RDX in the subsurface sample (0316-97-1768) collected 10 ft north of 16-1401. A second subsurface sample was collected 10 ft further north; field screening found no HE contamination in this sample (0316-97-0330). Field screening of the subsurface sample collected 10 ft south of 16-1400 revealed no HE contamination. Two surface and three subsurface (one collocated) laboratory confirmatory samples were collected from this transect.

DTech field screening was done for the surface samples collected along the 600-ft transect at 5, 10, and 15 ft north of 16-1409, and at 5 ft south of 16-1408. The screening revealed RDX in the surface samples as well as detectable levels of TNT in the surface sample collected 5 ft south of 16-1408. No subsurface samples were collected because the soil/tuff interface was less than 1 ft below the surface. Two confirmatory samples were collected from this transect.

Screening and laboratory samples were also collected from near-surface sediments at the tops of BHs 16-2709 and 16-2710. The screening sample collected from 16-2709 contained 5.4 ppm RDX and between 5.3 and 50.0 ppm TNT. The near-surface screening sample collected from 16-2710 contained 5.48 ppm of RDX and 4.47 ppm TNT. The HE spot test was positive for both samples. Both samples were submitted for laboratory analysis.

2.3.3 Deviations from and Augmentation to the Phase II SAP

Several deviations from the original Phase II SAP presented in the Phase I RFI report (LANL 1996, 55077) were implemented through the course of field operations at the TA-16-260 outfall. The majority of these deviations were actually an expansion of the investigation scope and, therefore, enhanced the resolution of investigation objectives. Most were discussed with the AA (Hickmott 1996, 58848; Shanley 1996, 58850; Hickmott 1998, 58851; Hickmott 1997, 58854; McInroy and Mose 1997, 58857; Michelotti 1997, 58858).

- All screening samples were analyzed using the DTech immunoassay/colorimetric method(s). The Phase II SAP specified that DTech analysis was to be performed only on samples that tested positive for HE based on the Spot Test Kit.

- Engineering Application Science Division-Facility Management (ESA-FM), the facility management group in charge of the investigation area, required that all BHs be drilled with water, regardless of depth, for safety reasons. Therefore, samples were not analyzed for moisture content. Also, due to contractual issues, other geotechnical parameter analyses are still pending. Detection of in situ moisture was difficult due to the use of drilling fluid. Nevertheless, groundwater was observed in two BHs (see Section 2.3.4).

- TNT was observed in laboratory samples collected from BHs 16-2700, 16-2705, and 16-2707, during fall 1996. Therefore, all samples collected from subsequent BHs during the 1997 field season were screened using the TNT DTech immunoassay kit, in addition to the prescribed RDX screening analysis. Also, additional laboratory samples were submitted from 10-ft intervals to verify DTech results when DTech field screening indicated the presence of TNT or RDX.

- BH 16-2700, located in the ponded area of the drainage, was to be drilled to the depth of contamination. Groundwater was observed in the hole at a depth of approximately 17 ft (see Section 2.3.4.) As a result, drilling was stopped and a well was installed in the BH. A tuff sample collected at 15.5–16.5 ft (sample 0316-96-0254) showed high concentrations of explosives in field screening tests. An additional sample of the muddy groundwater was collected (sample 0316-96-0252) and submitted to the laboratory without screening. However, the depth of contamination below the pond cannot be ascertained using the currently available data.

- The Phase II SAP specified that no BH was to be drilled to a depth exceeding 70 ft. The center BH in each transect was to be drilled to the depth of contamination and subsequent BHs in each transect were to be drilled 5 ft deeper than the center BH. After the detection of HE contamination at 70 ft in BH 16-2707, however, all BHs were drilled until three uncontaminated (based on field screening results) sample intervals were observed. All 1997 BHs, except 16-2709 and 16-2710, were drilled to a minimum depth of 70 ft.

- The initial BH sites described in the Phase II SAP were based on previous Phase I sampling and a survey of the site geomorphology on three transects across the drainage. Following the discovery of groundwater in BH 16-2700, geophysical anomalies identified by a Schlumberger resistivity survey were used to modify this plan. These anomalies are shown on Figure 2.3-1 and described in Section 4.4.1.2.

- Ultimately, six BHs were located within the drainage channel (see Figure 2.3-1). BH 16-2700 is located within the pond, in an area of high HE contamination. BH 16-2705 and its continuation, 16-2735, are located immediately down drainage from the rock dam below the pond. BH 16-2706 is located in the drainage in a sediment accumulation area outside of a geophysical anomaly. The BH was intentionally located outside of a geophysical anomaly to evaluate the correlation between geophysical anomalies and surge beds. BHs 16-2709, 16-2710, 16-2711, and 16-2712 were sited along a transect 325 ft down drainage from the outfall, just upstream of the 15-ft cliff, and outside of geophysical anomalies. BHs 16-2709

and 16-2710 are located within the drainage channel; BHs 16-2711 and 16-2712 lie outside the drainage channel.

- BHs 16-2707, BH 16-2708, and its continuation, 16-2736, are located on the mesa top, along the southern bank of the drainage, within geophysical anomalies. BHs 16-2704 and BH 16-2702 are located on the mesa top, south of the drainage, in the direction of SWSC Spring from the outfall area. BH 16-2704 is located within an anomaly, and BH 16-2702 is located outside of an anomaly. Finally, BHs 16-2701 and 16-2703 are sited on the mesa top, north of the drainage channel, within a geophysical anomaly.

- The resulting pattern of BHs provides two (instead of three, as envisioned in the Phase II SAP) transects across the outfall drainage: one through the former pond and one about 350 ft down drainage from the outfall. One additional BH 16-2706, is located midway between the pond and the eastern transect, within the drainage; the remaining BHs (16-2702 and 16-2704) were sited between the former pond and the nearest of the springs. This pattern provides adequate coverage of the source area, and allows the possibility of using geophysics to identify regions of subsurface moisture.

2.3.4 Occurrence of Groundwater and Installation of Monitoring Wells

2.3.4.1 BH 16-2700

During the drilling of BH 16-2700, water was ejected from the casing to a level approximately 3 in. above the casing at a depth of approximately 16.5 ft. Drilling with water had been discontinued prior to this run due to high formation moisture content. Therefore, it is assumed that the source of this water was groundwater. The slurry that came up with the water and coated the drill rod consisted of crushed tuff, surge bed material, and water. Just prior to the ejection of the water, the drilling became much easier, indicating that the drill string intersected a softer formation. The auger was advanced beyond the surge bed to 17.5 ft to seal off the saturated zone. The following day the water/slurry level within the casing was sounded at 6.5 ft below grade, and the bottom of the BH was sounded at 15.75 feet; approximately 1.75 ft of dense mud filled the bottom of the BH. A water/slurry sample was collected from within the casing and submitted for analysis (sample 0316-96-0252). However, as described in Section 2.4.2, the water from this sample was evaporated by the laboratory and only the solid residue was analyzed.

A monitoring well was successfully installed in BH 16-2700. This monitoring well consisted of a 4-in., inside diameter (ID), schedule 20, polyvinyl chloride (PVC) pipe with a 5-ft-by-4-in. ID prepacked well screen. The screen ran from a depth of 16.75 ft to 12 ft. This BH has not subsequently produced water.

2.3.4.2 BH 16-2709

Groundwater was also encountered in BH 16-2709 (see Figure 2.3-1.) At a depth of 9 ft, slurry began filling the augers. The water appeared to be flowing into the BH from the soil/tuff interface. A steel casing was set to a depth of approximately 9 ft, but slurry continued to flow into the auger string. At a depth of 15.25 ft, water continued to fill the steel casing to a depth of 2 ft below grade. As drilling water had not been used in the previous 3.75 ft of drilling, it is assumed that the water encountered was groundwater. Following completion of the BH to a depth of 40 ft, the BH was sealed with bentonite to 20 ft, below the possible shallow surge bed horizons. Sixteen hours after sealing the BH to 20 ft, the BH had filled to 16 ft

below grade with slurry and water. A monitoring well (a 10-ft-by-1.5-in ID, 10-slot well screen and 5 ft of 1.5-in., schedule 40 PVC casing) was installed in this BH. The screen runs from a depth of 14.6 ft to 4.6 ft.

2.3.4.3 BHs 16-2736 and 16-2712

Two additional monitoring wells were installed in two holes where water was not encountered during drilling (16-2736 and 16-2712). A monitoring well was installed in BH 16-2736 to monitor the surge bed encountered from 44.5 to 68 ft. This monitoring well consisted of 30 ft of 1.5-in., 10-slot, PVC well screen and 40 ft of 1.5-in, schedule 40, PVC casing. The well screen runs from the 38.5-ft depth to the 68.5-ft depth. A monitoring well was installed in BH 16-2712 because it is located at the confluence of the source drainage with a side drainage channel. This monitoring well consists of 85 ft of 1.5-in., 10-slot well screen and 12.5 ft of 1.5-in., schedule 40, casing. The screened interval runs from 10 to 95 ft below grade.

Since the installation of the wells, the BHs have been monitored weekly. All holes remained dry until March 1998, when water appeared in BH 16-2712. Data from the sample collected at that time will be reported in future CMS reporting for this site.

2.4 Results

2.4.1 Geology

Appendix B of this report surveys the geology of TA-16 Section 4 discusses, in detail, the observations and interpretations resulting from extensive drilling during the Phase II investigation. Table 2.4-1 lists the most important features observed in the holes drilled in and near the outfall.

- The thickness of surface sediments in the vicinity of the outfall ranges from less than 1 ft up to 10 ft. In the drainage, the surface sediments are deepest in the ponded area, where the depth to the soil/tuff interface is about 5 ft. Farther down the drainage, near the edge of the drop into Cañon de Valle, the sediment depth is approximately 1 ft.
- These sediments are underlain by 15–25 ft of Unit 5 of the Tshirege Member of the Bandelier Tuff (Qbt_5). This unit is found only in the western part of the Laboratory and has not been extensively characterized. Below the former pond it includes a layer of 5–8 ft of densely welded tuff. Downgradient from the pond, near the edge of the drop into Cañon de Valle, this layer is only moderately welded. The topography of Unit 5 suggests that there was a channel along the current 260-Line outfall drainage prior to the eruption of Unit 5 (see Section 4).
- All of the source area BHs penetrated to the bottom of Qbt_5.
- Unit 5 is separated from Unit 4 (Qbt_4) by a thin surge bed (the "upper surge layer" in Table 2.4-1), which is sometimes manifested by a gap in the core. In the drainage, the depth of this layer varies from 16 to 30 feet. Material from this layer was recovered from BH 16-2700, where it was saturated.
- Unit 4 contains a thick layer (about 20 ft) of powdery, nonwelded material (the "powder unit" in Table 2.4-1.) In general, there is a layer of moderately to densely welded tuff between the surge bed at the base of Unit 5 and this powder layer, although near the edge of the drop into Cañon de Valle, Unit 5 rests directly on this powder layer.
- Below the powder layer and a thin, moderately welded transition layer in Unit 4 is another thick layer of densely welded material.

Table 2.4-1
Major Geologic Horizons Intersected by Outfall BHs

	BHs												
	16-2700[a]	16-2701	16-2702	16-2703	16-2704	16-2705/2735	16-2706	16-2707[a]	16-2708/2736	16-2709	16-2710[a]	16-2711	16-2712
Location[b]	DW	NW	SE	NW	SE	DW	DW	SW	SW	DE	DE	NE	SE
Month drilled	11/96	10/97	10/97	11/97	11/97	12/96 & 7/97	8/97	11/96	6-7/97	8/97	8/97	9/97	9/97
Top of hole[c]	7536.4	7547	7535	7549.6	7538.9	7537.1	7530.2	7546.6	7543.9	7519.8	7520.3	7521	7522.4
Soil/tuff interface[c]	7531	7542	7526	7547	7538.9	7533	7528	7544	7534	7519	7520	7520	7520
Upper surge layer[c]	7518	7528	7506	7539	7525	7517	7509	7520	7520	7491	7491	7493	7493
Top of powder unit[c]	NA	7502	7489	7502	7495	7501	7490	NA[d]	7500	7489	7489	7492	7491
Bottom of powder unit[c]	NA	7484	7470	7493	7468	7477	7471	NA	7480	NA	NA	7473	7465
Lower surge layer[c]	NA	NA	NA	NA	NA	7453	7445	NA	7462	NA	NA	NA	7442
Bottom of Qbt_4	NA	NA	NA	NA	NA	NA	NA	NA	7452	NA	NA	NA	7428
Bottom of hole[c]	7519	7458	7464	7480	7468	7446	7440	7476	7429	7480	7471	7452	7422
Total depth (ft)	17.5	89	71	70	71	91	90	70	114.5	80	49.3	80	100
Well, screened interval (depth in ft)	12–16.25	None	None	None	None	None	None	None	38.5–68.5	4.6–14.6	None	None	10–95

[a] Hole not logged by geologist; elevations approximate.

[b] D = in drainage, N = north of drainage, S = south of drainage, W = west end (near outfall and pond), E = east end (near Cañon de Valle).

[c] Elevation in feet.

[d] NA = Hole did not penetrate to this depth.

Most of the 260-Line BHs extend through the powder layer. Four intercept a second surge bed within the welded unit at the base of Unit 4 (the "lower surge layer" in Table 2.4-1). The two deepest holes (16-2712 and 16-2736) penetrate Unit 3 (Qbt_3) at depths greater than 90 ft.

The correlation between contaminant levels and this complex stratigraphy can be investigated—to a limited extent—using the available data. Conceptually, densely welded layers might be expected to retard vertical migration and encourage lateral migration, although these layers also support fractures that could provide "fast" vertical pathways at discrete locations. Higher contaminant levels might be expected in the partially to moderately welded tuffs overlying such densely welded layers, specifically: (1) near the top of the Qbt_5 unit, particularly near the pond where the Qbt_5 is densely welded; (2) below the upper surge layer, where this is separated from the powder unit by a welded layer (again, this applies primarily to the west end of the outfall); and (3) at the base of the powder unit within Qbt_4. These hypotheses are considered further in Section 2.4.4.

2.4.2 Data Quality Assessment

All analytical samples were sent for fixed-laboratory analysis at commercial analytical laboratories. All results were sent through routine validation, and some results received focused validation as necessary. Validation results are summarized in Tables C-5.0-1 and C-5.0-2 of Appendix C. In total, 94 analytical samples were analyzed in 99 requests submitted during Phases I and II of the RFI.

Although qualifiers were frequently applied to the data, the source area data set had few significant data issues. The most significant analytical issue involving this data set was poor spike and duplicate recovery results during inorganic analysis, causing qualification of some inorganic results. This issue was only severe enough to warrant rejection of some data in four request numbers, and only cyanide, antimony, mercury, manganese, and chromium results were rejected. It is not uncommon for these elements to yield poor QC results. Most cases resulted in qualification of the affected inorganic analytes. Spike results indicate how well the analytical procedure can recover and quantify an analyte in a sample. When the spike recovery result is low, data may be qualified with a low bias or rejected. If the known spike amount cannot be quantitatively recovered, any amount in the sample is assumed to be affected similarly. Duplicate analyses provide an indication of the precision of the analytical method. Twenty-three request numbers were affected by poor spike recoveries. Twenty-one request numbers had poor duplicate results which affected a wide range of different analytes. Poor duplicate results are considered to be differences between the sample and duplicate that vary more than 35%, which takes into account natural heterogeneity of LANL samples. Analytes that differ by more than 35% are qualified as estimated.

Another common, and minor, data quality issue is the problem of laboratory contamination of samples. Common laboratory chemicals, such as acetone and methylene chloride, and phthalates, such as bis(2-ethylhexyl)phthalate, commonly found in man-made materials frequently contaminate analytical samples (Smith 1997 58478, pp. 157-8). The issue of blank contamination affected 28 request numbers. Blank contaminants included (in order of frequency) methylene chloride, acetone, and bis(2-ethylhexyl)-phthalate; dichlorodifluoromethane (a common refrigerant and aerosol propellant) was present in one request number. In some cases, inorganic analytes were present in the blank. Depending upon the concentration of the element in the blank, the analyte was U-qualified or J-qualified. Laboratory contamination is a problem in that it obscures the real source of an organic chemical. Phthalates are common industrial chemicals, and are used as plasticizers in some of the materials machined at Building TA-16-260, so phthalates may have been released through the outfall.

Holding times were an issue in two HE requests, two VOC requests, and three SVOC requests. Holding times were exceeded by as much as 25 days and as little as 6 minutes. Exceeding holding times caused rejection of both samples in request 3739R for HE. It caused rejection of tetryl results in request 3828R due to additional low laboratory control sample (LCS) results for tetryl. All results in request 3828R were undetected. Even HE compounds considered robust relative to degradation associated with long holding times were undetected in this request. Therefore, the remaining results were U-qualified. One sample in request 2778 exceeded holding times by 6 minutes; these data were accepted without qualification. Between these extremes, samples for SVOC analysis in requests 1222, 3579R, and 3737R exceeded holding times by one day, and samples in request 3388R for VOC analysis exceeded holding times by four days. In these cases, data were qualified as UJ or J as a result. The rejected data were not used for decision-making in this report. The remaining qualified data were useable, with qualification, and the qualifications had little influence on the final decisions.

Detection limits for antimony exceeded the background values for the majority of samples in both soil and tuff at the source area. This is not unexpected given the technical difficulties associated with quantifying antimony concentrations. Similar problems were encountered for cadmium, selenium, and thallium, and for silver and total cyanide, where the "background value" is actually the detection limit available in the background data. The effect of these high detection limits on our ability to detect releases of these chemicals at the 260 outfall is evaluated on a case-by-case basis in Section 2.4.3, as are other problems affecting smaller numbers of samples.

Most samples had adequate detection limits. However, some samples in this data set were highly contaminated with HE (up to 300 000 ppm), and this could cause interference that could elevate detection limits for HE and SVOC analyses.

HE compounds are also SVOCs, although they are not analyzed in the same way. Most HE compounds are not in the suite of SW-486 Method 8270; exceptions are 2,4-dinitrotoluene and 2,6-dinitrotoluene. However, if enough HE is present in a sample, some of these HE compounds will be carried along through sample preparation and extraction and be detected in an SVOC analysis, generally as tentatively identified compounds (TICs) since they are not in the formal SVOC suite. For example, request numbers 2850 and 3388R list the high explosives TNB, TNT, and RDX as TICs, indicating that enough HE was present in the samples to identify individual compounds and estimate their concentrations. (The results from these TICs are not used quantitatively in this report due to the availability of more precise data from the same location.) HE compounds that are present but cannot be identified can cause an increase in the background noise, which then elevates the detection limit. In addition, samples with high concentrations of HE require many dilutions in order to obtain concentrations in a range that the instrument can accurately quantify. As the dilution factor increases, so do the detection limits. This can also affect the quality of the data.

In request 1173 for HE, the detected compounds are qualified as J-, because two extractions were carried out on the sample. After analysis, the technician saw that the analytical results were so high that the extraction solution may have been saturated. This would have the effect of leaving some HE in the sample because no more could be dissolved in the extraction solution. Therefore, the sample was re-extracted, with much significantly lower concentrations of HE. The concentrations of HE in the re-extracted samples were 50–60 times lower than the results from the first extraction, although concentrations of HE were still on the order of hundreds of ppm of HE. This indicates that the extraction solution was not saturated, but that the first extraction results did not fully measure the true amount of HE in the samples. Therefore, these analytical results are qualified as estimated with a low bias, and the results then represent a lower bound on the concentrations of HE at this location.

Other QA/QC issues affecting HE analyses included high matrix spike results, limited suite LCS standards, and high and low LCS results. None of these issues significantly affected the data, although the low LCS results (mentioned above) caused rejection of tetryl results because, holding times for these samples were exceeded by 5–12 days. In request 2811, TNB had LCS recovery results of 125%, which is slightly greater than the acceptable limit of 120%. This caused detected results in the sample to be qualified as J+. Therefore, these results provide an upper bound to the contamination in this sample. Given that this sample was suspected to be contaminated prior to sampling, and that other samples are available in this area, obtaining an upper bound to the contamination is acceptable. In some analyses conducted during 1995, a limited suite of seven (compared to the usual 14) HE analytes was used as an LCS standard, and these data were PM-qualified. In later data from 1996 and 1997, this occasionally occurred, but the data was not qualified on this basis. Given that this site has been heavily sampled over the years and that the

data is expected to show some contamination, this minor change in procedure for the LCS portion of the QA/QC analysis is considered acceptable. Data were not qualified on this basis. In request 3903R, spike recoveries for all HE analytes (excluding tetryl) ranged from 120 to 131%, above the acceptable 120% limit. For samples in this request, the spike results indicated that an upward bias might be affecting the actual results. However, no HE was detected in these samples, despite the high bias. Therefore, these data were U-qualified.

Samples in four requests for VOC analysis had problems with surrogates and/or internal standards that caused data to be qualified. No internal standard or surrogate problem was serious enough to warrant rejection of data. Surrogates and internal standards indicate if matrix interferences are affecting the analytical results of a sample. In general, minor analytical problems with the surrogate or internal standard can cause the analytical result to be qualified as estimated or estimated undetected. In all cases, the internal standard results were lower than expected, which could cause falsely high reported values. However, only three compounds were detected in the four request numbers mentioned above, and very few VOCs were detected in any samples at this site. Therefore, these minor problems associated with poor internal standard and surrogate results have little effect on the data set overall.

All but one of the samples in the source area data set were solid samples, in other words, collected from surface and subsurface soils. Sample 0316-96-0252 in request numbers 2818, 2819, and 2820, was initially characterized as a muddy groundwater sample collected from the bottom of BH 16-2700. According to the analytical laboratory, the sample contained approximately 70% solids. The analytical laboratory attempted to filter the sample in order to obtain both solid and water samples for analysis. However, the sample could not be filtered. Therefore, the sample was handled as a solid sample and the water was evaporated, leaving the solids to be analyzed for HE, SVOCs, VOCs, and metals. In effect, the results reported are the sum of the contaminants dissolved in the water and the contaminants present in the solids. Some of these results, especially for HE and barium, are extremely high, but results from an adjacent tuff sample (0316-96-0254) are also elevated, so there is no doubt that a pathway to this layer from the surface exists. In tables in Section 2.4.3, sample 0316-96-0252 is denoted as the "surge" sample (instead of "tuff" or "Qbt_4"). The solid material in this sample appears to come from the upper surge layer described in Section 2.4.1.

Analytical methods are identified in Appendix I of this document. In general, standard analytical techniques were used for these analyses. These are described in the statement of work (SOW) provided to the commercial laboratories prior to sample analysis. However, for analysis of uranium, the method of preparation prior to sample analysis was not always well defined by the relevant SOW. For all uranium analyses of source area sediment samples, a nitric acid digestion method (with and without microwave assistance) was used. This method corresponds to EPA SW-846 Methods 3050 and 3051. The nitric acid method does not cause total decomposition of the sample matrix, despite the fact that the analysis is described as a *total* uranium analysis. This information is important when assessing the uranium results described later in this report; however; this digestion method had no effect on the quality of the uranium data.

No rejected data were used for decision-making purposes in this report. All other data are useable, with application of the relevant qualifiers.

This site has been heavily sampled for many years with known detections of HE and barium. Few QC problems affected the HE results, although one request number containing two samples was rejected

due to holding time issues. Less than a dozen request numbers had QC problems that involved barium. In general, the inorganic results had no unexpected QA problems associated with them, and only four request numbers contained rejected inorganic data. There were also no significant QA problems associated with non-HE organic analyses. Overall, the results in this data set are of very good quality and adequate for the decisions reported in this document.

A detailed description of the data quality assessment for all the data presented in this report can be found in Appendix C.

2.4.3 Data Presentation

Data from the TA-16-260 outfall are presented in two groups in this section. Results from samples collected in surface and near-surface sediments within the drainage are presented in Section 2.4.3.1. This data set contains 37 Phase I samples (including 3 field duplicates) and 9 Phase II samples, of which 2 come from within the drainage while the remaining 7 (including 1 field duplicate) were collected along 2 lateral bounding transects. Section 2.4.3.2 presents results from tuff samples in holes drilled within the drainage and results from both soil and tuff samples in holes drilled outside the drainage, for a total of 42 tuff samples, 5 soil samples, and 1 water/slurry sample from BH 16-2700.

The purpose of this section is to identify chemicals that have been released at the 260-Line outfall. This is done by comparison with background values (BVs) and method detection limits (DLs). Although assessment of the significance of such releases, from a risk perspective, will be postponed until Section 6, additional context and evaluation of the significance is provided in Section 2.4.4. The complete analytical data are found in Appendix I. Tables in this section summarize these data and present individual observations above BVs and DLs.

2.4.3.1 Surface/Near-Surface Channel Sediments

2.4.3.1.1 Inorganic Chemical Comparison with Background

Complete analytical data for inorganic chemical analyses of source area samples are provided in Table I-2.0-1 of Appendix I. Validation results for these data are summarized in Appendix C, Tables C-5.0-1 and C-5.0-2. Overall, the data quality for the 46 surface and near-surface samples in the drainage is satisfactory.

Chromium data for four out of five Phase II samples collected along the 200-ft transect were rejected; however, the remaining data, including samples from the most contaminated part of the outfall, are adequate to characterize chromium releases. DLs were above BVs for antimony, cadmium, total cyanide, and thallium in some samples.

The background sediment data are used for background comparisons, and the associated BVs are provided in Table 2.4-2 (Ryti et al. 1998, 58093.) This choice is based both on field observation and on the distribution of some of the major elements that are not expected to be contaminants at this site. The soil and sediment background data differ with respect to these major elements, and the distribution of these elements in samples from the TA-16-260 outfall are closer to the background sediment distribution than the background soil distribution (see Appendix D.) However, there is some variability among the samples from the drainage and, in particular, some samples may come from better-developed soils.

Table 2.4-2
Frequency of Detected Inorganic Chemicals in Surface and Near-Surface Drainage Samples

Analyte	Media	Number of Samples Analyzed	Number of Detects	Concentration Range (mg/kg)[a]	BV (mg/kg)	Frequency of Detects Above BV[a]
Aluminum	SED[b]	46	46	3190–29600	15400	2/46
Antimony	SED	46	0	[0.41–9.8][c]	0.83	DL > BV[d] (37/46)
Arsenic	SED	46	46	0.63–9.7	3.98	8/46
Barium	SED	46	46	80.4–33300	127	44/46
Beryllium	SED	46	33	0.28–1.7	1.31	3/46
Cadmium	SED	46	14	[0.62]–2.9	0.4	14/46 (plus 22 DL > BV)
Calcium	SED	46	46	623–5550	4420	2/46
Chromium, total	SED	46	41	3–26.8	10.5	12/41
Cobalt	SED	46	44	1.4–16.8	4.73	21/46
Copper	SED	46	46	3.5–40.5	11.2	18/46
Cyanide, total	SED	46	0	[0.26–2]	0.82	DL > BV (39/46)
Iron	SED	46	46	4530–21300	13800	5/46
Lead	SED	46	46	8–107	19.7	23/46
Magnesium	SED	46	46	374–3360	2370	1/46
Manganese	SED	46	46	86.2–1890	543	8/46
Mercury	SED	46	2	[0.02–0.09]	0.1	0/46
Nickel	SED	46	46	2.2–51.9	9.38	21/46
Potassium	SED	46	46	401–2560	2690	0/46
Selenium	SED	46	1	[0.25–1]	0.3	1/46 (plus 32 DL > BV)
Silver	SED	46	9	[0.083]–4.1	1	5/46
Sodium	SED	46	46	26–764	1470	0/46
Thallium	SED	46	2	[0.21–1.1]	0.73	DL > BV (5/46)
Uranium	SED	37	37	1.27–8.71	2.22	29/37
Vanadium	SED	46	46	7.6–55.7	19.7	28/46
Zinc	SED	46	46	12–226	60.2	18/46

[a] Value is the ratio of the number of detected values exceeding the BV to the number of analyses.

[b] SED = Sediment.

[c] Brackets indicate the value is below detection limits, although some analytes may be detected at values within this range.

[d] The DL for this analyte exceeded the BV.

Moreover, the drainage sediments are now dry and immobile, so although geochemically they appear to be sediments, from an exposure model and a risk perspective, they will be treated as soils (Section 6).

Phase I samples were analyzed for uranium using a partial digestion method, so the partial digestion uranium sediment background data and BV have been used for comparison.

Table 2.4-2 also summarizes the frequency of detected inorganic chemicals and of nondetected chemicals with DLs exceeding sediment BVs. Results above the BVs, including nondetected results at DLs above background, are shown in Table 2.4-3.

Table 2.4-3
Inorganic Chemicals with Concentrations Exceeding Sediment BVs in Surface and Near-Surface Drainage

Analyte	Location	Sample ID	Sample Concentration (mg/kg)	BV (mg/kg)	Media	Depth (ft)	Approximate Distance from Outfall (ft)
Aluminum	16-1397	0316-95-0013	21 700	15 400	SED	0–0.5	0
	16-1380	0316-95-0028	29 600		SED	0–0.5	20
Antimony	16-1396	0316-95-0014	5.5(U)[a]	0.83	SED	0–0.5	0
	16-1397	0316-95-0013	6.2(U)		SED	0–0.5	0
	16-1379	0316-95-0027	6.4(U)		SED	0–0.5	0
	16-1379	0316-95-0044	6.7(U)		SED	1–1.5	0
	16-1379	0316-95-2015	6.96(U)		SED	1–1.5	0
	16-1380	0316-95-0028	9.8(U)		SED	0–0.5	20
	16-1381	0316-95-0029	5.9(U)		SED	0–0.5	40
	16-1382	0316-95-2012	6.4(U)		SED	0–0.5	60
	16-1382	0316-95-0030	6.6(U)		SED	0–0.5	60
	16-1382	0316-95-0045	7.03(U)		SED	1.5–1.9	60
	16-1383	0316-95-2013	7.1(U)		SED	0–0.5	80
	16-1383	0316-95-0031	7.3(U)		SED	0–0.5	80
	16-1383	0316-95-0046	7.5(U)		SED	1.7–2.2	80
	16-1399	0316-95-0015	5.4(U)		SED	0–0.5	100
	16-1384	0316-95-0032	6.1(U)		SED	0–0.5	100
	16-1398	0316-95-0016	6.2(U)		SED	0–0.5	100
	16-1385	0316-95-0033	7.5(U)		SED	0–0.5	120
	16-1386	0316-95-0034	6.7(U)		SED	0–0.5	140
	16-1387	0316-95-0035	7.3(U)		SED	0–0.5	160
	16-1388	0316-95-0036	7.5(U)		SED	0–0.5	180
	16-1401	0316-95-0017	5.9(U)		SED	0–0.5	200
	16-1400	0316-95-0018	6.1(U)		SED	0–0.5	200
	16-1389	0316-95-0037	8.2(U)		SED	0–0.5	200
	16-1390	0316-95-0038	6.7(U)		SED	0–0.5	260
	16-1402	0316-95-0020	5.8(U)		SED	0–0.5	300

Table 2.4-3 (continued)

Analyte	Location	Sample ID	Sample Concentration (mg/kg)	BV (mg/kg)	Media	Depth (ft)	Approximate Distance from Outfall (ft)
Antimony (continued)	16-1403	0316-95-0019	6.1(U)	0.83	SED	0–0.5	300
	16-1391	0316-95-0039	6.1(U)		SED	0–0.5	320
	16-1392	0316-95-0040	7.1(U)		SED	0–0.5	380
	16-1405	0316-95-0021	5.8(U)		SED	0–0.5	400
	16-1404	0316-95-0022	8(U)		SED	0–0.2	400
	16-1393	0316-95-0041	5.7(U)		SED	0–0.5	440
	16-1406	0316-95-0024	5.3(U)		SED	0–0.5	500
	16-1407	0316-95-0023	6.3(U)		SED	0–0.5	500
	16-1394	0316-95-0042	6.3(U)		SED	0–0.5	500
	16-1395	0316-95-0043	6.2(U)		SED	0–0.5	560
	16-1409	0316-95-0025	5.9(U)		SED	0–0.5	600
	16-1408	0316-95-0026	8.5(U)		SED	0–0.5	600
Arsenic	16-1379	0316-95-2015	4.31	3.98	SED	1–1.5	0
	16-1380	0316-95-0028	5.4		SED	0–0.5	20
	16-1389	0316-95-0037	4.1(J-)[b]		SED	0–0.5	200
	16-1391	0316-95-0039	7.4		SED	0–0.5	320
	16-2710	0316-97-0388	9.7		SED	0.5–1	350
	16-1392	0316-95-0040	4.1		SED	0–0.5	380
	16-1394	0316-95-0042	4.2		SED	0–0.5	500
	16-1408	0316-95-0026	5.5(J-)		SED	0–0.5	600
Barium	16-1379	0316-95-0044	11 700	127	SED	1–1.5	0
	16-1396	0316-95-0014	498(J+)[c]		SED	0–0.5	0
	16-1379	0316-95-0027	5270		SED	0–0.5	0
	16-1397	0316-95-0013	583(J+)		SED	0–0.5	0
	16-1379	0316-95-2015	8820		SED	1–1.5	0
	16-1380	0316-95-0028	18 200		SED	0–0.5	20
	16-1381	0316-95-0029	2730(J)[d]		SED	0–0.5	40
	16-1382	0316-95-2012	12 100(J)		SED	0–0.5	60
	16-1382	0316-95-0030	12 700(J)		SED	0–0.5	60
	16-1382	0316-95-0045	7670		SED	1.5–1.9	60
	16-1383	0316-95-2013	13 800(J)		SED	0–0.5	80
	16-1383	0316-95-0031	14 600(J)		SED	0–0.5	80
	16-1383	0316-95-0046	16 200		SED	1.7–2.2	80
	16-1399	0316-95-0015	1170(J+)		SED	0–0.5	100
	16-1398	0316-95-0016	693(J+)		SED	0–0.5	100
	16-1384	0316-95-0032	8310		SED	0–0.5	100
	16-1385	0316-95-0033	19 000(J)		SED	0–0.5	120

Table 2.4-3 (continued)

Analyte	Location	Sample ID	Sample Concentration (mg/kg)	BV (mg/kg)	Media	Depth (ft)	Approximate Distance from Outfall (ft)
Barium (continued)	16-1386	0316-95-0034	11 100(J)	127	SED	0–0.5	140
	16-1387	0316-95-0035	21 100(J)		SED	0–0.5	160
	16-1388	0316-95-0036	26 100(J)		SED	0–0.5	180
	16-1400	0316-95-0018	12 100(J+)		SED	0–0.5	200
	16-2716	0316-97-0330	138		SED	2–2.8	200
	16-2717	0316-97-0329	1440		SED	0–0.5	200
	16-1389	0316-95-0037	26 900(J)		SED	0–0.5	200
	16-2713	0316-97-0328	653		SED	0–0.5	200
	16-1401	0316-95-0017	7500(J+)		SED	0–0.5	200
	16-1390	0316-95-0038	24 300		SED	0–0.5	260
	16-1402	0316-95-0020	172(J+)		SED	0–0.5	300
	16-1403	0316-95-0019	7750(J+)		SED	0–0.5	300
	16-1391	0316-95-0039	8550		SED	0–0.5	320
	16-2710	0316-97-0388	10 200		SED	0.5–1	350
	16-2709	0316-97-0389	8180		SED	0.5–1	350
	16-1392	0316-95-0040	33 300		SED	0–0.5	380
	16-1404	0316-95-0022	20 200(J+)		SED	0–0.2	400
	16-1405	0316-95-0021	3790(J+)		SED	0–0.5	400
	16-1393	0316-95-0041	7140		SED	0–0.5	440
	16-1394	0316-95-0042	20 600		SED	0 – 0.5	500
	16-1406	0316-95-0024	412(J-)		SED	0 – 0.5	500
	16-1407	0316-95-0023	619(J-)		SED	0 – 0.5	500
	16-1395	0316-95-0043	6230		SED	0 – 0.5	560
	16-2724	0316-97-0332	200		SED	0 – 0.5	600
	16-1408	0316-95-0026	29 500(J-)		SED	0 – 0.5	600
	16-1409	0316-95-0025	3000(J-)		SED	0 – 0.5	600
	16-2726	0316-97-0333	862		SED	0 – 0.5	600
Beryllium	16-1397	0316-95-0013	1.5	1.31	SED	0 – 0.5	0
	16-1380	0316-95-0028	1.7		SED	0 – 0.5	20
	16-1404	0316-95-0022	1.4		SED	0 – 0.2	400
Cadmium	16-1396	0316-95-0014	0.55(U)	0.4	SED	0 – 0.5	0
	16-1397	0316-95-0013	0.62(U)		SED	0 – 0.5	0
	16-1379	0316-95-0027	0.64(U)		SED	0 – 0.5	0
	16-1379	0316-95-0044	0.667(U)		SED	1 – 1.5	0
	16-1379	0316-95-2015	0.696(U)		SED	1 – 1.5	0
	16-1380	0316-95-0028	1.6		SED	0 – 0.5	20
	16-1381	0316-95-0029	0.59(U)		SED	0 – 0.5	40
	16-1382	0316-95-0045	0.703(U)		SED	1.5 – 1.9	60
	16-1382	0316-95-2012	0.76		SED	0 – 0.5	60

Table 2.4-3 (continued)

Analyte	Location	Sample ID	Sample Concentration (mg/kg)	BV (mg/kg)	Media	Depth (ft)	Approximate Distance from Outfall (ft)
Cadmium (continued)	16-1382	0316-95-0030	0.98	0.4	SED	0 – 0.5	60
	16-1383	0316-95-0046	0.937		SED	1.7 – 2.2	80
	16-1383	0316-95-2013	1.2		SED	0 – 0.5	80
	16-1383	0316-95-0031	1.3		SED	0 – 0.5	80
	16-1399	0316-95-0015	0.54(U)		SED	0 – 0.5	100
	16-1384	0316-95-0032	0.69		SED	0 – 0.5	100
	16-1385	0316-95-0033	2.6		SED	0 – 0.5	120
	16-1386	0316-95-0034	0.71		SED	0 – 0.5	140
	16-1387	0316-95-0035	2.4		SED	0 – 0.5	160
	16-1388	0316-95-0036	2.9		SED	0 – 0.5	180
	16-1401	0316-95-0017	0.59(U)		SED	0 – 0.5	200
	16-1400	0316-95-0018	0.61(U)		SED	0 – 0.5	200
	16-1389	0316-95-0037	2.1		SED	0 – 0.5	200
	16-1390	0316-95-0038	1.9		SED	0 – 0.5	260
	16-1402	0316-95-0020	0.58(U)		SED	0 – 0.5	300
	16-1403	0316-95-0019	0.61(U)		SED	0 – 0.5	300
	16-1391	0316-95-0039	0.61(U)		SED	0 – 0.5	320
	16-1392	0316-95-0040	0.76		SED	0–0.5	380
	16-1405	0316-95-0021	0.58(U)		SED	0–0.5	400
	16-1404	0316-95-0022	0.8(U)		SED	0–0.2	400
	16-1393	0316-95-0041	0.57(U)		SED	0–0.5	440
	16-1406	0316-95-0024	0.53(U)		SED	0–0.5	500
	16-1407	0316-95-0023	0.63(U)		SED	0–0.5	500
	16-1394	0316-95-0042	0.63(U)		SED	0–0.5	500
	16-1395	0316-95-0043	0.62(U)		SED	0–0.5	560
	16-1409	0316-95-0025	0.59(U)		SED	0–0.5	600
	16-1408	0316-95-0026	0.85(U)		SED	0–0.5	600
Calcium	16-1404	0316-95-0022	4470	4420	SED	0–0.2	400
	16-1407	0316-95-0023	5550		SED	0–0.5	500
Chromium, total	16-1397	0316-95-0013	14.8	10.5	SED	0–0.5	0
	16-1380	0316-95-0028	26.8		SED	0–0.5	20
	16-1383	0316-95-2013	11.2(J)		SED	0–0.5	80
	16-1383	0316-95-0031	11.7(J)		SED	0–0.5	80
	16-1383	0316-95-0046	12.2		SED	1.7–2.2	80
	16-1385	0316-95-0033	16.8(J)		SED	0–0.5	120
	16-1387	0316-95-0035	16.4(J)		SED	0–0.5	160
	16-1388	0316-95-0036	18.9(J)		SED	0–0.5	180
	16-1389	0316-95-0037	15.1(J)		SED	0–0.5	200

Table 2.4-3 (continued)

Analyte	Location	Sample ID	Sample Concentration (mg/kg)	BV (mg/kg)	Media	Depth (ft)	Approximate Distance from Outfall (ft)
Chromium, total (continued)	16-1390	0316-95-0038	18.3	10.5	SED	0–0.5	260
	16-1391	0316-95-0039	11		SED	0–0.5	320
	16-1392	0316-95-0040	13		SED	0–0.5	380
Cobalt	16-1396	0316-95-0014	11.1	4.73	SED	0–0.5	0
	16-1379	0316-95-0027	5.2(J)		SED	0–0.5	0
	16-1379	0316-95-2015	5.53(J)		SED	1–1.5	0
	16-1379	0316-95-0044	6.28(J)		SED	1–1.5	0
	16-1397	0316-95-0013	7.6		SED	0–0.5	0
	16-1380	0316-95-0028	6.7(J)		SED	0–0.5	20
	16-1382	0316-95-0045	5.3(J)		SED	1.5–1.9	60
	16-1383	0316-95-0031	5(J)		SED	0–0.5	80
	16-1398	0316-95-0016	5.7(J)		SED	0–0.5	100
	16-1385	0316-95-0033	6.5(J)		SED	0–0.5	120
	16-1387	0316-95-0035	6.9(J)		SED	0–0.5	160
	16-1388	0316-95-0036	7.1(J)		SED	0–0.5	180
	16-1401	0316-95-0017	4.8(J)		SED	0–0.5	200
	16-2717	0316-97-0329	5.4(J)		SED	0–0.5	200
	16-1389	0316-95-0037	6.2(J)		SED	0–0.5	200
	16-1390	0316-95-0038	5.1(J)		SED	0–0.5	260
	16-1402	0316-95-0020	7.8		SED	0–0.5	300
	16-1391	0316-95-0039	4.9(J)		SED	0–0.5	320
	16-2710	0316-97-0388	16.8		SED	0.5–1	350
	16-1404	0316-95-0022	6.9(J)		SED	0–0.2	400
	16-1409	0316-95-0025	6.4		SED	0–0.5	600
Copper	16-1379	0316-95-0044	11.8	11.2	SED	1–1.5	0
	16-1380	0316-95-0028	40.5		SED	0–0.5	20
	16-1382	0316-95-2012	17.8(J)		SED	0–0.5	60
	16-1382	0316-95-0030	19.9(J)		SED	0–0.5	60
	16-1383	0316-95-2013	20.1(J)		SED	0–0.5	80
	16-1383	0316-95-0046	22.4		SED	1.7–2.2	80
	16-1383	0316-95-0031	25.2(J)		SED	0–0.5	80
	16-1384	0316-95-0032	12.5		SED	0–0.5	100
	16-1385	0316-95-0033	35.9(J)		SED	0–0.5	120
	16-1386	0316-95-0034	17.5(J)		SED	0–0.5	140
	16-1387	0316-95-0035	31.8(J)		SED	0–0.5	160
	16-1388	0316-95-0036	38.5(J)		SED	0–0.5	180
	16-1389	0316-95-0037	31.3(J)		SED	0–0.5	200
	16-1390	0316-95-0038	26.8		SED	0–0.5	260
	16-1392	0316-95-0040	17.5		SED	0–0.5	380

Table 2.4-3 (continued)

Analyte	Location	Sample ID	Sample Concentration (mg/kg)	BV (mg/kg)	Media	Depth (ft)	Approximate Distance from Outfall (ft)
Copper (continued)	16-1404	0316-95-0022	16.1	11.2	SED	0–0.2	400
	16-1394	0316-95-0042	14.4		SED	0–0.5	500
	16-1408	0316-95-0026	12.1		SED	0–0.5	600
Cyanide, total	16-1396	0316-95-0014	1.1(U)	0.82	SED	0–0.5	0
	16-1397	0316-95-0013	1.2(U)		SED	0–0.5	0
	16-1379	0316-95-0027	1.3(U)		SED	0–0.5	0
	16-1379	0316-95-0044	1.4(U)		SED	1–1.5	0
	16-1379	0316-95-2015	1.41(U)		SED	1–1.5	0
	16-1380	0316-95-0028	2(U)		SED	0–0.5	20
	16-1381	0316-95-0029	1.2(U)		SED	0–0.5	40
	16-1382	0316-95-2012	1.3(U)		SED	0–0.5	60
	16-1382	0316-95-0030	1.4(U)		SED	0–0.5	60
	16-1382	0316-95-0045	1.41(U)		SED	1.5–1.9	60
	16-1383	0316-95-2013	1.4(U)		SED	0–0.5	80
	16-1383	0316-95-0031	1.5(U)		SED	0–0.5	80
	16-1383	0316-95-0046	1.55(U)		SED	1.7–2.2	80
	16-1399	0316-95-0015	1.1(U)		SED	0–0.5	100
	16-1384	0316-95-0032	1.2(U)		SED	0–0.5	100
	16-1398	0316-95-0016	1.3(U)		SED	0–0.5	100
	16-1385	0316-95-0033	1.5(U)		SED	0–0.5	120
	16-1386	0316-95-0034	1.4(U)		SED	0–0.5	140
	16-1387	0316-95-0035	1.5(U)		SED	0–0.5	160
	16-1388	0316-95-0036	1.6(U)		SED	0–0.5	180
	16-1401	0316-95-0017	1.2(U)		SED	0–0.5	200
	16-1400	0316-95-0018	1.2(U)		SED	0–0.5	200
	16-1389	0316-95-0037	1.7(U)		SED	0–0.5	200
	16-1390	0316-95-0038	1.4(U)		SED	0–0.5	260
	16-1402	0316-95-0020	1.2(U)		SED	0–0.5	300
	16-1403	0316-95-0019	1.3(U)		SED	0–0.5	300
	16-1391	0316-95-0039	1.2(U)		SED	0–0.5	320
	16-1392	0316-95-0040	1.5(U)		SED	0–0.5	380
	16-1405	0316-95-0021	1.2(U)		SED	0–0.5	400
	16-1404	0316-95-0022	1.6(U)		SED	0–0.2	400
	16-1393	0316-95-0041	1.2(U)		SED	0–0.5	440
	16-1406	0316-95-0024	1.1(U)		SED	0–0.5	500
	16-1407	0316-95-0023	1.3(U)		SED	0–0.5	500
	16-1394	0316-95-0042	1.3(U)		SED	0–0.5	500
	16-1395	0316-95-0043	1.3(U)		SED	0–0.5	560
	16-2724	0316-97-0332	1.1(U)		SED	0–0.5	600

Table 2.4-3 (continued)

Analyte	Location	Sample ID	Sample Concentration (mg/kg)	BV (mg/kg)	Media	Depth (ft)	Approximate Distance from Outfall (ft)
Cyanide, total (continued)	16-1409	0316-95-0025	1.2(U)	0.82	SED	0–0.5	600
	16-2726	0316-97-0333	1.3(U)		SED	0–0.5	600
	16-1408	0316-95-0026	1.8(U)		SED	0–0.5	600
Iron	16-1379	0316-95-0027	15 700	13 800	SED	0–0.5	0
	16-1397	0316-95-0013	18 100		SED	0–0.5	0
	16-1380	0316-95-0028	21 300		SED	0–0.5	20
	16-1391	0316-95-0039	14 200		SED	0–0.5	320
	16-2710	0316-97-0388	17 800		SED	0.5–1	350
Lead	16-1379	0316-95-2015	42.7	19.7	SED	1–1.5	0
	16-1379	0316-95-0044	46.2		SED	1–1.5	0
	16-1380	0316-95-0028	107		SED	0–0.5	20
	16-1381	0316-95-0029	27.2		SED	0–0.5	40
	16-1382	0316-95-0030	36.7		SED	0–0.5	60
	16-1382	0316-95-2012	38.6		SED	0–0.5	60
	16-1382	0316-95-0045	46.5		SED	1.5–1.9	60
	16-1383	0316-95-2013	41.2		SED	0–0.5	80
	16-1383	0316-95-0031	43.1		SED	0–0.5	80
	16-1383	0316-95-0046	48.5		SED	1.7–2.2	80
	16-1385	0316-95-0033	58		SED	0–0.5	120
	16-1386	0316-95-0034	35.5		SED	0–0.5	140
	16-1387	0316-95-0035	57.8		SED	0–0.5	160
	16-1388	0316-95-0036	47.3		SED	0–0.5	180
	16-1389	0316-95-0037	46.5		SED	0–0.5	200
	16-1390	0316-95-0038	46.3		SED	0–0.5	260
	16-1403	0316-95-0019	30.3		SED	0–0.5	300
	16-1391	0316-95-0039	38.8		SED	0–0.5	320
	16-2710	0316-97-0388	23.6		SED	0.5–1	350
	16-1392	0316-95-0040	22.4		SED	0–0.5	380
	16-1404	0316-95-0022	39.4		SED	0–0.2	400
	16-1394	0316-95-0042	33.8		SED	0–0.5	500
	16-1395	0316-95-0043	22.5		SED	0–0.5	560
Magnesium	16-1380	0316-95-0028	3360	2370	SED	0–0.5	20
Manganese	16-1396	0316-95-0014	1380(J)	543	SED	0–0.5	0
	16-1398	0316-95-0016	644(J)		SED	0–0.5	100
	16-2710	0316-97-0388	1890		SED	0.5–1	350
	16-1404	0316-95-0022	642(J)		SED	0–0.2	400
	16-1407	0316-95-0023	910		SED	0–0.5	500
	16-2726	0316-97-0333	557(J-)		SED	0–0.5	600

Table 2.4-3 (continued)

Analyte	Location	Sample ID	Sample Concentration (mg/kg)	BV (mg/kg)	Media	Depth (ft)	Approximate Distance from Outfall (ft)
Manganese (continued)	16-1408	0316-95-0026	693	543	SED	0–0.5	600
	16-1409	0316-95-0025	776		SED	0–0.5	600
Nickel	16-1379	0316-95-0027	10.3	9.38	SED	0–0.5	0
	16-1397	0316-95-0013	11.5		SED	0–0.5	0
	16-1379	0316-95-2015	11.5		SED	1–1.5	0
	16-1379	0316-95-0044	11.8		SED	1–1.5	0
	16-1380	0316-95-0028	37.3		SED	0–0.5	20
	16-1382	0316-95-0045	10.8		SED	1.5–1.9	60
	16-1382	0316-95-0030	11.2		SED	0–0.5	60
	16-1382	0316-95-2012	9.9		SED	0–0.5	60
	16-1383	0316-95-0031	10.9		SED	0–0.5	80
	16-1383	0316-95-2013	9.4		SED	0–0.5	80
	16-1385	0316-95-0033	12.8		SED	0–0.5	120
	16-1386	0316-95-0034	13.3		SED	0–0.5	140
	16-1387	0316-95-0035	51.9		SED	0–0.5	160
	16-1388	0316-95-0036	16.3		SED	0–0.5	180
	16-2716	0316-97-0330	19.3(J)		SED	2–2.8	200
	16-1389	0316-95-0037	30.1		SED	0–0.5	200
	16-1390	0316-95-0038	25.9		SED	0–0.5	260
	16-1391	0316-95-0039	31.9		SED	0–0.5	320
	16-1392	0316-95-0040	21.3		SED	0–0.5	380
	16-1404	0316-95-0022	10.2		SED	0–0.2	400
	16-1394	0316-95-0042	20.1		SED	0–0.5	500
Selenium	16-1379	0316-95-0027	0.32(U)	0.3	SED	0–0.5	0
	16-1379	0316-95-0044	0.34(U)		SED	1–1.5	0
	16-1379	0316-95-2015	0.348(U)		SED	1–1.5	0
	16-1380	0316-95-0028	0.49(U)		SED	0–0.5	20
	16-1382	0316-95-2012	0.33(UJ)[e]		SED	0–0.5	60
	16-1382	0316-95-0030	0.34(UJ)		SED	0–0.5	60
	16-1382	0316-95-0045	0.347(U)		SED	1.5–1.9	60
	16-1383	0316-95-0031	0.35(UJ)		SED	0–0.5	80
	16-1383	0316-95-2013	0.35(UJ)		SED	0–0.5	80
	16-1383	0316-95-0046	0.385(U)		SED	1.7–2.2	80
	16-1398	0316-95-0016	0.31(UJ)		SED	0–0.5	100
	16-1385	0316-95-0033	0.37(UJ)		SED	0–0.5	120
	16-1386	0316-95-0034	0.33(UJ)		SED	0–0.5	140
	16-1387	0316-95-0035	0.37(UJ)		SED	0–0.5	160
	16-1388	0316-95-0036	0.39(UJ)		SED	0–0.5	180
	16-1400	0316-95-0018	0.31(UJ)		SED	0–0.5	200

Table 2.4-3 (continued)

Analyte	Location	Sample ID	Sample Concentration (mg/kg)	BV (mg/kg)	Media	Depth (ft)	Approximate Distance from Outfall (ft)
Selenium (continued)	16-1389	0316-95-0037	0.42(UJ)	0.3	SED	0–0.5	200
	16-2716	0316-97-0330	0.92(U)		SED	2–2.8	200
	16-2713	0316-97-0328	0.94(U)		SED	0–0.5	200
	16-2718	0316-97-2021	0.95(U)		SED	2–2.75	200
	16-2718	0316-97-0331	0.96(U)		SED	2–2.8	200
	16-2717	0316-97-0329	1(U)		SED	0–0.5	200
	16-1390	0316-95-0038	0.34(U)		SED	0–0.5	260
	16-1403	0316-95-0019	0.31(UJ)		SED	0–0.5	300
	16-2709	0316-97-0389	0.65(U)		SED	0.5–1	350
	16-2710	0316-97-0388	0.89(J)		SED	0.5–1	350
	16-1392	0316-95-0040	0.38(U)		SED	0–0.5	380
	16-1404	0316-95-0022	0.39(UJ)		SED	0–0.2	400
	16-1394	0316-95-0042	0.32(U)		SED	0–0.5	500
	16-1407	0316-95-0023	0.32(UJ)		SED	0–0.5	500
	16-1395	0316-95-0043	0.32(U)		SED	0–0.5	560
	16-2726	0316-97-0333	0.33(U)		SED	0–0.5	600
	16-1408	0316-95-0026	0.42(UJ)		SED	0–0.5	600
Silver	16-1387	0316-95-0035	1.1(J)	1	SED	0–0.5	160
	16-1389	0316-95-0037	1.6(J)		SED	0–0.5	200
	16-1390	0316-95-0038	4.1		SED	0–0.5	260
	16-1391	0316-95-0039	1.3		SED	0–0.5	320
	16-1404	0316-95-0022	1.2(J)		SED	0–0.2	400
Thallium	16-2713	0316-97-0328	1(U)	0.73	SED	0–0.5	200
	16-2716	0316-97-0330	1(U)		SED	2–2.8	200
	16-2718	0316-97-0331	1(U)		SED	2–2.8	200
	16-2718	0316-97-2021	1(U)		SED	2–2.75	200
	16-2717	0316-97-0329	1.1(U)		SED	0–0.5	200
Uranium	16-1397	0316-95-0013	2.39	2.22	SED	0–0.5	0
	16-1396	0316-95-0014	2.51		SED	0–0.5	0
	16-1379	0316-95-2015	3.66		SED	1–1.5	0
	16-1379	0316-95-0044	4.08		SED	1–1.5	0
	16-1380	0316-95-0028	3.17		SED	0–0.5	20
	16-1381	0316-95-0029	2.2		SED	0–0.5	40
	16-1382	0316-95-0045	2.53		SED	1.5–1.9	60
	16-1382	0316-95-0030	3.25		SED	0–0.5	60
	16-1382	0316-95-2012	4.3		SED	0–0.5	60
	16-1383	0316-95-0046	4.21		SED	1.7–2.2	80
	16-1383	0316-95-2013	4.32		SED	0–0.5	80
	16-1383	0316-95-0031	5.77		SED	0–0.5	80

Table 2.4-3 (continued)

Analyte	Location	Sample ID	Sample Concentration (mg/kg)	BV (mg/kg)	Media	Depth (ft)	Approximate Distance from Outfall (ft)
Uranium (continued)	16-1384	0316-95-0032	3.11	2.22	SED	0–0.5	100
	16-1385	0316-95-0033	5.07		SED	0–0.5	120
	16-1386	0316-95-0034	6.98		SED	0–0.5	140
	16-1387	0316-95-0035	6.39		SED	0–0.5	160
	16-1388	0316-95-0036	6.43		SED	0–0.5	180
	16-1389	0316-95-0037	8.71		SED	0–0.5	200
	16-1390	0316-95-0038	4.84		SED	0–0.5	260
	16-1391	0316-95-0039	2.94		SED	0–0.5	320
	16-1392	0316-95-0040	6.69		SED	0–0.5	380
	16-1404	0316-95-0022	3.58		SED	0–0.2	400
	16-1393	0316-95-0041	2.58		SED	0–0.5	440
	16-1406	0316-95-0024	2.92		SED	0–0.5	500
	16-1407	0316-95-0023	3.62		SED	0–0.5	500
	16-1394	0316-95-0042	4.08		SED	0–0.5	500
	16-1395	0316-95-0043	2.73		SED	0–0.5	560
	16-1409	0316-95-0025	2.48		SED	0–0.5	600
	16-1408	0316-95-0026	3.18		SED	0–0.5	600
Vanadium	16-1396	0316-95-0014	22.2	19.7	SED	0–0.5	0
	16-1379	0316-95-0027	26.7		SED	0–0.5	0
	16-1379	0316-95-2015	29.1		SED	1–1.5	0
	16-1397	0316-95-0013	29.2		SED	0–0.5	0
	16-1379	0316-95-0044	31.7		SED	1–1.5	0
	16-1380	0316-95-0028	55.7		SED	0–0.5	20
	16-1382	0316-95-0030	24.3		SED	0–0.5	60
	16-1382	0316-95-0045	27.3		SED	1.5–1.9	60
	16-1382	0316-95-2012	28.2		SED	0–0.5	60
	16-1383	0316-95-0046	30.5		SED	1.7–2.2	80
	16-1383	0316-95-2013	32		SED	0–0.5	80
	16-1383	0316-95-0031	33.7		SED	0–0.5	80
	16-1398	0316-95-0016	23.1		SED	0–0.5	100
	16-1384	0316-95-0032	28.5		SED	0–0.5	100
	16-1385	0316-95-0033	40.1		SED	0–0.5	120
	16-1386	0316-95-0034	24.8		SED	0–0.5	140
	16-1387	0316-95-0035	48.8		SED	0–0.5	160
	16-1388	0316-95-0036	42.5		SED	0–0.5	180
	16-1389	0316-95-0037	40.7		SED	0–0.5	200
	16-1390	0316-95-0038	48		SED	0–0.5	260
	16-1402	0316-95-0020	25.3		SED	0–0.5	300
	16-1391	0316-95-0039	42		SED	0–0.5	320

Table 2.4-3 (concluded)

Analyte	Location	Sample ID	Sample Concentration (mg/kg)	BV (mg/kg)	Media	Depth (ft)	Approximate Distance from Outfall (ft)
Vanadium (continued)	16-2710	0316-97-0388	53	19.7	SED	0.5–1	350
	16-1392	0316-95-0040	37		SED	0–0.5	380
	16-1404	0316-95-0022	22.8		SED	0–0.2	400
	16-1393	0316-95-0041	21.8		SED	0–0.5	440
	16-1394	0316-95-0042	29.9		SED	0–0.5	500
	16-1395	0316-95-0043	25.8		SED	0–0.5	560
	16-1408	0316-95-0026	21.2		SED	0–0.5	600
Zinc	16-1380	0316-95-0028	226	60.2	SED	0–0.5	20
	16-1381	0316-95-0029	86.1(J+)		SED	0–0.5	40
	16-1382	0316-95-2012	100(J+)		SED	0–0.5	60
	16-1382	0316-95-0030	104(J+)		SED	0–0.5	60
	16-1383	0316-95-2013	112(J+)		SED	0–0.5	80
	16-1383	0316-95-0031	116(J+)		SED	0–0.5	80
	16-1383	0316-95-0046	97.9		SED	1.7–2.2	80
	16-1384	0316-95-0032	85.2		SED	0–0.5	100
	16-1385	0316-95-0033	150(J+)		SED	0–0.5	120
	16-1386	0316-95-0034	76.8(J+)		SED	0–0.5	140
	16-1387	0316-95-0035	152(J+)		SED	0–0.5	160
	16-1388	0316-95-0036	151(J+)		SED	0–0.5	180
	16-1389	0316-95-0037	133(J+)		SED	0–0.5	200
	16-1390	0316-95-0038	139		SED	0–0.5	260
	16-1391	0316-95-0039	68.2		SED	0–0.5	320
	16-1392	0316-95-0040	76		SED	0–0.5	380
	16-1404	0316-95-0022	62.2		SED	0–0.2	400
	16-1394	0316-95-0042	62.6		SED	0–0.5	500

[a] U = The analyte was analyzed for, but not detected above the reported estimated quantitation limit or sample detection limit.

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

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

[d] J = The reported value is an estimated quantity.

[e] UJ = The analyte was analyzed for, but not detected. The associated value is an estimate.

Data qualifier flags are defined in the glossary in Appendix A.

Table 2.4-4 summarizes the evidence for a release of those inorganic chemicals appearing in Table 2.4-3, and identifies those that are carried forward as COPCs to Sections 5 and 6. Appendix D presents statistical analyses and plots to support the elimination of several inorganic chemicals observed above the sediment BV from the list of COPCs. Statistical evaluation is not possible for cyanide, which was not detected in any sample. However, some of the reported DLs at PRS 16-021(c) exceed the BV, so cyanide is retained for further assessment.

Most of the remaining analytes retained in Table 2.4-4 are (1) observed above the BV in several samples, (2) have distributions that are significantly different from the background distribution, and (3) exhibit both downgradient and lateral trends, as discussed further in Section 2.4.4. Two exceptions are manganese and arsenic, for which the elevated results were not found in the center of the drainage, and which may not represent releases from the TA-16-260 outfall.

Figure 2.4-1 identifies the locations of some of the detected above-background results for retained inorganic chemicals. Barium was found to be above background in almost every sample; it is not shown in this figure. A trend plot for barium is presented in Section 2.4.4 below. Six other metals—cobalt, copper, lead, nickel, vanadium, and zinc—had similar distributions (see Appendix D), so Figure 2.4-1 merely identifies the number of these metals, if any, that were above background.

2.4.3.1.2 Evaluation of HE

Complete analytical data for HE analyses of source area samples are provided in Table I-2.0-2 of Appendix I. The validation results for these data are summarized in Appendix C, Tables C-5.0-1 and C-5.0-2. Overall, the quality of the HE data for the 46 surface and near-surface samples in the drainage is satisfactory. In many samples, high levels of HMX, RDX, and/or TNT masked other HE that could have been present as well, but conclusions about the nature and extent of the release of HE at the TA-16-260 outfall can be made despite this problem. The majority of the analytes in the HE analytical suite were positively detected or estimated in at least six samples. The exceptions were the nitrotoluenes, for which estimated values were reported in only a couple of samples, and tetryl, which was not detected in any sample.

Tetryl data were rejected for four of the five Phase II samples collected along the transect 200 ft below the outfall. The remaining results for these samples (most of which were nondetects) were qualified as UJ-. This qualification restricts the ability to say definitively that contamination has been bounded along this transect. However, no HE were detected in the three outermost samples from this transect (0316-97-0330, 0316-97-0331, and collocated sample 0316-97-2021).

Screening data are available for the Phase II sampling locations only. Twenty screening samples were collected along the two Phase II transects and near the top of BHs 16-2709 and 16-2710. Eight of these 20 were paired with laboratory samples. The laboratory samples along the transects were chosen because the field tests were negative. HMX, RDX, and amino-2,6-dinitrotoluene[4-] were reported at less than 0.5 mg/kg in sample 0316-97-0333 (from the south end of the 600-ft transect). Neither RDX nor TNT were reported in the samples from the 200-ft transect, but HMX was present at 6.7 and 50 mg/kg in surface bounding samples 0316-97-0328 and 0316-97-0329, respectively; the latter sample also contained 2.3 mg/kg of amino-2,6-dinitrotoluene[4-]. The subsurface bounding samples from this transect, which were collected another 5 ft further away from the main axis of the drainage, were clean, as mentioned in the previous paragraph.

Table 2.4-4
Results of Inorganic Data Review for Surface and Near-Surface Drainage Samples

Analyte	Media	Result	Rationale for Retaining or Eliminating as a COPC
Aluminum	SED[a]	Eliminated	Statistically indistinguishable from background. The two results above the sediment BV occur near the outfall and are well within the soil background range.
Antimony	SED	Retained	Not detected in any sample, but Phase I DLs exceed the BV.
Arsenic	SED	Retained	Several samples above the sediment BV.
Barium	SED	Retained	Consistently above background, in concentrations up to 3 wt %.
Beryllium	SED	Eliminated	Statistically indistinguishable from background. The two highest results occur near the outfall and are well within the soil background range.
Cadmium	SED	Retained	Several samples above the BV.
Calcium	SED	Eliminated	Statistically indistinguishable from background.
Chromium, total	SED	Retained	Several samples above the sediment BV.
Cobalt	SED	Retained	Several samples above the sediment BV.
Copper	SED	Retained	Several samples above the sediment BV.
Cyanide, total	SED	Retained	Not detected in any sample, but most DLs in these data exceed the DL reported in the background data set.
Iron	SED	Eliminated	Statistically indistinguishable from background. The highest results occur near the outfall and are well within the soil background range. Spatial distribution of above-BVs does not suggest release from outfall; see Appendix D.
Lead	SED	Retained	Exceeds the sediment BV in half the samples.
Magnesium	SED	Eliminated	Statistically indistinguishable from background. The one result above the sediment BV occurs near the outfall and is well within the soil background range.
Manganese	SED	Retained	Several samples above the sediment BV.
Mercury	SED	Eliminated	No results reported above the sediment background detection limit.
Nickel	SED	Retained	Several samples above the sediment BV.
Selenium	SED	Retained	One detected value above the sediment BV. Most DLs exceed the sediment BV.
Silver	SED	Retained	Several samples above the sediment background detection limit as well as some reported as estimated below the background DL.
Thallium	SED	Eliminated	Detected values are below the sediment BV. Higher DLs are comparable to higher DLs found in some samples from the background data set.
Uranium	SED	Retained	Several samples above the sediment BV.
Vanadium	SED	Retained	Several samples above the sediment BV.
Zinc	SED	Retained	Several samples above the sediment BV.

[a] SED = Sediment.

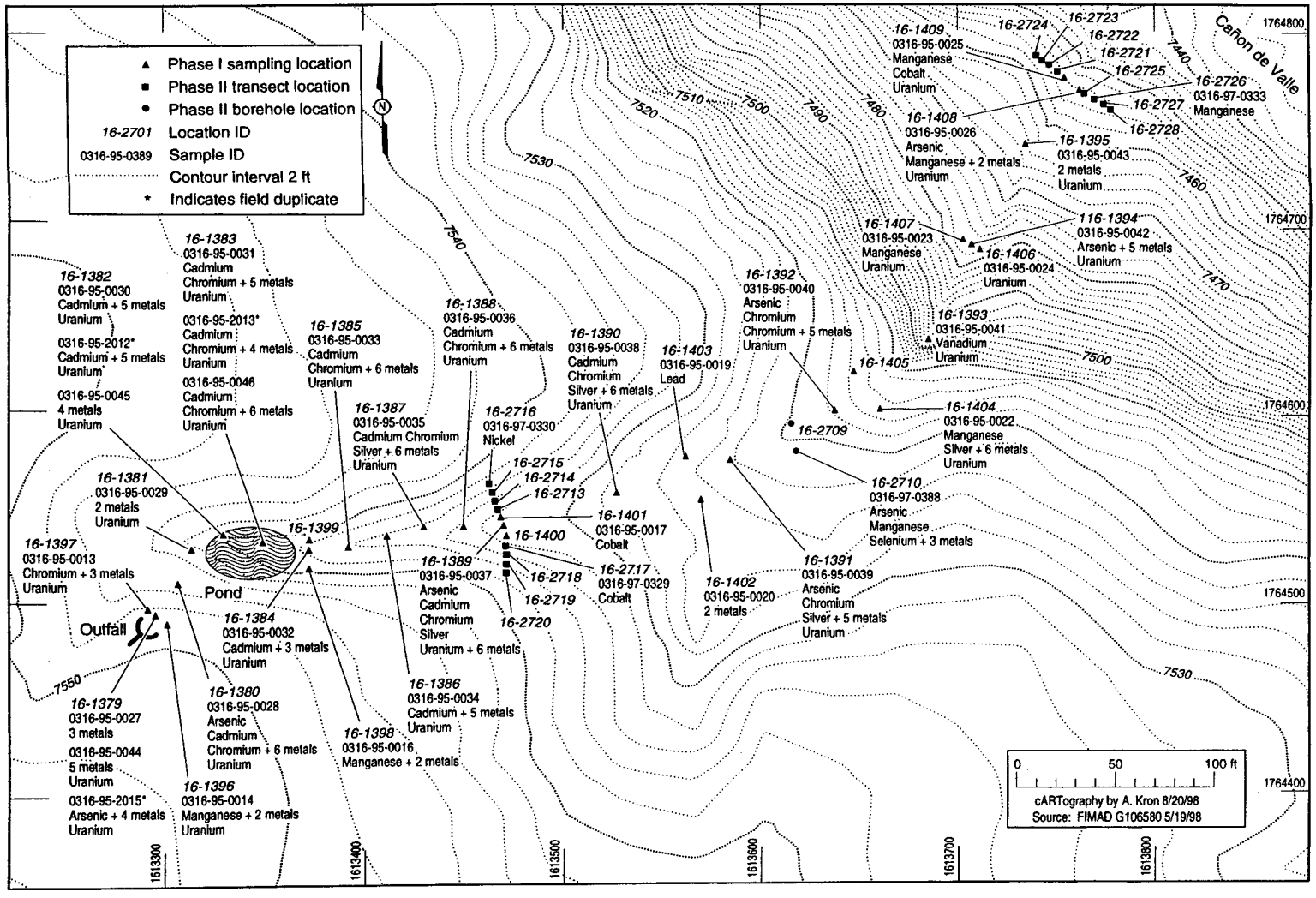


Figure 2.4-1. Inorganic chemicals with concentrations exceeding sediment BVs in surface and near-surface drainage samples. NOTE: (1) barium was above its sediment BV in almost every sample and is not shown on this plot; (2) plot indicates number of six highly correlated metals—cobalt, copper, lead, nickel, vanadium, and zinc—appearing in each sample; (3) any contaminant not detected (i.e., bearing a U qualifier in Table 2.4-3), or eliminated in Table 2.4-4, does not appear in this figure.

Field-screening results for the near-surface samples in the drainage BHs 16-2709 and 16-2710 were reported above the upper quantitative limit of the field kits. The corresponding laboratory results for RDX, TNT, and all other HE analytes, except HMX, were nondetects with very high DLs due to large amounts of HMX in the samples.

Table 2.4-5 summarizes the frequency of detected HE chemicals. All results above the DLs are shown in Table 2.4-6. Because most samples contained HE, they are best presented graphically in the trend plots of Section 2.4.4 rather than in a figure in the format of Figure 2.4-1.

Table 2.4-7 summarizes the evidence for a release of the HE chemicals that appear in Table 2.4-6. All are carried forward as COPCs to Sections 5 and 6.

Table 2.4-5

Frequency of Detected HE Chemicals in Surface and Near-Surface Drainage Samples

Analyte	Media	Number of Analyses	Contract-Required EQL (mg/kg)	Range of Concentrations (mg/kg)	Frequency of Detects[a]
Amino-2,6-dinitrotoluene[4-]	SED[b]	46	ND[c]	[0.085–250][d]	20/46
Amino-4,6-dinitrotoluene[2-]	SED	41	0.26	[0.077–250]	28/41
Dinitrobenzene[1,3-]	SED	46	0.25	[0.068–250]	2/46
Dinitrotoluene[2,4-]	SED	46	0.25	[0.057–250]	20/46
Dinitrotoluene[2,6-]	SED	46	0.26	[0.08–260]	2/46
HMX	SED	46	2.2	[0.162]–137 000	42/46
Nitrobenzene	SED	46	0.26	[0.09–260]	2/46
Nitrotoluene[3-]	SED	41	0.25	[0.154–250]	1/41
Nitrotoluene[4-]	SED	41	0.25	[0.162–250]	1/41
RDX	SED	46	1	[0.162]–118 000	33/46
Trinitrobenzene[1,3,5-]	SED	46	0.25	[0.081–250]	8/46
Trinitrotoluene[2,4,6-]	SED	46	0.25	[0.085]–10 2000	26/46

[a] Value is the ratio of the number of detected values to the number of analyses.
[b] SED = Sediment.
[c] ND = No CRQL available.
[d] Brackets indicate the value is below detection limits, although some analytes may be detected at values within this range. The extremely high detection limits correspond to samples highly contaminated with HMX and RDX.

Table 2.4-6
Detected HE Chemicals in Surface and Near-Surface Drainage Samples

Analyte	Location ID	Sample ID	Sample Concentration (mg/kg)	Media	Depth (ft)	Approximate Distance from Outfall (ft)
Amino-2,6-dinitrotoluene[4-]	16-1379	0316-95-0027	6.85	SED[a]	0–0.5	0
	16-1381	0316-95-0029	5.31	SED	0–0.5	40
	16-1382	0316-95-0030	3.11(J)[b]	SED	0–0.5	60
	16-1383	0316-95-0031	22.8	SED	0–0.5	80
	16-1387	0316-95-0035	3.51	SED	0–0.5	160
	16-2717	0316-97-0329	2.3(J-)[c]	SED	0–0.5	200
	16-1401	0316-95-0017	20.1	SED	0–0.5	200
	16-1400	0316-95-0018	21.6	SED	0–0.5	200
	16-1390	0316-95-0038	34.7	SED	0–0.5	260
	16-1403	0316-95-0019	1.63	SED	0–0.5	300
	16-1391	0316-95-0039	10.1	SED	0–0.5	320
	16-1392	0316-95-0040	60.8	SED	0–0.5	380
	16-1393	0316-95-0041	10.5	SED	0–0.5	440
	16-1394	0316-95-0042	33	SED	0–0.5	500
	16-1395	0316-95-0043	27.3	SED	0–0.5	560
	16-2726	0316-97-0333	0.169	SED	0–0.5	600
	16-1409	0316-95-0025	1.69	SED	0–0.5	600
	16-1408	0316-95-0026	64.1	SED	0–0.5	600
Amino-4,6-dinitrotoluene[2-]	16-1397	0316-95-0013	0.288	SED	0–0.5	0
	16-1379	0316-95-0027	6.55	SED	0–0.5	0
	16-1380	0316-95-0028	5.26	SED	0–0.5	20
	16-1382	0316-95-0030	14	SED	0–0.5	60
	16-1382	0316-95-2012	17.2	SED	0–0.5	60
	16-1383	0316-95-0031	40.2	SED	0–0.5	80
	16-1398	0316-95-0016	0.265	SED	0–0.5	100
	16-1399	0316-95-0015	0.274	SED	0–0.5	100
	16-1384	0316-95-0032	41.4	SED	0–0.5	100
	16-1385	0316-95-0033	28	SED	0–0.5	120
	16-1386	0316-95-0034	27.8	SED	0–0.5	140
	16-1387	0316-95-0035	25.6	SED	0–0.5	160
	16-1388	0316-95-0036	59.6	SED	0–0.5	180
	16-1401	0316-95-0017	25.4	SED	0–0.5	200
	16-1389	0316-95-0037	35.9	SED	0–0.5	200
	16-1400	0316-95-0018	42.2	SED	0–0.5	200
	16-1390	0316-95-0038	38.3	SED	0–0.5	260
	16-1403	0316-95-0019	2.82	SED	0–0.5	300
	16-1391	0316-95-0039	11.5	SED	0–0.5	320

Table 2.4-6 (continued)

Analyte	Location ID	Sample ID	Sample Concentration (mg/kg)	Media	Depth (ft)	Approximate Distance from Outfall (ft)
Amino-4,6-dinitrotoluene[2-] (continued)	16-1392	0316-95-0040	64.4	SED	0–0.5	380
	16-1404	0316-95-0022	27.7	SED	0–0.2	400
	16-1405	0316-95-0021	6.38	SED	0–0.5	400
	16-1393	0316-95-0041	13.2	SED	0–0.5	440
	16-1394	0316-95-0042	38.2	SED	0–0.5	500
	16-1395	0316-95-0043	33.1	SED	0–0.5	560
	16-2726	0316-97-0333	0.406	SED	0–0.5	600
	16-1409	0316-95-0025	2.8	SED	0–0.5	600
	16-1408	0316-95-0026	82.7	SED	0–0.5	600
Dinitrobenzene[1,3-]	16-1382	0316-95-0045	2.04(J-)	SED	1.5–1.9	60
	16-1383	0316-95-2013	29(J)	SED	0–0.5	80
Dinitrotoluene[2,4-]	16-1379	0316-95-0027	0.122	SED	0–0.5	0
	16-1379	0316-95-0044	10.5(J-)	SED	1–1.5	0
	16-1380	0316-95-0028	0.917	SED	0–0.5	20
	16-1381	0316-95-0029	0.239	SED	0–0.5	40
	16-1382	0316-95-0045	46.1(J-)	SED	1.5–1.9	60
	16-1383	0316-95-0046	24.2(J-)	SED	1.7–2.2	80
	16-1384	0316-95-0032	2.54	SED	0–0.5	100
	16-1401	0316-95-0017	0.446	SED	0–0.5	200
	16-1400	0316-95-0018	1.2	SED	0–0.5	200
	16-1390	0316-95-0038	1.45	SED	0–0.5	260
	16-1403	0316-95-0019	0.305	SED	0–0.5	300
	16-1391	0316-95-0039	0.308	SED	0–0.5	320
	16-1392	0316-95-0040	0.88	SED	0–0.5	380
	16-1405	0316-95-0021	0.407	SED	0–0.5	400
	16-1404	0316-95-0022	3.99	SED	0–0.2	400
	16-1393	0316-95-0041	1.13	SED	0–0.5	440
	16-1394	0316-95-0042	0.916	SED	0–0.5	500
	16-1395	0316-95-0043	0.877	SED	0–0.5	560
	16-1409	0316-95-0025	0.144	SED	0–0.5	600
	16-1408	0316-95-0026	0.761	SED	0–0.5	600
Dinitrotoluene[2,6-]	16-1391	0316-95-0039	0.144	SED	0–0.5	320
	16-1394	0316-95-0042	0.537	SED	0–0.5	500
HMX	16-1396	0316-95-0014	0.822	SED	0–0.5	0
	16-1379	0316-95-0027	1360	SED	0–0.5	0
	16-1397	0316-95-0013	22.4	SED	0–0.5	0
	16-1379	0316-95-2015	3310(J-)	SED	1–1.5	0

Table 2.4-6 (continued)

Analyte	Location ID	Sample ID	Sample Concentration (mg/kg)	Media	Depth (ft)	Approximate Distance from Outfall (ft)
HMX (continued)	16-1379	0316-95-0044	5240(J-)	SED	1–1.5	0
	16-1380	0316-95-0028	4860	SED	0–0.5	20
	16-1381	0316-95-0029	10 600	SED	0–0.5	40
	16-1382	0316-95-0045	24 600(J-)	SED	1.5–1.9	60
	16-1382	0316-95-0030	34 800	SED	0–0.5	60
	16-1382	0316-95-2012	43 100	SED	0–0.5	60
	16-1383	0316-95-2013	102 000	SED	0–0.5	80
	16-1383	0316-95-0031	124 000	SED	0–0.5	80
	16-1383	0316-95-0046	70 900(J-)	SED	1.7–2.2	80
	16-1398	0316-95-0016	16.5	SED	0–0.5	100
	16-1384	0316-95-0032	32 900	SED	0–0.5	100
	16-1399	0316-95-0015	6.26	SED	0–0.5	100
	16-1385	0316-95-0033	77 200	SED	0–0.5	120
	16-1386	0316-95-0034	81 300	SED	0–0.5	140
	16-1387	0316-95-0035	33 700	SED	0–0.5	160
	16-1388	0316-95-0036	137 000	SED	0–0.5	180
	16-1400	0316-95-0018	172	SED	0–0.5	200
	16-1401	0316-95-0017	2590	SED	0–0.5	200
	16-2717	0316-97-0329	50(J-)	SED	0–0.5	200
	16-1389	0316-95-0037	54 000	SED	0–0.5	200
	16-2713	0316-97-0328	6.7(J-)	SED	0–0.5	200
	16-1390	0316-95-0038	54 700	SED	0–0.5	260
	16-1403	0316-95-0019	38.3	SED	0–0.5	300
	16-1402	0316-95-0020	4.02	SED	0–0.5	300
	16-1391	0316-95-0039	2750	SED	0–0.5	320
	16-2709	0316-97-0389	12 000	SED	0.5–1	350
	16-2710	0316-97-0388	15 000	SED	0.5–1	350
	16-1392	0316-95-0040	23 000	SED	0–0.5	380
	16-1405	0316-95-0021	1.89	SED	0–0.5	400
	16-1404	0316-95-0022	367	SED	0–0.2	400
	16-1393	0316-95-0041	5200	SED	0–0.5	440
	16-1406	0316-95-0024	0.404	SED	0–0.5	500
	16-1407	0316-95-0023	0.969	SED	0–0.5	500
	16-1394	0316-95-0042	20 300	SED	0–0.5	500
	16-1395	0316-95-0043	12 500	SED	0–0.5	560
	16-2726	0316-97-0333	0.322	SED	0–0.5	600
	16-1409	0316-95-0025	108	SED	0–0.5	600
	16-1408	0316-95-0026	378	SED	0–0.5	600

Table 2.4-6 (continued)

Analyte	Location ID	Sample ID	Sample Concentration (mg/kg)	Media	Depth(ft)	Approximate Distance from Outfall (ft)
Nitrobenzene	16-1401	0316-95-0017	0.091	SED	0–0.5	200
	16-1404	0316-95-0022	1.2	SED	0–0.2	400
Nitrotoluene[3-]	16-1400	0316-95-0018	2.12	SED	0–0.5	200
Nitrotoluene[4-]	16-1389	0316-95-0037	6.66(J)	SED	0–0.5	200
RDX	16-1397	0316-95-0013	1.38	SED	0–0.5	0
	16-1379	0316-95-2015	41 000(J-)	SED	1–1.5	0
	16-1379	0316-95-0044	61 500(J-)	SED	1–1.5	0
	16-1379	0316-95-0027	898	SED	0–0.5	0
	16-1380	0316-95-0028	6830	SED	0–0.5	20
	16-1382	0316-95-0045	118 000(J-)	SED	1.5–1.9	60
	16-1382	0316-95-0030	12 400	SED	0–0.5	60
	16-1382	0316-95-2012	18 800	SED	0–0.5	60
	16-1383	0316-95-0046	116 000(J-)	SED	1.7–2.2	80
	16-1383	0316-95-0031	21 100	SED	0–0.5	80
	16-1383	0316-95-2013	23 500	SED	0–0.5	80
	16-1399	0316-95-0015	0.541	SED	0–0.5	100
	16-1384	0316-95-0032	29 600	SED	0–0.5	100
	16-1398	0316-95-0016	4.18	SED	0–0.5	100
	16-1385	0316-95-0033	14 500	SED	0–0.5	120
	16-1386	0316-95-0034	10 200	SED	0–0.5	140
	16-1387	0316-95-0035	15 500	SED	0–0.5	160
	16-1388	0316-95-0036	9060	SED	0–0.5	180
	16-1400	0316-95-0018	26.6	SED	0–0.5	200
	16-1389	0316-95-0037	5290	SED	0–0.5	200
	16-1401	0316-95-0017	94.6	SED	0–0.5	200
	16-1390	0316-95-0038	3500	SED	0–0.5	260
	16-1403	0316-95-0019	4.83	SED	0–0.5	300
	16-1391	0316-95-0039	1220	SED	0–0.5	320
	16-1392	0316-95-0040	137	SED	0–0.5	380
	16-1405	0316-95-0021	0.348	SED	0–0.5	400
	16-1404	0316-95-0022	2.44	SED	0–0.2	400
	16-1393	0316-95-0041	452	SED	0–0.5	440
	16-1394	0316-95-0042	611	SED	0–0.5	500
	16-1395	0316-95-0043	302	SED	0–0.5	560
	16-2726	0316-97-0333	0.456	SED	0–0.5	600
	16-1409	0316-95-0025	1.21	SED	0–0.5	600
	16-1408	0316-95-0026	74.8	SED	0–0.5	600
Trinitrobenzene[1,3,5-]	16-1379	0316-95-0044	1.66(J-)	SED	1–1.5	0
	16-1380	0316-95-0028	0.488	SED	0–0.5	20

Table 2.4-6 (concluded))

Analyte	Location ID	Sample ID	Sample Concentration (mg/kg)	Media	Depth (ft)	Approximate Distance from Outfall (ft)
Trinitrobenzene[1,3,5-] (continued)	16-1382	0316-95-0045	3.99(J-)	SED	1.5–1.9	60
	16-1383	0316-95-0046	4.68(J-)	SED	1.7–2.2	80
	16-1401	0316-95-0017	0.199	SED	0–0.5	200
	16-1391	0316-95-0039	0.276	SED	0–0.5	320
	16-1394	0316-95-0042	0.735	SED	0–0.5	500
	16-1408	0316-95-0026	0.129	SED	0–0.5	600
Trinitrotoluene[2,4,6-]	16-1379	0316-95-2015	17 700(J-)	SED	1–1.5	0
	16-1379	0316-95-0027	22.8	SED	0–0.5	0
	16-1379	0316-95-0044	31 900(J-)	SED	1–1.5	0
	16-1380	0316-95-0028	1760	SED	0–0.5	20
	16-1381	0316-95-0029	15.1	SED	0–0.5	40
	16-1382	0316-95-0045	102 000(J-)	SED	1.5–1.9	60
	16-1382	0316-95-0030	185	SED	0–0.5	60
	16-1382	0316-95-2012	255	SED	0–0.5	60
	16-1383	0316-95-0031	325	SED	0–0.5	80
	16-1383	0316-95-2013	370	SED	0–0.5	80
	16-1383	0316-95-0046	57 300(J-)	SED	1.7–2.2	80
	16-1384	0316-95-0032	4570	SED	0–0.5	100
	16-1385	0316-95-0033	422	SED	0–0.5	120
	16-1386	0316-95-0034	311	SED	0–0.5	140
	16-1387	0316-95-0035	240	SED	0–0.5	160
	16-1388	0316-95-0036	402	SED	0–0.5	180
	16-1389	0316-95-0037	181	SED	0–0.5	200
	16-1401	0316-95-0017	32.5	SED	0–0.5	200
	16-1400	0316-95-0018	5.45	SED	0–0.5	200
	16-1390	0316-95-0038	106	SED	0–0.5	260
	16-1391	0316-95-0039	19.8	SED	0–0.5	320
	16-1392	0316-95-0040	95.2	SED	0–0.5	380
	16-1393	0316-95-0041	19.9	SED	0–0.5	440
	16-1394	0316-95-0042	44.3	SED	0–0.5	500
	16-1395	0316-95-0043	14.3	SED	0–0.5	560
	16-1408	0316-95-0026	16.8	SED	0–0.5	600

[a] SED = Sediment.
[b] J = The reported value is an estimated quantity.
[c] J- = The analyte was positively identified, and the result is likely biased low.
Data qualifier flags are defined in the glossary in Appendix A.

Table 2.4-7
Results of HE Chemicals Data Review for Surface and Near-Surface Drainage Samples

Analyte	Media	Result	Rationale for Retaining as a COPC
Amino-2,6-dinitrotoluene[4-]	Soil	Retained	Detected in almost half the samples, at levels up to 65 mg/kg.
Amino-4,6-dinitrotoluene[2-]	Soil	Retained	Detected in more than half the samples, at levels up to 83 mg/kg.
Dinitrobenzene[1,3-]	Soil	Retained	Detected in only two samples, but at levels up to 29 mg/kg.
Dinitrotoluene[2,4-]	Soil	Retained	Detected in almost half the samples, at levels up to 46 mg/kg.
Dinitrotoluene[2,6-]	Soil	Retained	Detected in two samples, at less than 1 mg/kg.
HMX	Soil	Retained	Detected in almost all samples, at levels up to 13.7 wt %.
Nitrobenzene	Soil	Retained	Detected in two samples, at less than 2 mg/kg.
Nitrotoluene[3-]	Soil	Retained	Detected in one sample, at 2.1 mg/kg.
Nitrotoluene[4-]	Soil	Retained	Detected in one sample, at 6.7 mg/kg.
RDX	Soil	Retained	Detected in 75% of the samples, at levels up to 11.8 wt %.
Trinitrobenzene [1,3,5-]	Soil	Retained	Detected in several samples, at less than 5 mg/kg.
Trinitrotoluene[2,4,6-]	Soil	Retained	Detected in more than half the samples, at levels up to 10.2 wt %.

2.4.3.1.3 Evaluation of VOCs and SVOCs

Complete analytical data for volatile and semivolatile organic chemical analyses of source area samples are provided in Tables I-2.0-3 and I-2.0-4 of Appendix I. Validation results for these data are summarized in Appendix C, Tables C-5.0-1 and C-5.0-2. Overall, the quality of the other organic chemical data for the 46 surface and near-surface samples in the drainage is satisfactory.

High DLs affected SVOC analyses for the four subsurface samples included in Phase I (all submitted in request 1173). In two of these samples, bis(2-ethylhexyl)phthalate and anthracene were reported at levels above 100 mg/kg. Both of these analytes were detected in several other samples as well. The remaining drainage samples adequately represent SVOCs present in the surface and near-surface soils in the drainage.

Table 2.4-8 summarizes the frequency of detected organic chemicals, excluding HE. All results above the DLs are shown in Table 2.4-9.

Table 2.4-10 summarizes the evidence for a release of those organic chemicals that appear in Table 2.4-9. All are carried forward as COPCs to Sections 5 and 6 for assessment. Figure 2.4-2 identifies the locations of detected results for the major organic chemicals. Locations where dinitrotoluene, an HE chemical included in the SVOC analytical suite, was detected are not identified in Figure 2.4-2.

Table 2.4-8

Frequency of Detected Organic Chemicals, Excluding HE, in Surface and Near-Surface Drainage Samples

Analyte	Media	Number of Analyses	Contract-Required EQL (mg/kg)	Range of Concentrations (mg/kg)	Frequency of Detects[a]
Volatiles					
Acetone	SED[b]	13	0.02	[0.011][c]–0.067	4/13
Benzene	SED	13	0.005	0.002–[0.008]	1/13
Butylbenzene[sec-]	SED	13	0.005	[0.0056]–0.04	1/13
Dichlorobenzene[1,2-]	SED	13	0.005	[0.0056]–0.01	1/13
Isopropyltoluene[4-]	SED	13	0.005	[0.0056]–0.14	3/13
Toluene	SED	13	0.005	0.002–[0.008]	1/13
Trichloroethane[1,1,1-]	SED	13	0.005	[0.0056]–0.065	1/13
Trimethylbenzene[1,2,4-]	SED	13	0.005	[0.0056]–0.08	2/13
Semivolatiles					
Anthracene	SED	46	0.33	[0.33]–540	9/46
Benzoic Acid	SED	46	0.33	0.07–[1300]	6/46
Bis(2-ethylhexyl)phthalate	SED	46	0.33	0.16–4600	20/46
Dichlorobenzene[1,2-]	SED	46	0.33	[0.33–130]	1/46
Dinitrotoluene[2,4-]	SED	46	0.33	0.048–[130]	14/46
Dinitrotoluene[2,6-]	SED	46	0.33	0.053–[130]	6/46
Hexachlorocyclopentadiene	SED	46	0.33	[0.33–130]	1/46
Nitrosodiphenylamine[N-]	SED	46	0.33	0.057–[130]	1/46
Phenanthrene	SED	46	0.33	0.052–[130]	3/46
Pyrene	SED	46	0.33	0.071–[130]	1/46

[a] Value is the ratio of the number of detected values to the number of analyses.

[b] SED = Sediment.

[c] Brackets indicate the value is below detection limits, although some analytes may be detected at values within this range.

Table 2.4-9

Detected Organic Chemicals, Excluding HE, in Surface and Near-Surface Drainage Samples

Analyte	Location ID	Sample ID	Sample Concentration (mg/kg)	Media	Depth (ft)	Approximate Distance from Outfall (ft)
Volatiles						
Acetone	16-1379	0316-95-2015	0.014(J)[a]	SED[b]	1–1.5	0
	16-1379	0316-95-0044	0.067(J-)[c]	SED	1–1.5	0
	16-1383	0316-95-0046	0.044(J-)	SED	1.7–2.2	80
	16-2709	0316-97-0389	0.017(J)	SED	0.5–1	350

Table 2.4-9 (continued)

Analyte	Location ID	Sample ID	Sample Concentration (mg/kg)	Media	Depth (ft)	Approximate Distance from Outfall (ft)
Benzene	16-2713	0316-97-0328	0.002(J+)[d]	SED	0–0.5	200
Butylbenzene[sec-]	16-1382	0316-95-0045	0.04(J-)	SED	1.5–1.9	60
Dichlorobenzene[1,2-]	16-1383	0316-95-0046	0.01	SED	1.7–2.2	80
Isopropyltoluene[4-]	16-1379	0316-95-0044	0.015(J-)	SED	1–1.5	0
	16-1382	0316-95-0045	0.14(J-)	SED	1.5–1.9	60
	16-1383	0316-95-0046	0.008(J-)	SED	1.7–2.2	80
Toluene	16-2713	0316-97-0328	0.002(J+)	SED	0–0.5	200
Trichloroethane[1,1,1-]	16-1383	0316-95-0046	0.065(J-)	SED	1.7–2.2	80
Trimethylbenzene[1,2,4-]	16-1383	0316-95-0046	0.015(J-)	SED	1.7–2.2	80
	16-1382	0316-95-0045	0.08(J-)	SED	1.5–1.9	60
Semivolatiles						
Anthracene	16-1382	0316-95-2012	1.9(J)	SED	0–0.5	60
	16-1382	0316-95-0045	260	SED	1.5–1.9	60
	16-1383	0316-95-0031	3.3(J)	SED	0–0.5	80
	16-1383	0316-95-0046	540	SED	1.7–2.2	80
	16-1383	0316-95-2013	6.2(J)	SED	0–0.5	80
	16-1385	0316-95-0033	6.9(J)	SED	0–0.5	120
	16-1386	0316-95-0034	0.95(J)	SED	0–0.5	140
	16-1387	0316-95-0035	1(J)	SED	0–0.5	160
	16-1389	0316-95-0037	0.87(J)	SED	0–0.5	200
Benzoic Acid	16-1398	0316-95-0016	0.08(J)	SED	0–0.5	100
	16-1400	0316-95-0018	0.13(J)	SED	0–0.5	200
	16-1404	0316-95-0022	0.43(J)	SED	0–0.2	400
	16-1406	0316-95-0024	0.07(J)	SED	0–0.5	500
	16-1407	0316-95-0023	0.12(J)	SED	0–0.5	500
	16-1408	0316-95-0026	0.12(J)	SED	0–0.5	600
Bis(2-ethylhexyl)phthalate	16-1379	0316-95-0027	0.41(J)	SED	0–0.5	0
	16-1379	0316-95-0044	4600	SED	1–1.5	0
	16-1380	0316-95-0028	4(J)	SED	0–0.5	20
	16-1381	0316-95-0029	2.2	SED	0–0.5	40
	16-1382	0316-95-2012	26(J)	SED	0–0.5	60
	16-1383	0316-95-0046	150	SED	1.7–2.2	80
	16-1383	0316-95-0031	45(J)	SED	0–0.5	80
	16-1383	0316-95-2013	57(J)	SED	0–0.5	80
	16-1384	0316-95-0032	16	SED	0–0.5	100
	16-1385	0316-95-0033	52(J)	SED	0–0.5	120
	16-1389	0316-95-0037	12(J)	SED	0–0.5	200
	16-1390	0316-95-0038	4.8	SED	0–0.5	260
	16-1391	0316-95-0039	0.59(J)	SED	0–0.5	320

Table 2.4-9 (concluded)

Analyte	Location ID	Sample ID	Sample Concentration (mg/kg)	Media	Depth (ft)	Approximate Distance from Outfall (ft)
Bis(2-ethylhexyl)phthalate (continued)	16-2710	0316-97-0388	0.37(J)	SED	0.5–1	350
	16-2709	0316-97-0389	0.4(J)	SED	0.5–1	350
	16-1392	0316-95-0040	1.4	SED	0–0.5	380
	16-1393	0316-95-0041	0.77	SED	0–0.5	440
	16-1406	0316-95-0024	0.16(J)	SED	0–0.5	500
	16-1394	0316-95-0042	0.86	SED	0–0.5	500
	16-1395	0316-95-0043	0.45	SED	0–0.5	560
Dichlorobenzene[1,2-]	16-1386	0316-95-0034	9.2	SED	0–0.5	140
Dinitrotoluene[2,4-]	16-1379	0316-95-0027	0.048(J)	SED	0–0.5	0
	16-1384	0316-95-0032	0.61(J)	SED	0–0.5	100
	16-1401	0316-95-0017	0.1(J)	SED	0–0.5	200
	16-1400	0316-95-0018	0.31(J)	SED	0–0.5	200
	16-1389	0316-95-0037	0.79(J)	SED	0–0.5	200
	16-1390	0316-95-0038	0.79	SED	0–0.5	260
	16-1391	0316-95-0039	0.2(J)	SED	0–0.5	320
	16-1392	0316-95-0040	0.5	SED	0–0.5	380
	16-1405	0316-95-0021	0.5(J)	SED	0–0.5	400
	16-1404	0316-95-0022	2.6	SED	0–0.2	400
	16-1393	0316-95-0041	0.28(J)	SED	0–0.5	440
	16-1394	0316-95-0042	0.33(J)	SED	0–0.5	500
	16-1395	0316-95-0043	0.28(J)	SED	0–0.5	560
	16-1409	0316-95-0025	0.094(J)	SED	0–0.5	600
Dinitrotoluene[2,6-]	16-1390	0316-95-0038	0.34(J)	SED	0–0.5	260
	16-1392	0316-95-0040	0.2(J)	SED	0–0.5	380
	16-1393	0316-95-0041	0.089(J)	SED	0–0.5	440
	16-1394	0316-95-0042	0.1(J)	SED	0–0.5	500
	16-1395	0316-95-0043	0.053(J)	SED	0–0.5	560
	16-1408	0316-95-0026	0.084(J)	SED	0–0.5	600
Nitrosodiphenylamine[N-]	16-1390	0316-95-0038	0.057(J)	SED	0–0.5	260
Phenanthrene	16-1384	0316-95-0032	4.6	SED	0–0.5	100
	16-1390	0316-95-0038	0.23(J)	SED	0–0.5	260
	16-1393	0316-95-0041	0.052(J)	SED	0–0.5	440
Pyrene	16-1390	0316-95-0038	0.071(J)	SED	0–0.5	260

[a] J = The reported value is an estimated quantity.
[b] SED = Sediment.
[c] J- = The analyte was positively identified, and the result is likely biased low.
[d] J+ = The analyte was positively identified, and the result is likely biased high.
Data qualifier flags are defined in the glossary in Appendix A.

Table 2.4-10
Results of Organic Chemical Data Review for Surface and Near-Surface Drainage Samples

Analyte	Media	Result	Rationale for Retaining as a COPC
Volatiles			
Acetone	Soil	Retained	Reported in four samples, at less than 0.07 mg/kg.
Benzene	Soil	Retained	Reported in one sample, at 0.002 mg/kg.
Butylbenzene[sec-]	Soil	Retained	Reported in one sample, at 0.04 mg/kg.
Dichlorobenzene[1,2-]	Soil	Retained	Reported in one sample, at 0.01 mg/kg.
Isopropyltoluene[4-]	Soil	Retained	Reported in three samples, at less than 0.2 mg/kg.
Toluene	Soil	Retained	Reported in one sample, at 0.002 mg/kg.
Trichloroethane[1,1,1-]	Soil	Retained	Reported in one sample, at 0.065 mg/kg.
Trimethylbenzene [1,2,4-]	Soil	Retained	Reported in two samples, at less than 0.1 mg/kg.
Semivolatiles			
Anthracene	Soil	Retained	Reported in several samples, at up to 540 mg/kg.
Benzoic Acid	Soil	Retained	Reported in several samples, at less than 0.5 mg/kg.
Bis(2-ethylhexyl)phthalate	Soil	Retained	Reported in almost half the samples, at up to 4600 mg/kg.
Dichlorobenzene[1,2-]	Soil	Retained	Reported in one sample, at 9.2 mg/kg.
Dinitrotoluene[2,4-]	Soil	Retained	Reported in several samples (an HE).
Dinitrotoluene[2,6-]	Soil	Retained	Reported in several samples (an HE).
Hexachlorocyclopentadiene	Soil	Retained	Reported in one sample, at 9.6 mg/kg.
Nitrosodiphenylamine [N-]	Soil	Retained	Reported in one sample, at 0.06 mg/kg.
Phenanthrene	Soil	Retained	Reported in several samples, at up to 4.6 mg/kg.
Pyrene	Soil	Retained	Reported in one sample, at 0.07 mg/kg.

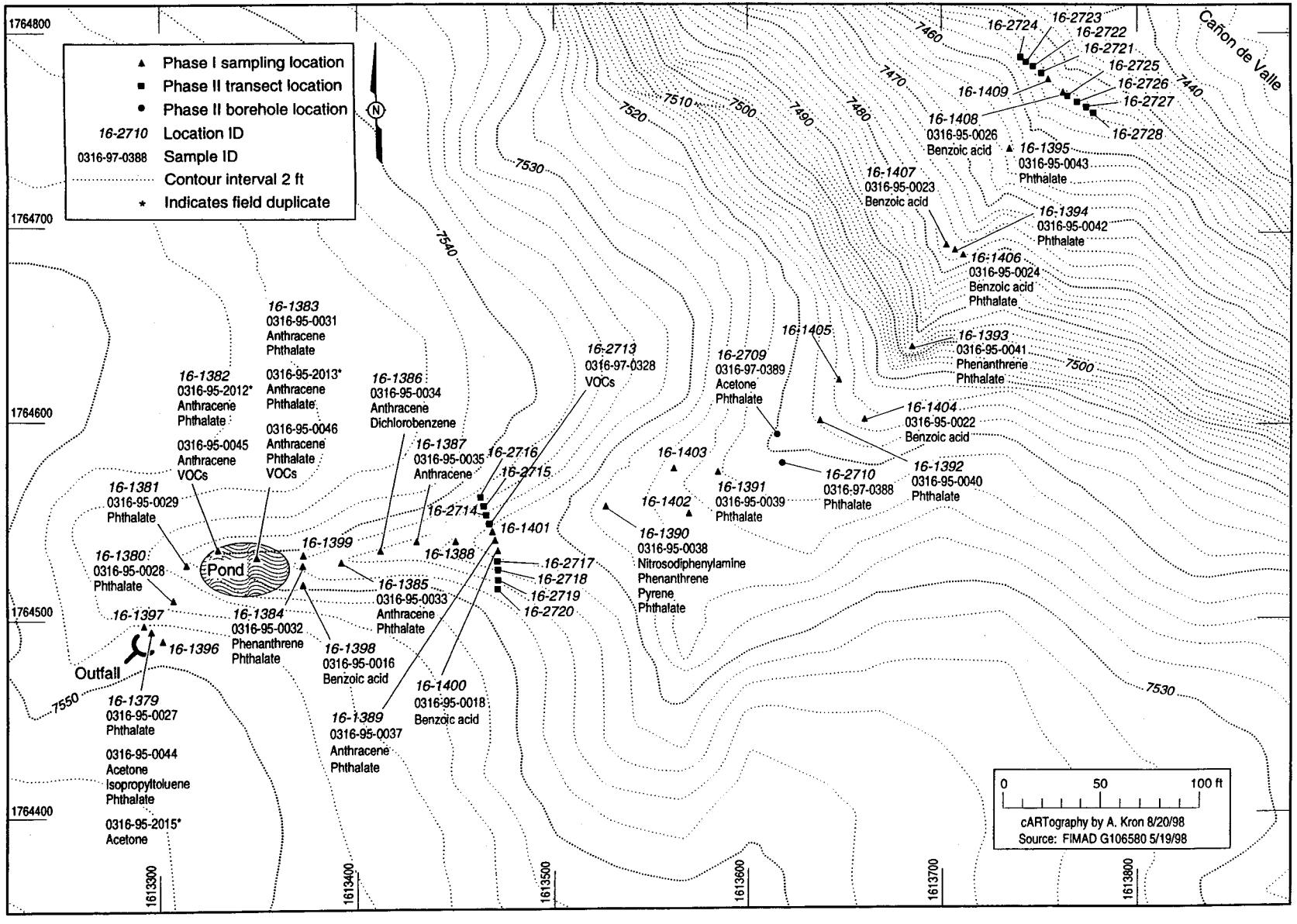


Figure 2.4-2. Detected organic chemicals in surface and near-surface drainage samples

2.4.3.2 BH Data

2.4.3.2.1 Inorganic Chemical Comparison with Background

Complete analytical data for inorganic chemical analyses of source area samples are provided in Table I-2.0-5 of Appendix I. Validation results for these data are summarized in Appendix C, Tables C-5.0-1 and C-5.0-2. Overall, the data quality for the 47 BH samples that are discussed in this section is satisfactory.

The most significant gap in the BH data arises from the rejection of nondetected results for antimony and mercury in the two samples collected at the bottom of BH 16-2706, which was drilled in the drainage about 210 ft below the outfall. Barium, copper, and lead were found in the upper of these two samples at levels slightly above background. While antimony was not detected in any BH sample, mercury was reported slightly above DL at a comparable depth in a nearby hole (16-2707).

Other rejected data include nondetected total cyanide results from BH 16-2707 (outside of the drainage south of the pond), chromium reported within the background ranges in some samples from 16-2701 and 16-2704 (both of which are outside the drainage), and a manganese result, also reported within the background range, from 16-2709 at the east end of the drainage. These results are scattered throughout the domain. In some samples, being investigated, and their unavailability does not materially affect conclusions based on this data set. DLs were above BVs for antimony, selenium, silver, and total cyanide.

The combined background soil data (i.e., data from A, B, and C soil horizons) were used for background comparisons for the five soil samples. Soil samples in this data set came from outside the TA-16-260 outfall drainage in areas where the soil is relatively thick and well developed, in contrast to the drainage sediments discussed in Section 2.4.3.1. The combined background data from Bandelier Tuff units Qbt_4, Qbt_3, and Qbt_2 were used for background comparisons for the remaining samples. The tuff samples in this data set came from Bandelier Tuff units Qbt_3, Qbt_4, and Qbt_5 (Qbt_5 is not represented in the background data set).

Table 2.4-11 summarizes the frequency of (1) detected inorganic chemicals and (2) nondetected chemicals with DLs exceeding BVs based on the background soil data or background tuff data, respectively. Results above the BVs, including nondetected results at DLs above background, are shown in Table 2.4-12. The water/slurry sample from the surge bed between Qbt_4 and Qbt_5 was collected from BH 16-2700 (from which the water was evaporated prior to analysis). It is compared to the tuff background and included with the other tuff samples in Table 2.4-11. However, it is explicitly identified by the word surge in the media column of Table 2.4-12 because the results reported represent the sum of the contaminants dissolved in the water and the contaminants present in the solids. Thus, they are not strictly comparable to results from other tuff samples.

Table 2.4-13 summarizes the evidence for a release of those inorganic chemicals that appear in Table 2.4-12 and identifies those that are carried forward as COPCs to Sections 5 and 6. Statistical analysis and plots to support the elimination of analytes with one or two results above background are presented in Appendix D. Statistical evaluation is not possible for antimony, cyanide, selenium, or silver, none of which were detected in any sample. However, some of the reported DLs exceed the BVs, so these four chemicals are retained for further assessment. Most of the remaining analytes in Table 2.4-13 were observed above the BV in several samples and have distributions that were significantly different from the background distribution. Figure 2.4-3 identifies the locations of detected above-background results for retained inorganic chemicals.

Table 2.4-11
Frequency of Detected Inorganic Chemicals in Phase II BHs

Analyte	Media	Number of Analyses	Number of Detects	Concentration Range (mg/kg)	BV (mg/kg)	Frequency of Detects Above BV[a]
Aluminum	Soil	5	4	3110–11000	29 200	0/5
	Surge	1	1	3510	7340	0/1
	Tuff	41	41	160–8900	7340	2/41
Antimony	Soil	5	0	[0.48–7.6][b]	0.83	DL > BV[c] (2/5)
	Surge	1	0	[0.62]	0.5	DL > BV (1/1)
	Tuff	41	0	[0.38–11]	0.5	DL > BV (32/39)
Arsenic	Soil	5	5	0.78–4.4	8.17	0/5
	Surge	1	1	2.3	2.79	0/1
	Tuff	41	35	[0.24]–8.2	2.79	3/41
Barium	Soil	5	5	59.3–329	295	1/5
	Surge	1	1	560	46	1/1
	Tuff	41	40	5.9–600	46	9/41
Beryllium	Soil	5	5	0,.46–1.5	1.83	0/5
	Surge	1	0	[0.52]	1.21	0/1
	Tuff	41	23	0.15–1.4	1.21	1/41
Cadmium	Soil	5	1	[0.04–0.42]	0.4	1/5
	Surge	1	1	0.27	1.63	0/1
	Tuff	41	2	[0.04]–0.69	1.63	0/41
Calcium	Soil	5	5	1250–2750	6120	0/5
	Surge	1	1	723	2200	0/1
	Tuff	41	41	307–1900	2200	0/41
Chromium, total	Soil	5	3	2.5–[7.9]	19.3	0/4
	Surge	1	1	5.7	7.14	0/1
	Tuff	41	19	0.32–9.5	7.14	1/39
Cobalt	Soil	5	5	2.2–6.8	8.64	0/5
	Surge	1	1	2.1	3.14	0/1
	Tuff	41	22	[0.13]–3.1	3.14	0/41
Copper	Soil	5	5	3.8–9.3	14.7	0/5
	Surge	1	1	5.1	4.66	1/1
	Tuff	41	35	0.31–29.6	4.66	2/41
Cyanide, total	Soil	5	0	[0.05–1.1]	0.5	3/5
	Surge	1	0	[0.35]	0.5	0/1
	Tuff	36	0	[0.05–1.4]	0.5	DL > BV (17/33)
Iron	Soil	5	5	4830–13 200	21 500	0/5
	Surge	1	1	6440	14 500	0/1
	Tuff	41	41	1050–9350	14 500	0/41

Table 2.4-11 (concluded)

Analyte	Media	Number of Analyses	Number of Detects	Concentration Range (mg/kg)	BV (mg/kg)	Frequency of Detects Above BV[a]
Lead	Soil	5	5	4.9–13.1	22.3	0/5
	Surge	1	1	6.6	11.2	0/1
	Tuff	41	41	0.55–33	11.2	2/41
Magnesium	Soil	5	5	553–2180	4610	0/5
	Surge	1	1	373	1690	0/1
	Tuff	41	38	[26]–1690	1690	0/41
Manganese	Soil	5	5	215–573	671	0/5
	Surge	1	1	184	482	0/1
	Tuff	41	40	56.3–340	482	0/40
Mercury	Soil	5	1	[0.024–0.06]	0.1	0/5
	Surge	1	0	[0.07]	0.1	0/1
	Tuff	41	4	[0.012]–0.11	0.1	1/39 (plus 3 DL > BV)
Nickel	Soil	5	5	5.2–9.6	15.4	0/5
	Surge	1	1	15.4	6.58	1/1
	Tuff	41	21	0.18–4.5	6.58	0/41
Potassium	Soil	5	4	328–1570	3460	0/5
	Surge	1	1	889	3500	0/1
	Tuff	41	37	69.1–931	3500	0/41
Selenium	Soil	5	1	[0.23–1.1]	1.52	0/5
	Surge	1	0	[0.84]	0.3	DL > BV (1/1)
	Tuff	41	0	[0.2–0.94]	0.3	DL > BV (24/41)
Silver	Soil	5	0	[0.096–0.42]	1	0/5
	Surge	1	0	[0.34]	1	0/1
	Tuff	41	0	[0.079–2.3]	1	DL > BV (7/41)
Sodium	Soil	5	4	[232]–419	915	0/5
	Surge	1	1	843	2770	0/1
	Tuff	41	39	41.4–671	2770	0/41
Thallium	Soil	5	2	[0.23–1.2]	0.73	1/5 (plus 2 DL > BV)
	Surge	1	0	[0.81]	1.1	0/1
	Tuff	41	4	0.079–1.4	1.1	1/41

[a] Value is the ratio of the number of detected values exceeding the BV to the number of analyses.

[b] Brackets indicate the value is below detection limits, although some analytes may be detected at values within this range.

[c] The detection limit for this analyte exceeded the background value.

Table 2.4-12
Inorganic Chemicals with Concentrations Exceeding Sediment BVs in Phase II BHs

Analyte	Location ID	Sample ID	Sample Concentration (mg/kg)	BV (mg/kg)	Media	Depth (ft)
Aluminum	16-2705	0316-96-0280	7720	7340	Qbt_5	4–5
	16-2707	0316-96-0292	8900		Qbt_5	7.5–8.5
Antimony	16-2701	0316-97-0256	4.2(U)[a]		Soil	3.5–4.5
	16-2702	0316-97-0262	7.6(UJ)[b]	0.83	Soil	3–4
	16-2700	0316-96-0252	0.62(U)	0.5	Surge	6.2–17.5
	16-2709	0316-97-0304	0.77(U)	0.5	Qbt_5	3.5–4.5
	16-2735	0316-97-0390	0.75(U)		Qbt_4	54–55
	16-2736	0316-97-0300	0.7(U)		Qbt_3	99–100
	16-2709	0316-97-0305	5.19(U)		Qbt_5	21.5–22.5
	16-2711	0316-97-0316	5.2(U)		Qbt_5	3.5–4.5
	16-2711	0316-97-0317	4.6(U)		Qbt_4	69–70
	16-2735	0316-97-0391	0.74(U)		Qbt_4	63–63.8
	16-2735	0316-97-0392	0.71(U)		Qbt_4	74.4–75.4
	16-2735	0316-97-0393	0.71(U)		Qbt_4	80.5–81.5
	16-2700	0316-96-0254	5.1(U)		Qbt_5	15.5–16.5
	16-2705	0316-96-0280	0.55(U)		Qbt_5	4–5
	16-2702	0316-97-0263	0.53(U)		Qbt_4	69–70
	16-2704	0316-97-0276	7.3(U)		Qbt_4	23–24
	16-2704	0316-97-0277	8.3(U)		Qbt_4	28–29
	16-2735	0316-97-0280	5.2(U)		Qbt_5	4–5
	16-2735	0316-97-0282	5.8(U)		Qbt_4	24.7–25.3
	16-2735	0316-97-0283	5.7(U)		Qbt_4	34–35
	16-2706	0316-97-0286	0.75(U)		Qbt_5	4–5
	16-2736	0316-97-0299	0.71(U)		Qbt3	104–105
	16-2710	0316-97-0311	6.2(U)		Qbt_4	38.5–39.5
	16-2710	0316-97-0312	6.2(U)		Qbt_4	35–36
	16-2712	0316-97-0323	8.1(U)		Qbt_4	89–90
	16-2712	0316-97-0324	8.3(U)		Qbt_4	83–83.8
	16-2706	0316-97-2020	0.76(U)		Qbt_5	4–5
	16-2707	0316-96-0296	10(UJ)		Qbt_4	39–40
	16-2712	0316-97-0322	11(UJ)		Qbt_5	4–5
	16-2705	0316-96-0281	11(UJ)		Qbt_5	12.5–13.5
	16-2701	0316-97-0257	0.6(UJ)		Qbt_4	74–75
	16-2704	0316-97-0275	0.62(UJ)		Qbt_4	69–70
	16-2710	0316-97-0310	0.77(UJ)		Qbt_5	4–5
	16-2707	0316-96-0292	11(UJ)		Qbt_5	7.5–8.5
	16-2707	0316-96-0293	10(UJ)		Qbt_5	24–25

Table 2.4-12 (continued)

Analyte	Location ID	Sample ID	Sample Concentration (mg/kg)	BV (mg/kg)	Media	Depth (ft)
Arsenic	16-2735	0316-97-0390	5.2	2.79	Qbt_4	54–55
	16-2735	0316-97-0391	8.2		Qbt_4	63–63.8
	16-2712	0316-97-0322	3.3		Qbt_5	4–5
Barium	16-2704	0316-97-0274	329	295	Soil	4–5
	16-2700	0316-96-0252	560	46	Surge	6.2–17.5
	16-2705	0316-96-0281	600(J)[c]	46	Qbt_5	12.5–13.5
	16-2705	0316-96-0280	234		Qbt_5	4–5
	16-2707	0316-96-0292	59		Qbt_5	7.5–8.5
	16-2709	0316-97-0304	171		Qbt_5	3.5–4.5
	16-2735	0316-97-0390	60.2		Qbt_4	54–55
	16-2700	0316-96-0254	335		Qbt_5	15.5–16.5
	16-2735	0316-97-0280	215		Qbt_5	4–5
	16-2706	0316-97-0289	52.7		Qbt_5	18–19
	16-2706	0316-97-2020	116		Qbt_5	4–5
Beryllium	16-2735	0316-97-0390	1.4	1.21	Qbt_4	54–55
Cadmium	16-2701	0316-97-0256	0.42(U)	0.4	Soil	3.5–4.5
Chromium, total	16-2705	0316-96-0281	9.5	7.14	Qbt_5	12.5–13.5
Copper	16-2700	0316-96-0252	5.1(J)	4.66	Surge	6.2–17.5
	16-2706	0316-97-0289	6.3(J)	4.66	Qbt_5	18–19
	16-2735	0316-97-0391	29.6		Qbt_4	63–63.8
Cyanide, total	16-2703	0316-97-0268	1.1(U)	0.5	Soil	3.5–4.5
	16-2708	0316-97-0298	0.5(U)		Soil	4–5
	16-2701	0316-97-0256	1.1(UJ)		Soil	3.5–4.5
	16-2703	0316-97-0269	1(U)	0.5	Qbt_4	69–70
	16-2703	0316-97-0270	0.98(U)		Qbt_4	53–54
	16-2706	0316-97-0288	0.51(U)		Qbt_4	74–75
	16-2700	0316-96-0254	0.62(U)		Qbt_5	15.5–16.5
	16-2705	0316-96-0281	0.57(U)		Qbt_5	12.5–13.5
	16-2702	0316-97-0263	1.1(U)		Qbt_4	69–70
	16-2702	0316-97-0264	1.1(U)		Qbt_4	29–30
	16-2735	0316-97-0280	1.1(U)		Qbt_5	4–5
	16-2735	0316-97-0282	1.2(U)		Qbt_4	24.7–25.3
	16-2735	0316-97-0283	1.3(U)		Qbt_4	34–35
	16-2706	0316-97-0287	0.53(U)		Qbt_4	79–80
	16-2709	0316-97-0305	1.17(U)		Qbt_5	21.5–22.5
	16-2710	0316-97-0311	1.4(U)		Qbt_4	38.5–39.5
	16-2710	0316-97-0312	1.4(U)		Qbt_4	35–36
	16-2712	0316-97-0322	0.54(U)		Qbt_5	4–5

Table 2.4-12 (continued)

Analyte	Location ID	Sample ID	Sample Concentration (mg/kg)	BV (mg/kg)	Media	Depth (ft)
Cyanide, total (continued)	16-2711	0316-97-0316	1.1(UJ)		Qbt_5	3.5–4.5
	16-2711	0316-97-0317	1.1(UJ)		Qbt_4	69–70
Lead	16-2706	0316-97-0287	18	11.2	Qbt_4	79–80
	16-2706	0316-97-0288	33		Qbt_4	74–75
Mercury	16-2707	0316-96-0292	0.11(U)	0.1	Qbt_5	7.5–8.5
	16-2712	0316-97-0322	0.11(U)		Qbt_5	4–5
	16-2705	0316-96-0281	0.11(UJ)		Qbt_5	12.5–13.5
	16-2707	0316-96-0294	0.11		Qbt_4	64–65
Nickel	16-2700	0316-96-0252	15.4	6.58	Surge	6.2–17.5
Selenium	16-2700	0316-96-0252	0.84(U)	0.3	Surge	6.2–17.5
	16-2736	0316-97-0300	0.56(U)	0.3	Qbt_3	99–100
	16-2709	0316-97-0304	0.61(U)		Qbt_5	3.5–4.5
	16-2710	0316-97-0310	0.61(U)		Qbt_5	4–5
	16-2735	0316-97-0390	0.59(U)		Qbt_4	54–55
	16-2735	0316-97-0391	0.58(U)		Qbt_4	63–63.8
	16-2735	0316-97-0392	0.57(U)		Qbt_4	74.4–75.4
	16-2735	0316-97-0393	0.56(U)		Qbt_4	80.5–81.5
	16-2700	0316-96-0250	0.43(U)		Qbt_5	7–8
	16-2700	0316-96-0254	0.31(U)		Qbt_5	15.5–16.5
	16-2705	0316-96-0280	0.75(U)		Qbt_5	4–5
	16-2707	0316-96-0294	0.4(U)		Qbt_4	64–65
	16-2707	0316-96-0295	0.41(U)		Qbt_4	68.5–69.5
	16-2701	0316-97-0257	0.9(U)		Qbt_4	74–75
	16-2702	0316-97-0263	0.32(U)		Qbt_4	69–70
	16-2704	0316-97-0275	0.94(U)		Qbt_4	69–70
	16-2704	0316-97-0276	0.45(U)		Qbt_4	23–24
	16-2704	0316-97-0277	0.51(U)		Qbt_4	28–29
	16-2706	0316-97-0286	0.6(U)		Qbt_5	4–5
	16-2706	0316-97-0287	0.43(U)		Qbt_4	79–80
	16-2706	0316-97-0288	0.41(U)		Qbt_4	74–75
	16-2706	0316-97-0289	0.72(U)		Qbt_5	18–19
	16-2736	0316-97-0299	0.56(U)		Qbt_3	104–105
	16-2712	0316-97-0322	0.54(U)		Qbt_5	4–5
	16-2706	0316-97-2020	0.6(U)		Qbt_5	4–5
Silver	16-2705	0316-96-0281	2.3(U)	1	Qbt_5	12.5–13.5
	16-2707	0316-96-0292	2.3(U)		Qbt_5	7.5–8.5
	16-2707	0316-96-0293	2(U)		Qbt_5	24–25
	16-2706	0316-97-0288	2(U)		Qbt_4	74–75
	16-2707	0316-96-0296	2(U)		Qbt_4	39–40

Table 2.4-12 (concluded)

Analyte	Location ID	Sample ID	Sample Concentration (mg/kg)	BV (mg/kg)	Media	Depth (ft)
Silver (continued)	16-2706	0316-97-0287	2.1(U)		Qbt_4	79–80
	16-2712	0316-97-0322	2.2(U)		Qbt_5	4–5
Thallium	16-2702	0316-97-0262	0.93(J)	0.73	Soil	3–4
	16-2704	0316-97-0274	1.2(U)		Soil	4–5
	16-2708	0316-97-0298	0.79(U)		Soil	4–5
	16-2706	0316-97-0286	1.4(J)	1.1	Qbt_5	4–5

[a] U = The analyte was analyzed for but not detected above the reported estimated quantitation limit or sample detection limit.

[b] UJ = The analyte was analyzed for but not detected; the associated value is an estimate.

[c] J = The reported value is an estimated quantity.

Data qualifier flags are defined in the glossary in Appendix A.

Table 2.4-13

Results of Inorganic Data Review for BH Soil and Tuff Samples Beneath and Outside the Drainage

Analyte	Media	Result	Rationale for Retaining or Eliminating as a COPC
Aluminum	Tuff	Eliminated	Statistically indistinguishable from background.
Antimony	Soil	Retained	Not detected in any sample, but Phase I DLs greatly exceed the BV.
	Tuff	Retained	Not detected in any sample, but Phase I DLs greatly exceed the BV.
Arsenic	Tuff	Retained	Three samples above the BV, and statistically greater than the background distribution. See Appendix D.
Barium	Soil	Eliminated	One sample slightly above the BV, but within the background range.
	Tuff	Retained	Several samples above the BV, up to ten times the BV.
Beryllium	Tuff	Eliminated	One sample slightly above the BV but within the background range.
Cadmium	Soil	Eliminated	Detected values within background range; one DL marginally above the BV.
Chromium, total	Tuff	Eliminated	One sample slightly above the BV but within the background range.
Copper	Tuff	Retained	Three samples above the BV; one at four times the background maximum.
Cyanide, total	Soil	Retained	Not detected in any sample, but most DLs in these data exceed the DL reported in the background data set.
	Tuff	Retained	Not detected in any sample, but most DLs in these data exceed the DL reported in the background data set.
Lead	Tuff	Retained	Two samples above background, at depth, in one BH.
Mercury	Tuff	Retained	One sample above the background DL at depth.
Nickel	Tuff	Retained	Above Qbt background only in the surge bed sample.
Selenium	Tuff	Retained	Not detected in any sample, but most DLs in these data exceed the DL reported in the background data set.
Silver	Tuff	Retained	Not detected in any sample, but several DLs in these data exceed the DL reported in the background data set.
Thallium	Soil	Eliminated	Detected values are below the BV. Higher DLs are comparable to higher DLs found in the background data set.
	Tuff	Eliminated	Above the BV in one sample, but within the background range.

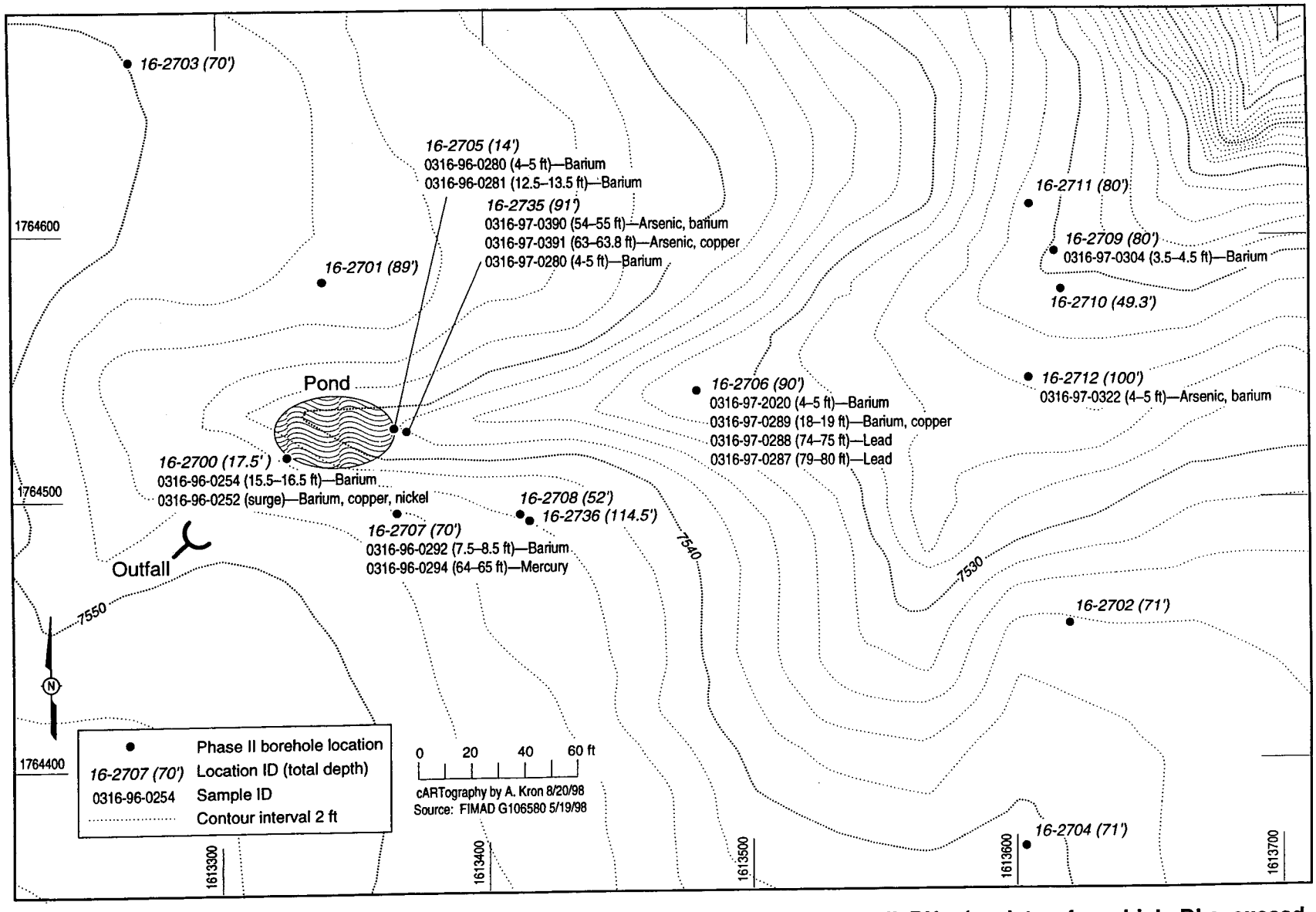


Figure 2.4-3. Inorganic chemicals with concentrations exceeding BVs in Phase II BHs (analytes for which DLs exceed BVs not shown)

2.4.3.2.2 Evaluation of HE

Complete analytical data for HE analyses of source area samples are provided in Table I-2.0-6 of Appendix I. Validation results for these data are summarized in Appendix C, Tables C-5.0-1 and C-5.0-2. Overall, the data quality for the 47 samples from the BHs that are discussed in this subsection is satisfactory.

HE results (nondetects) for the two samples from the bottom of BH 16-2712 were rejected. One of these two samples (0316-97-0324) had been biased by a positive DTech RDX result, which cannot be confirmed. Other rejected HE results are scattered and do not materially affect the quality of the data set as a whole.

Higher-than-usual DLs were reported for two collocated samples from a depth of 4–5 ft in BH 16-2706. HMX was reported in these samples at 29 and 47 mg/kg; RDX was undetected at 5 and 10 mg/kg (compared to a positive field-screening result of about 2 mg/kg); and other HE were undetected at 1.3–2.5 mg/kg. Otherwise DLs were satisfactory.

Screening data are available not only for most of the 47 samples submitted to the laboratory but also for an additional 141 samples from the BHs. These data are presented in Table 2.3-2, above, and are further discussed below in Section 2.4.4.

Table 2.4-14 summarizes the frequency of detected HE chemicals. All results above the DLs are shown in Table 2.4-15. Figure 2.4-4 identifies the locations of these detected results. No HE was detected in the five soil samples collected near the tops of BHs outside the drainage.

Table 2.4-16 summarizes the evidence for a release of the HE chemicals that appear in Table 2.4-15. All are carried forward as COPCs to Sections 5 and 6.

Table 2.4-14
Frequency of Detected HE Chemicals in Phase II BH Samples

Analyte	Media	Number of Analyses	EQL (mg/kg)	Concentration Range (mg/kg)	Frequency of Detects[a]
Amino-2,6-dinitrotoluene[4-]	Tuff	41	ND	[0.084][b]–3	2/39
Amino-4,6-dinitrotoluene[2-]	Tuff	35	0.26	[0.082–2.5]	4/35
Dinitrotoluene[2,4-]	Tuff	41	0.25	[0.054–2.5]	2/39
HMX	Surge	1	2.2	1700	1/1
	Tuff	41	2.2	[0.16]–315	14/39
Nitrotoluene[3-]	Tuff	36	0.25	[0.158–2.5]	1/36
RDX	Surge	1	1	4500	1/1
	Tuff	41	1	[0.16–10]	16/39
Trinitrobenzene[1,3,5-]	Surge	1	0.25	0.7	1/1
	Tuff	41	0.25	[0.08]–6.49	11/39
Trinitrotoluene[2,4,6-]	Surge	1	0.25	3500	1/1
	Tuff	41	0.25	[0.084]–424	7/39

[a] Value is the ratio of the number of detected values to the number of analyses.
[b] Brackets indicate the value is below detection limits, although some analytes may be detected at values within this range.

Table 2.4-15
Detected HE Chemicals in Phase II BHs

Analyte	Location ID	Sample ID	Sample Concentration (mg/kg)	Media	Depth (ft)
Amino-2,6-dinitrotoluene[4-]	16-2735	0316-97-0280	0.381	Qbt_5	4–5
	16-2705	0316-96-0280	3	Qbt_5	4–5
Amino-4,6-dinitrotoluene[2-]	16-2711	0316-97-0316	0.117	Qbt_5	3.5–4.5
	16-2735	0316-97-0280	0.515	Qbt_5	4–5
	16-2700	0316-96-0254	1.04(J+)[a]	Qbt_5	15.5–16.5
	16-2705	0316-96-0281	1.45	Qbt_5	12.5–13.5
Dinitrotoluene[2,4-]	16-2700	0316-96-0254	0.149(J+)	Qbt_5	15.5–16.5
	16-2705	0316-96-0281	0.225	Qbt_5	12.5–13.5
HMX	16-2710	0316-97-0311	0.224	Qbt_4	38.5–39.5
	16-2711	0316-97-0316	0.359	Qbt_5	3.5–4.5
	16-2700	0316-96-0250	1.15	Qbt_5	7–8
	16-2710	0316-97-0312	1.46	Qbt_4	35–36
	16-2709	0316-97-0305	1.69	Qbt_5	21.5–22.5
	16-2709	0316-97-0304	2.5	Qbt_5	3.5–4.5
	16-2705	0316-96-0280	3.1	Qbt_5	4–5
	16-2710	0316-97-0310	9.2	Qbt_5	4–5
	16-2706	0316-97-0289	14	Qbt_5	18–19
	16-2706	0316-97-2020	29	Qbt_5	4–5
	16-2735	0316-97-0280	32.8	Qbt_5	4–5
	16-2706	0316-97-0286	47	Qbt_5	4–5
	16-2705	0316-96-0281	278	Qbt_5	12.5–13.5
	16-2700	0316-96-0254	315(J+)	Qbt_5	15.5–16.5
	16-2700	0316-96-0252	1700	Surge	6.2–17.5
Nitrotoluene[3-]	16-2735	0316-97-0280	0.228	Qbt_5	4–5
RDX	16-2710	0316-97-0311	0.489	Qbt_4	38.5–39.5
	16-2735	0316-97-0283	0.508	Qbt_4	34–35
	16-2709	0316-97-0305	0.855	Qbt_5	21.5–22.5
	16-2735	0316-97-0282	0.897	Qbt_4	24.7–25.3
	16-2711	0316-97-0316	1.26	Qbt_5	3.5–4.5
	16-2709	0316-97-0304	1.3	Qbt_5	3.5–4.5
	16-2712	0316-97-0322	2	Qbt_5	4–5
	16-2707	0316-96-0294	2.4	Qbt_4	64–65
	16-2707	0316-96-0295	2.78	Qbt_4	68.5–69.5
	16-2710	0316-97-0312	3.51	Qbt_4	35–36
	16-2735	0316-97-0390	3.6	Qbt_4	54–55
	16-2700	0316-96-0250	4.83	Qbt_5	7–8
	16-2705	0316-96-0280	15	Qbt_5	4–5

Table 2.4-15 (concluded)

Analyte	Location ID	Sample ID	Sample Concentration (mg/kg)	Media	Depth (ft)
RDX (continued)	16-2735	0316-97-0280	16.8	Qbt_5	4–5
	16-2705	0316-96-0281	477	Qbt_5	12.5–13.5
	16-2700	0316-96-0254	908(J+)	Qbt_5	15.5–16.5
	16-2700	0316-96-0252	4500	Surge	6.2–17.5
Trinitrobenzene[1,3,5-]	16-2705	0316-96-0281	0.195	Qbt_5	12.5–13.5
	16-2709	0316-97-0305	0.197	Qbt_5	21.5–22.5
	16-2700	0316-96-0254	0.269(J+)	Qbt_5	15.5–16.5
	16-2735	0316-97-0283	0.498	Qbt_4	34–35
	16-2735	0316-97-0280	0.631	Qbt_5	4–5
	16-2710	0316-97-0311	0.815	Qbt_4	38.5–39.5
	16-2735	0316-97-0282	0.886	Qbt_4	24.7–25.3
	16-2705	0316-96-0280	1.6	Qbt_5	4–5
	16-2710	0316-97-0312	2.31	Qbt_4	35–36
	16-2707	0316-96-0295	3.04	Qbt_4	68.5–69.5
	16-2707	0316-96-0294	6.49	Qbt_4	64–65
	16-2700	0316-96-0252	0.7	Surge	6.2–17.5
Trinitrotoluene[2,4,6-]	16-2709	0316-97-0304	0.35	Qbt_5	3.5–4.5
	16-2709	0316-97-0305	0.364	Qbt_5	21.5–22.5
	16-2700	0316-96-0250	1.24	Qbt_5	7–8
	16-2735	0316-97-0280	4.14	Qbt_5	4–5
	16-2705	0316-96-0280	7.9	Qbt_5	4–5
	16-2705	0316-96-0281	143	Qbt_5	12.5–13.5
	16-2700	0316-96-0254	424(J+)	Qbt_5	15.5–16.5
	16-2700	0316-96-0252	3500	Surge	6.2–17.5

[a] J+ = The analyte was positively identified, and the result is likely biased high.
Data qualifier flags are defined in the glossary in Appendix A.

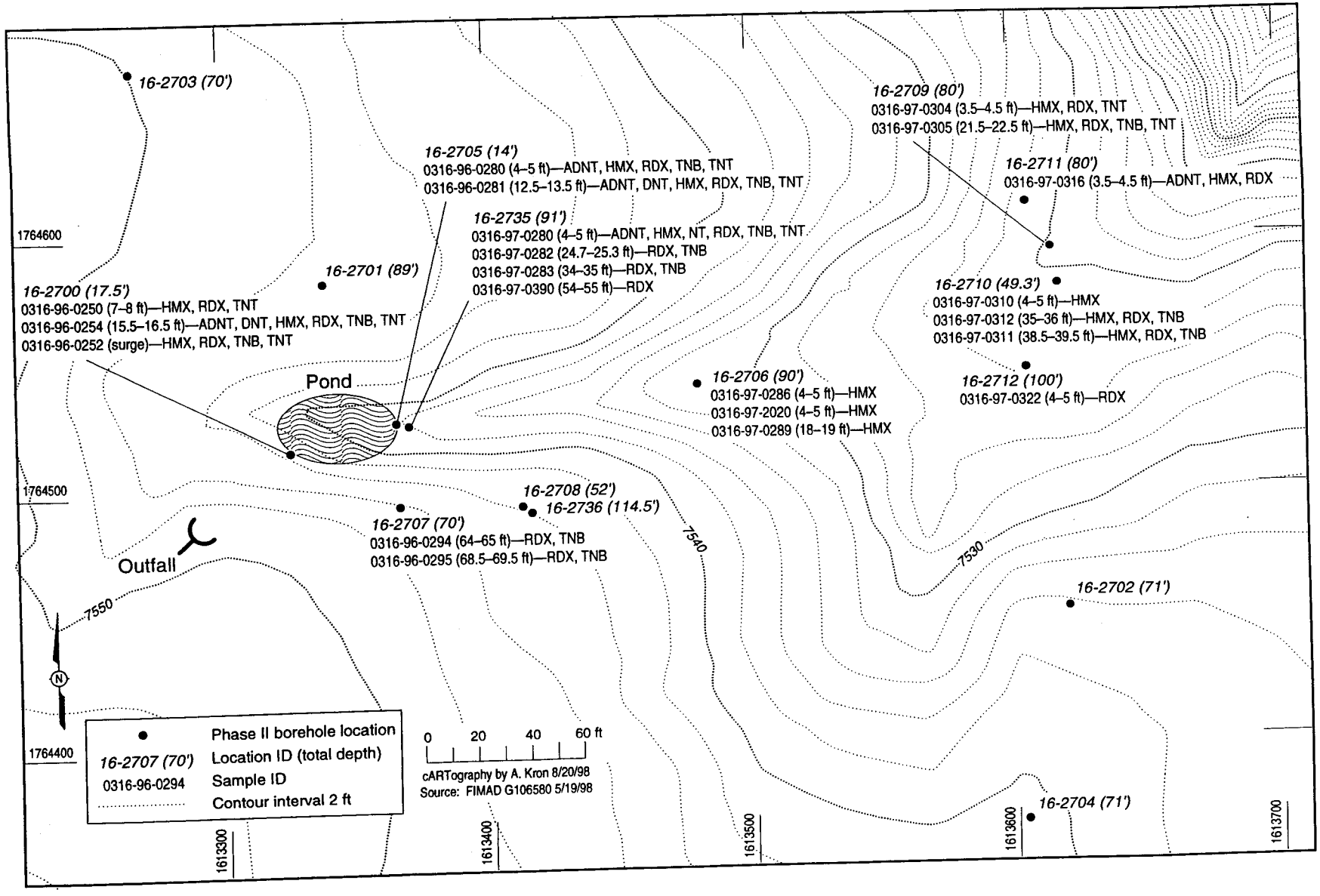


Figure 2.4-4. Detected HE chemicals in Phase II BH samples

Table 2.4-16
Results of HE Data Review for Surface and Near-Surface Samples from the Drainage

Analyte	Media	Result	Rationale for Retaining as a COPC
Amino-2,6-dinitrotoluene[4-]	Tuff	Retained	Detected only in two soil/tuff interface samples in the drainage, up to 3 mg/kg.
Amino-4,6-dinitrotoluene[2-]	Tuff	Retained	Detected in five samples to a depth of 16 ft, up to 1.45 mg/kg.
Dinitrotoluene[2,4-]	Tuff	Retained	Detected in two samples to a depth of 16 ft, up to 0.225 mg/kg.
HMX	Tuff	Retained	Detected in 12 Qbt_5 samples at up to 315 mg/kg; at 1700 mg/kg in the surge sample; and in two Qbt_4 samples, to a depth of 39 ft, at up to 1.46 mg/kg.
Nitrotoluene[3-]	Tuff	Retained	Detected only in one soil/tuff interface sample in the drainage at 0.228 mg/kg.
RDX	Tuff	Retained	Detected in 9 Qbt_5 samples at up to 908 mg/kg; at 4500 mg/kg in the surge sample; and in seven Qbt_4 samples, to a depth of 69 ft, at up to 3.6 mg/kg.
Trinitrobenzene[1,3,5-]	Tuff	Retained	Detected in 12 tuff samples at depths up to 69 ft, and in concentrations up to 6.5 mg/kg.
Trinitrotoluene[2,4,6-]	Tuff	Retained	Detected in seven Qbt_5 samples at up to 424 mg/kg, and at 3500 mg/kg in the surge sample.

2.4.3.2.3 Evaluation of Organic Chemicals

Complete analytical data for other organic chemical analyses of source area samples are provided in Tables I-2.0-7 and I-2-8 of Appendix I. Validation results for these data are summarized in Appendix C, Tables C-5.0-1 and C-5.0-2. Overall, the quality of the other organic chemical data for the 48 samples from the BHs that are discussed in this section is satisfactory.

Table 2.4-17 summarizes the frequency of detected organic chemicals, excluding HE. All results above the DLs are shown in Tables 2.4-18 (VOCs) and 2.4-19 (SVOCs). Figure 2.4-5 identifies the locations of detected results for the principal organic contaminants.

Table 2.4-20 summarizes the evidence for a release of those organic chemicals that appear in Tables 2.4-18 and 2.4-19. All are carried forward as COPCs to Sections 5 and 6 for assessment, although several are detected in only one sample.

2.4.4 Data Summary and Interpretation

This section provides additional graphical and summary information to place the results presented in Section 2.4.3 into context for the development of the site conceptual model in Section 5 and the recommendations in Section 7.

Table 2.4-17

Frequency of Detected Organic Chemicals, Excluding HE, in Phase II BH Samples

Analyte	Media	Number of Analyses	Contract-Required EQL (mg/kg)	Range of Concentrations (mg/kg)	Frequency of Detects[a]
Volatiles					
Acetone	Surge	1	0.02	0.1	1/1
	Tuff	42	0.02	0.003–0.43	14/42
Butanone[2-]	Tuff	42	0.02	0.0048–[0.028][b]	4/42
Chlorobenzene	Tuff	42	0.005	0.001–[0.007]	1/42
	Surge	1	0.01	0.02	1/1
Dibromo-3-chloropropane[1,2-]	Soil	5	0.01	0.0049–[0.014]	1/5
Dichlorobenzene[1,4-]	Tuff	42	0.005	0.002–[0.007]	1/42
Dichloroethane[1,2-]	Surge	1	0.01	0.004	1/1
Styrene	Tuff	42	0.005	[0.005]–0.008	1/42
Tetrachloroethene	Tuff	42	0.005	0.002–[0.007]	1/42
Toluene	Surge	1	0.005	0.003	1/1
	Tuff	42	0.005	0.001–[0.007]	1/42
Trichlorofluoromethane	Tuff	42	0.005	[0.005–0.012]	1/42
Trimethylbenzene[1,3,5-]	Surge	1	0.005	0.003	1/1
Semivolatiles					
Anthracene	Surge	1	0.33	4.3	1/1
	Tuff	41	0.33	[0.17]–2.8	2/41
Benzo(a)pyrene	Surge	1	0.33	0.075	1/1
Benzo(b)fluoranthene	Surge	1	0.33	0.064	1/1
Benzo(g,h,i)perylene	Surge	1	0.33	0.061	1/1
Benzo(k)fluoranthene	Surge	1	0.33	0.072	1/1
	Tuff	32	0.33	[0.17–0.45]	1/32
Bis(2-ethylhexyl)phthalate	Soil	5	0.33	0.073–0.57	3/5
	Surge	1	0.33	1.2	1/1
	Tuff	42	0.33	0.055–0.97	9/42
Butylbenzylphthalate	Tuff	41	0.33	0.04–[0.45]	4/41
Di-n-butylphthalate	Tuff	41	0.33	0.034–[0.45]	4/41
Dibenz(a,h)anthracene	Surge	1	0.33	0.079	1/1
Diethylphthalate	Soil	5	0.33	[0.35]–1.5	1/5
	Tuff	41	0.33	0.072–[0.45]	12/41
Dinitrotoluene[2,4-]	Surge	1	0.33	0.29	1/1
	Tuff	41	0.33	0.058–[0.45]	3/41
Dinitrotoluene[2,6-]	Surge	1	0.33	0.071	1/1
Indeno(1,2,3-cd)pyrene	Surge	1	0.33	0.08	1/1
Phenanthrene	Surge	1	0.33	0.057	1/1

[a] Value is the ratio of the number of detected values to the number of analyses.

[b] Brackets indicate the value is below detection limits, although some analytes may be detected at values within this range.

Table 2.4-18
Detected VOCs in Phase II BH Samples

Analyte	Location ID	Sample ID	Sample Concentration (mg/kg)	Media	Depth (ft)
Acetone	16-2700	0316-96-0252	0.1	Surge	6.2–17.5
	16-2735	0316-97-0283	0.003	Qbt_4	34–35
	16-2710	0316-97-0311	0.006	Qbt_4	38.5–39.5
	16-2710	0316-97-0312	0.01	Qbt_4	35–36
	16-2711	0316-97-0316	0.014	Qbt_5	3.5–4.5
	16-2707	0316-96-0293	0.022	Qbt_5	24–25
	16-2705	0316-96-0282	0.03(J-)[a]	Qbt_5	8.5–9.5
	16-2704	0316-97-0276	0.038	Qbt_4	23–24
	16-2709	0316-97-0305	0.055	Qbt_5	21.5–22.5
	16-2707	0316-96-0292	0.073	Qbt_5	7.5–8.5
	16-2702	0316-97-0263	0.11	Qbt_4	69–70
	16-2704	0316-97-0277	0.15	Qbt_4	28–29
	16-2707	0316-96-0296	0.16	Qbt_4	39–40
	16-2702	0316-97-0264	0.28	Qbt_4	29–30
	16-2735	0316-97-0390	0.43	Qbt_4	54–55
Butanone[2-]	16-2709	0316-97-0304	0.0048	Qbt_5	3.5–4.5
	16-2704	0316-97-0277	0.006	Qbt_4	28–29
	16-2704	0316-97-0276	0.007	Qbt_4	23–24
	16-2709	0316-97-0305	0.011	Qbt_5	21.5–22.5
Chlorobenzene	16-2704	0316-97-0276	0.001	Qbt_4	23–24
Chloromethane	16-2700	0316-96-0252	0.02(J)[b]	Surge	6.2–17.5
Dibromo-3-chloropropane[1,2-]	16-2708	0316-97-0298	0.0049	Soil	4–5
Dichlorobenzene[1,4-]	16-2704	0316-97-0276	0.002	Qbt_4	23–24
Dichloroethane[1,2-]	16-2700	0316-96-0252	0.004(J)	Surge	6.2–17.5
Styrene	16-2711	0316-97-0317	0.008	Qbt_4	69–70
Tetrachloroethene	16-2704	0316-97-0277	0.002	Qbt_4	28–29
Toluene	16-2700	0316-96-0252	0.003(J)	Surge	6.2–17.5
	16-2706	0316-97-0289	0.001	Qbt_5	18–19
Trichlorofluoromethane	16-2700	0316-96-0254	0.01	Qbt_5	15.5–16.5
Trimethylbenzene[1,3,5-]	16-2700	0316-96-0252	0.003(J)	Surge	6.2–17.5

[a] J- = The analyte was positively identified, and the result is likely biased low.
[b] J = The reported value is an estimated quantity.
Data qualifier flags are defined in the Glossary in Appendix A2.

Table 2.4-19
Detected SVOCs in Phase II BH Samples

Analyte	Location ID	Sample ID	Sample Concentration (mg/kg)	Media	Depth (ft)
Anthracene	16-2700	0316-96-0252	4.3	Surge	6.2–17.5
	16-2700	0316-96-0254	1.6	Qbt_5	15.5–16.5
	16-2705	0316-96-0281	2.8	Qbt_5	12.5–13.5
Benzo(a)pyrene	16-2700	0316-96-0252	0.075(J)[a]	Surge	6.2–17.5
Benzo(b)fluoranthene	16-2700	0316-96-0252	0.064(J)	Surge	6.2–17.5
Benzo(g,h,i)perylene	16-2700	0316-96-0252	0.061(J)	Surge	6.2–17.5
Benzo(k)fluoranthene	16-2700	0316-96-0252	0.072(J)	Surge	6.2–17.5
	16-2735	0316-97-0280	0.37	Qbt_5	4–5
Bis(2-ethylhexyl)phthalate	16-2704	0316-97-0274	0.073(J)	Soil	4–5
	16-2702	0316-97-0262	0.44	Soil	3–4
	16-2703	0316-97-0268	0.57	Soil	3.5–4.5
	16-2700	0316-96-0252	1.2	Surge	6.2–17.5
	16-2735	0316-97-0391	0.055(J)	Qbt_4	63–63.8
	16-2736	0316-97-0299	0.098(J)	Qbt_3	104–105
	16-2703	0316-97-0269	0.14	Qbt_4	69–70
	16-2710	0316-97-0311	0.26(J)	Qbt_4	38.5–39.5
	16-2735	0316-97-0280	0.27(J)	Qbt_5	4–5
	16-2704	0316-97-0276	0.42	Qbt_4	23–24
	16-2710	0316-97-0312	0.47	Qbt_4	35–36
	16-2704	0316-97-0277	0.48	Qbt_4	28–29
	16-2705	0316-96-0281	0.97	Qbt_5	12.5–13.5
Butylbenzylphthalate	16-2707	0316-96-0294	0.04(J)	Qbt_4	64–65
	16-2707	0316-96-0295	0.049(J)	Qbt_4	68.5–69.5
	16-2700	0316-96-0250	0.052(J)	Qbt_5	7–8
	16-2735	0316-97-0391	0.088(J)	Qbt_4	63–63.8
Di-n-butylphthalate	16-2712	0316-97-0324	0.034(J)	Qbt_4	83–83.8
	16-2707	0316-96-0295	0.038(J)	Qbt_4	68.5–69.5
	16-2735	0316-97-0392	0.043(J)	Qbt_4	74.4–75.4
	16-2735	0316-97-0391	0.17(J)	Qbt_4	63–63.8
Dibenz(a,h)anthracene	16-2700	0316-96-0252	0.079(J)	Surge	6.2–17.5

Table 2.4-19 (concluded)

Analyte	Location ID	Sample ID	Sample Concentration (mg/kg)[a]	Media	Depth (ft)
Diethylphthalate	16-2704	0316-97-0274	1.5	Soil	4–5
	16-2735	0316-97-0283	0.072(J)	Qbt_4	34–35
	16-2735	0316-97-0282	0.075(J)	Qbt_4	24.7–25.3
	16-2736	0316-97-0299	0.12(J)	Qbt_3	104–105
	16-2735	0316-97-0390	0.13(J)	Qbt_4	54–55
	16-2735	0316-97-0392	0.14(J)	Qbt_4	74.4–75.4
	16-2709	0316-97-0304	0.15(J)	Qbt_5	3.5–4.5
	16-2706	0316-97-0286	0.37(J)	Qbt_5	4–5
	16-2706	0316-97-2020	0.37(J)	Qbt_5	4–5
	16-2735	0316-97-0280	0.38	Qbt_5	4–5
	16-2702	0316-97-0263	0.43	Qbt_4	69–70
	16-2709	0316-97-0305	1.4	Qbt_5	21.5–22.5
	16-2736	0316-97-0300	1.7	Qbt_3	99–100
Dinitrotoluene[2,4-]	16-2700	0316-96-0252	0.29(J)	Surge	6.2–17.5
	16-2735	0316-97-0283	0.058(J)	Qbt_4	34–35
	16-2735	0316-97-0282	0.067(J)	Qbt_4	24.7–25.3
	16-2700	0316-96-0254	0.12(J)	Qbt_5	15.5–16.5
Dinitrotoluene[2,6-]	16-2700	0316-96-0252	0.071(J)	Surge	6.2–17.5
Indeno(1,2,3-cd)pyrene	16-2700	0316-96-0252	0.08(J)	Surge	6.2–17.5
Phenanthrene	16-2700	0316-96-0252	0.057(J)	Surge	6.2–17.5

[a] J = The reported value is an estimated quantity.
Data qualifier flags are defined in the Glossary in Appendix A.

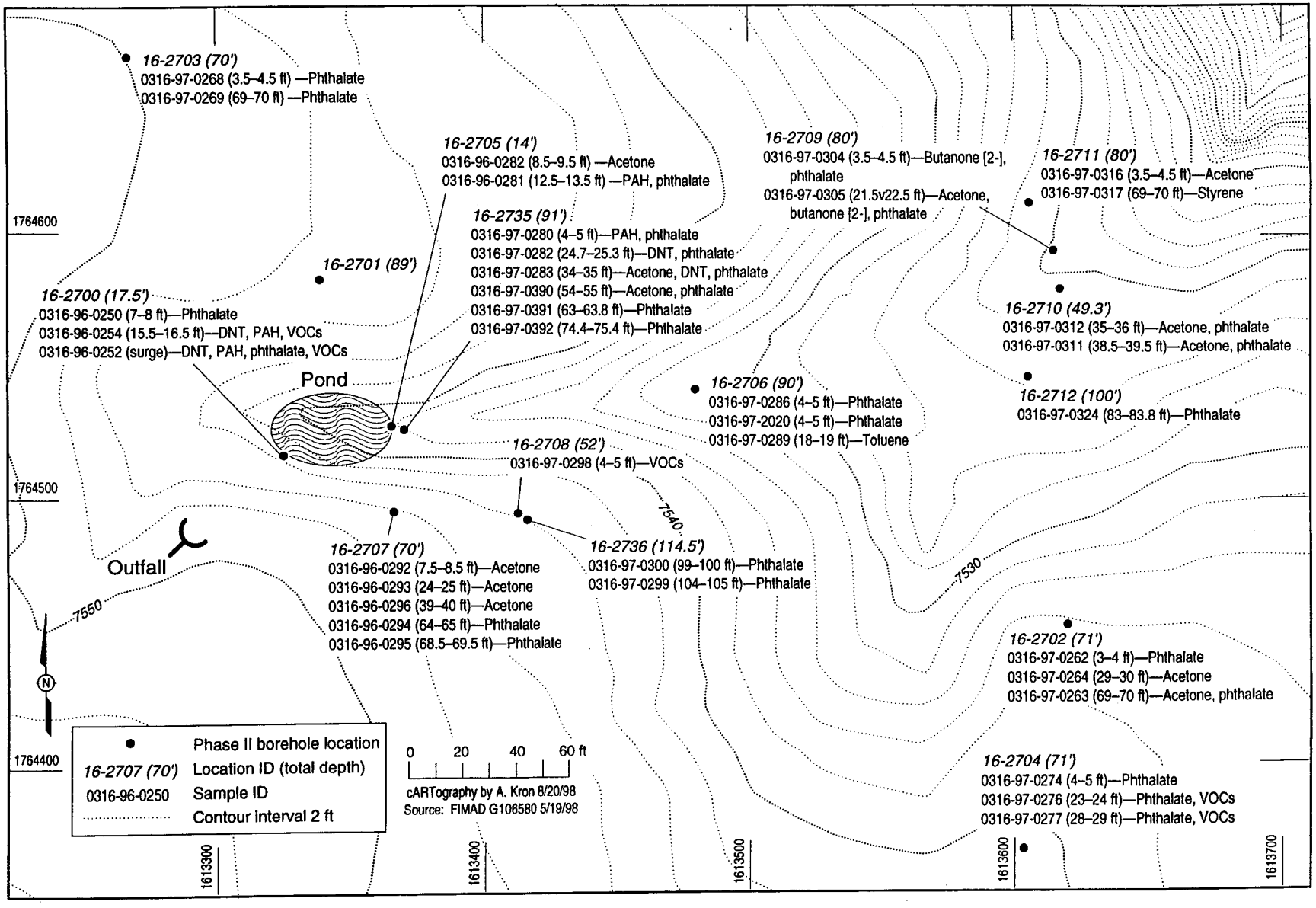


Figure 2.4-5. Detected VOCs and SVOCs in Phase II BH samples

Table 2.4-20
Results of Organic Chemical Data Review in Phase II BH Samples

Analyte	Media	Result	Rationale for Retaining as a COPC
Volatiles			
Acetone	Soil	Retained	Detected in one of the five soil samples at 0.041 mg/kg, but also detected in several tuff samples.
	Tuff	Retained	Detected in 15 tuff samples, including the surge sample, at depths up to 70 feet, and at concentrations up to 0.43 mg/kg.
Butanone[2-]	Tuff	Retained	Detected in four tuff samples at depths up to 29 feet, and at concentrations up to 0.011 mg/kg.
Chlorobenzene	Tuff	Retained	Detected in one tuff sample at 0.001 mg/kg.
Chloromethane	Tuff	Retained	Detected in the surge sample at 0.02 mg/kg.
Dibromo-3-chloropropane[1,2-]	Soil	Retained	Detected in one soil sample at 0.005 mg/kg.
Dichlorobenzene[1,4-]	Tuff	Retained	Detected in one tuff sample at 0.002 mg/kg.
Dichloroethane[1,2-]	Tuff	Retained	Detected in the surge sample at 0.004 mg/kg.
Styrene	Tuff	Retained	Detected in one tuff sample at 0.008 mg/kg.
Tetrachloroethene	Tuff	Retained	Detected in one tuff sample at 0.002 mg/kg.
Toluene	Tuff	Retained	Detected in two tuff samples, including the surge sample, at up to 0.003 mg/kg.
Trichlorofluoromethane	Tuff	Retained	Detected in one tuff sample at 0.01 mg/kg.
Trimethylbenzene[1,3,5-]	Tuff	Retained	Detected in the surge sample at 0.003 mg/kg
Semivolatiles			
Anthracene	Tuff	Retained	Detected in three Qbt_5 samples, including the surge sample, at up to 4.3 mg/kg.
Benzo(a)pyrene	Surge	Retained	One of a suite of payaromatic hydrocarbons (PAHs) detected in the surge sample.
Benzo(b)fluoranthene	Surge	Retained	One of a suite of PAHs detected in the surge sample.
Benzo(g,h,i)perylene	Surge	Retained	One of a suite of PAHs detected in the surge sample.
Benzo(k)fluoranthene	Tuff	Retained	One of a suite of PAHs detected in the surge sample, and also in one soil/tuff interface sample in the drainage.
Bis(2-ethylhexyl)phthalate	Soil	Retained	Detected in three soil samples at up to 0.57 mg/kg.
	Tuff	Retained	Detected in ten tuff samples. Highest value was 1.2 mg/kg in the surge sample. Deepest sample was in Qbt_3 at 105 ft (0.098 mg/kg).
Butylbenzylphthalate	Tuff	Retained	Detected in four tuff samples at depths up to 69 feet and concentrations up to 0.09 mg/kg.
Di-n-butylphthalate	Tuff	Retained	Detected in four tuff samples at depths up to 69 feet and concentrations up to 0.17 mg/kg.
Dibenz(a,h)anthracene	Surge	Retained	One of a suite of PAHs detected in the surge sample.
Diethylphthalate	Soil	Retained	Detected in one of the five soil samples at 1.5 mg/kg.
	Tuff	Retained	Detected in 12 tuff samples at depths up to 105 ft and at concentrations up to 1.7 mg/kg.
Dinitrotoluene[2,4-]	Tuff	Retained	An HE, detected in four tuff samples, including the surge sample, at depths up to 35 ft and at concentrations less than 0.07 mg/kg.
Dinitrotoluene[2,6-]	Surge	Retained	An HE, detected in the surge sample at 0.071 mg/kg.
Indeno(1,2,3-cd)pyrene	Surge	Retained	One of a suite of PAHs detected in the surge sample.
Phenanthrene	Surge	Retained	One of a suite of PAHs detected in the surge sample.

Spatial trends in the concentrations of the major COPCs, with respect to distance from the outfall and distance from the center line of the drainage, are shown in Figures 2.4-6, 2.4-7, and 2.4-8. (Note the logarithmic scale on the y-axes in Figure 2.4-6.) Above-background levels of a number of HE, barium, and inorganic chemicals; and above-detection levels of a few other organic chemicals, are found consistently in samples collected down the center of the drainage and above the soil/tuff interface, particularly within 300 ft of the outfall. Lateral bounding samples within 12 ft of the center line are sometimes contaminated, especially with HE and barium, but at much lower levels. Almost no surface contamination is found outside the drainage proper.

Most contaminants show a marked decrease between the pond area and the lower end of the drainage (Figures 2.4-6, 2.4-7, and 2.4-8). Barium, however, is found in the range of 1–3% down into Cañon de Valle. The average levels of HMX, although not as high as in the pond area, are close to 1%, even at the lower end of the drainage, which is more than 400 ft from the outfall. The area affected by the outfall also widens out lower in the drainage, and percent levels of barium, as well as HMX at concentrations exceeding 1000 mg/kg, were reported in some of the Phase I lateral bounding samples between 200 and 600 ft from the outfall.

The consistent pattern seen on Figures 2.4-6, 2.4-7, and 2.4-8 is not found in the distribution of other inorganics that were eliminated as COPCs in Section 2.4.3.1; see Figure D-1.3-2 in Appendix D. It is also not characteristic of some of the inorganic chemicals that were retained, particularly arsenic and manganese. As discussed in Appendix D, arsenic as well as beryllium, which was eliminated in Table 2.4-4 because it was also statistically indistinguishable from background, are well correlated with iron and other major elements in data from the drainage sediments—as they are in background soil and sediment data sets. It is therefore likely that the few observations above background represent slightly better developed soils rather than releases from the TA-16-260 outfall. The samples with manganese come not from the center of the drainage but only from lateral bounding samples collected 5–12 ft from the center line of the drainage (see Figure D-1.4-3 in Appendix D.) Thus manganese, too, may not be associated with the outfall.

Data from the BHs are presented graphically in Figures 2.4-9 through 2.4-23. The depth of key stratigraphic features—the soil/tuff interface, the upper surge bed, the powder unit and, in the deepest holes, the lower surge bed—are indicated in these figures, together with the depths of all field screening and laboratory samples. The consolidated strata between the soil/tuff interface and the upper surge bed, between the surge bed and the top of the powder unit, and below the powder unit, include partially, moderately, and densely welded tuffs. These variations, which are described in more detail in Section 4, are not shown in the figures in this section but can be expected to influence the transport of contaminants away from the outfall. Laboratory HE results above DL are identified in the figures, and other chemicals detected above BVs and DLs are listed.

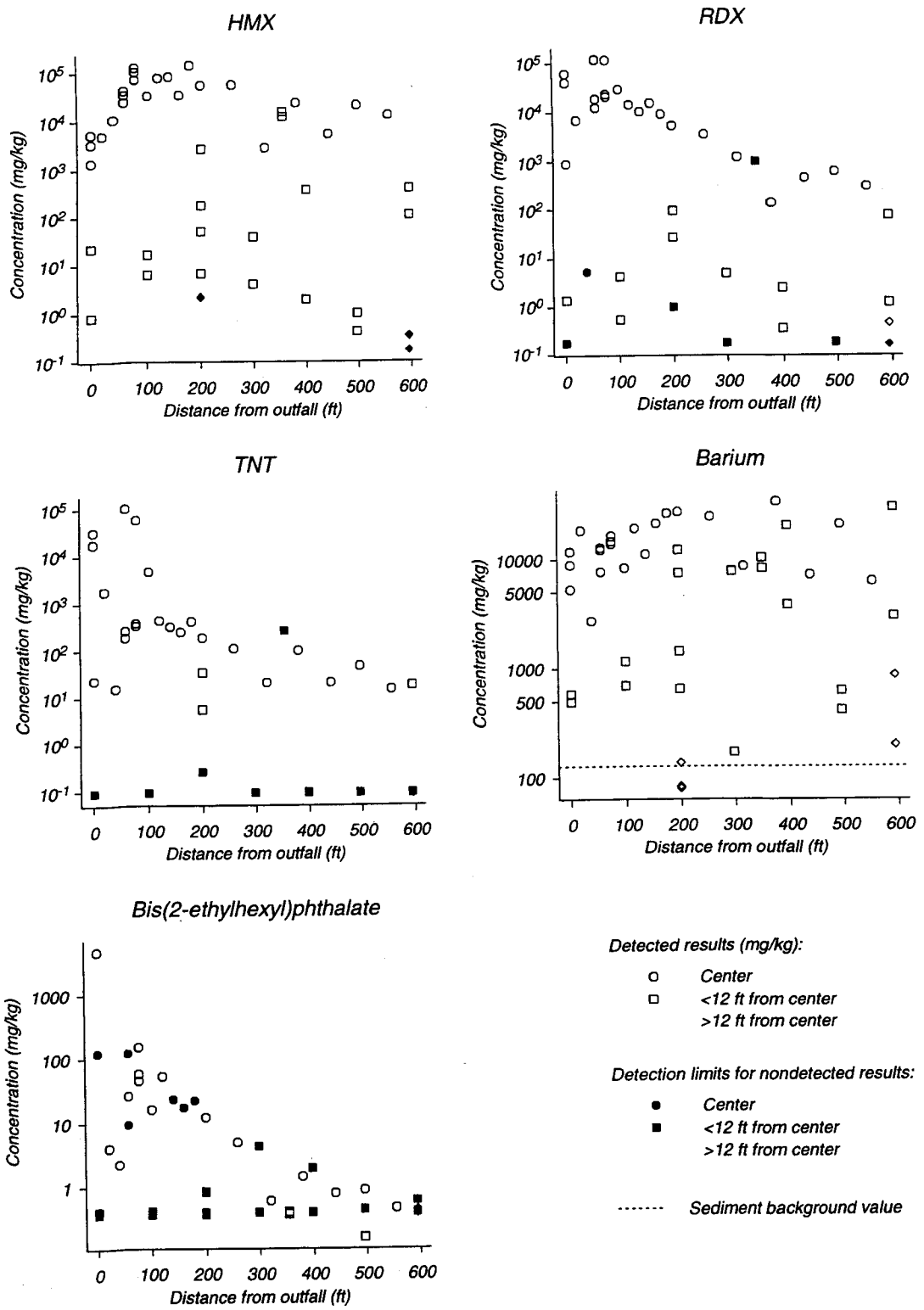


Figure 2.4-6. Trend plots for the principal contaminants in the TA-16-260 outfall drainage sediments

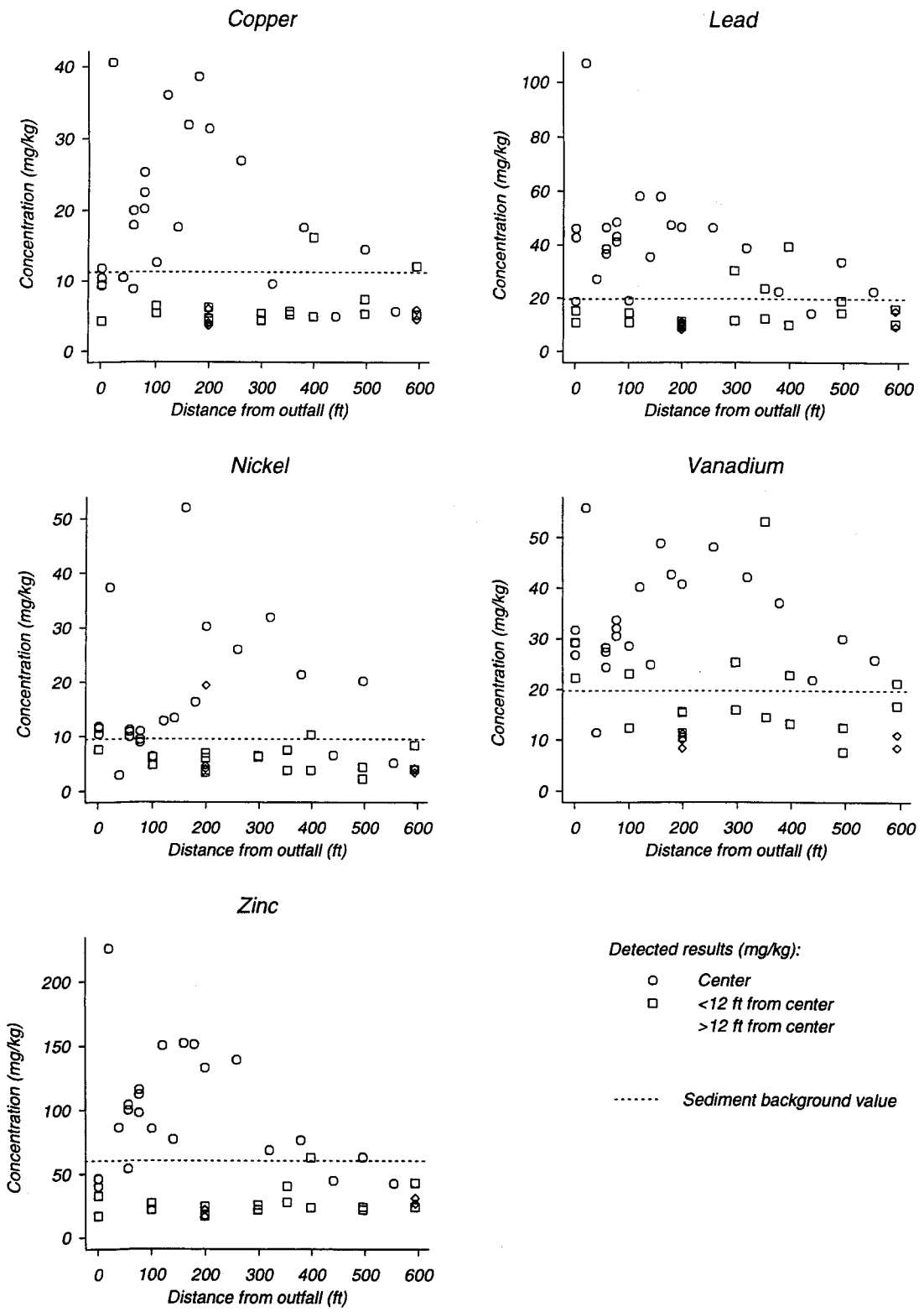


Figure 2.4-7. Trend plots for inorganic contaminants in the TA-16-260 outfall drainage sediments

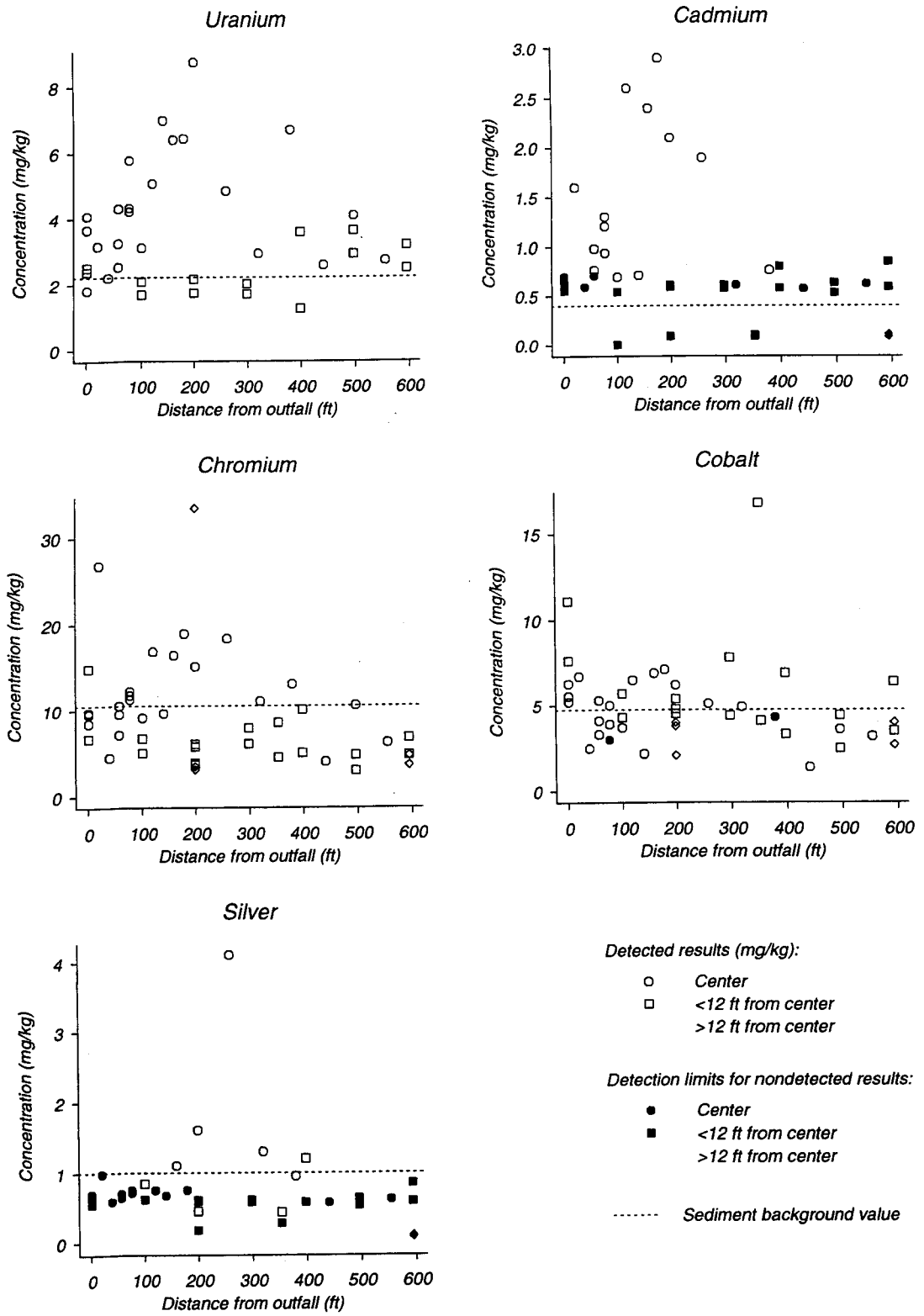
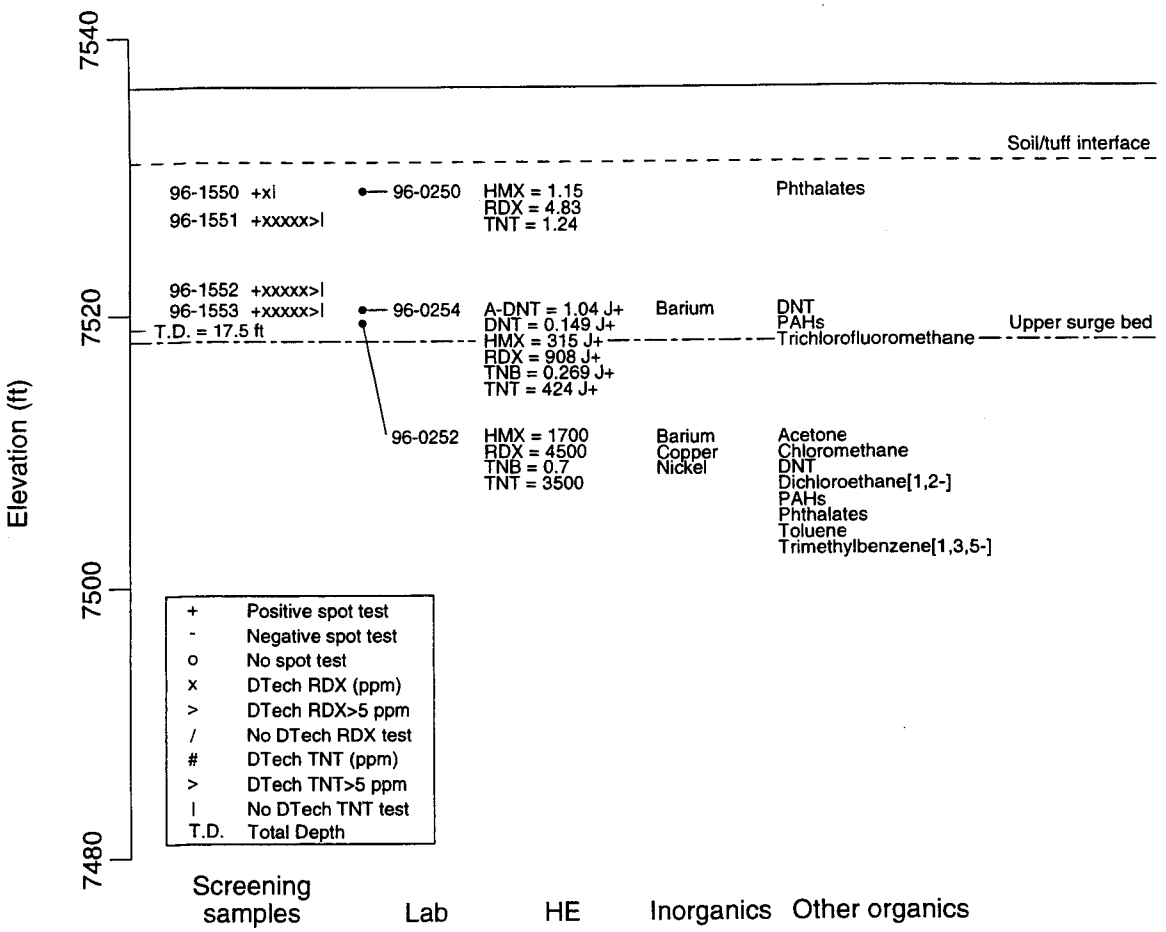


Figure 2.4-8. Trend plots for additional inorganic contaminants in the TA-16-260 outfall drainage sediments



INDEX MAP TO BOREHOLE LOCATIONS

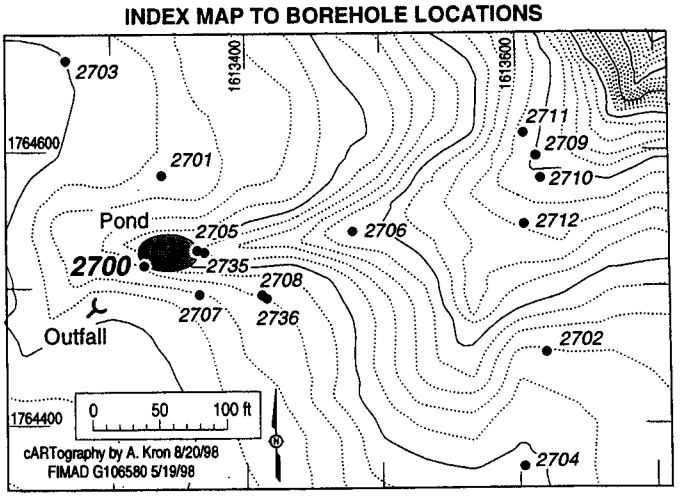


Figure 2.4-9. Screening and laboratory results above DLs and BVs for BH 16-2700

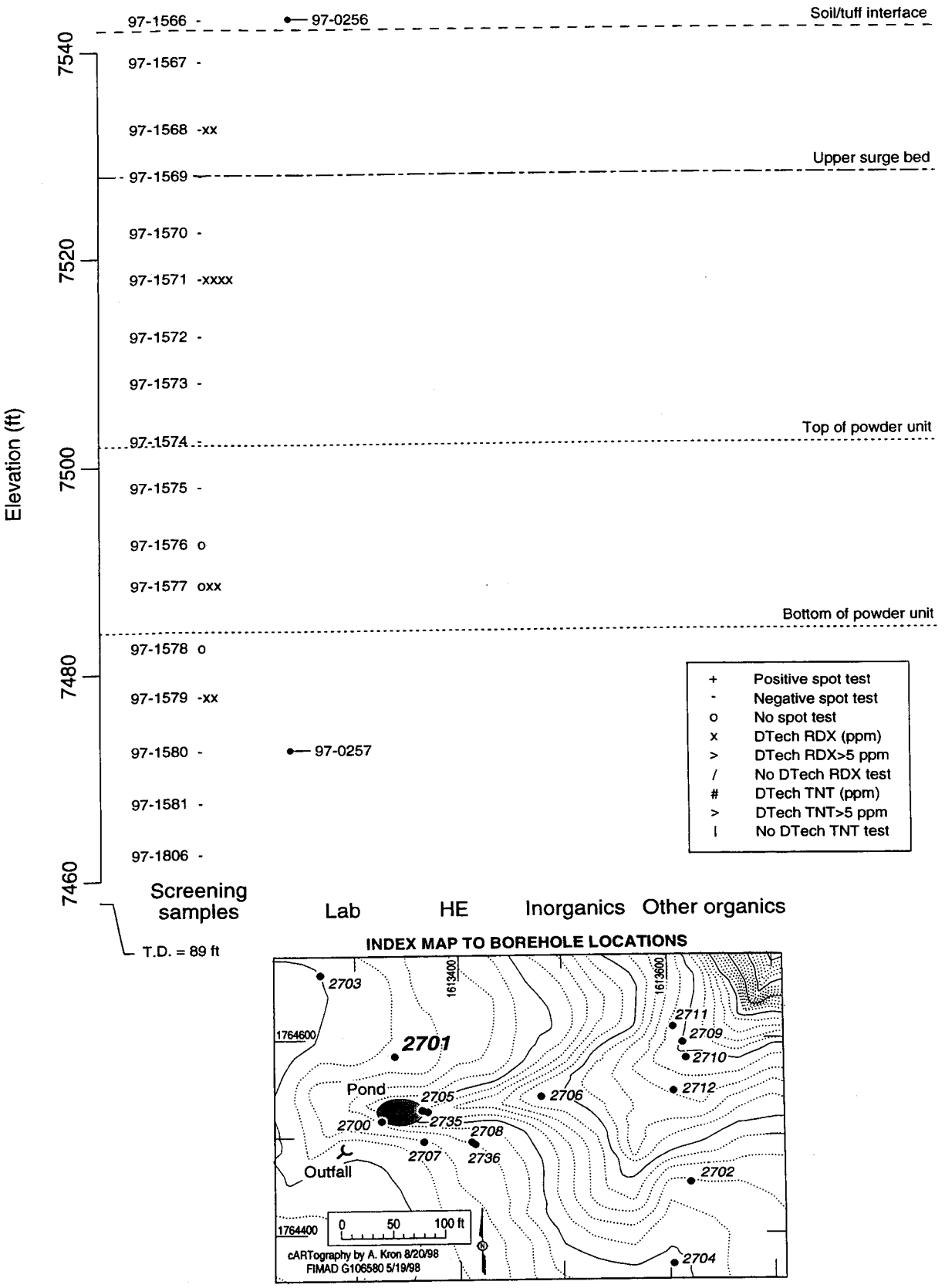
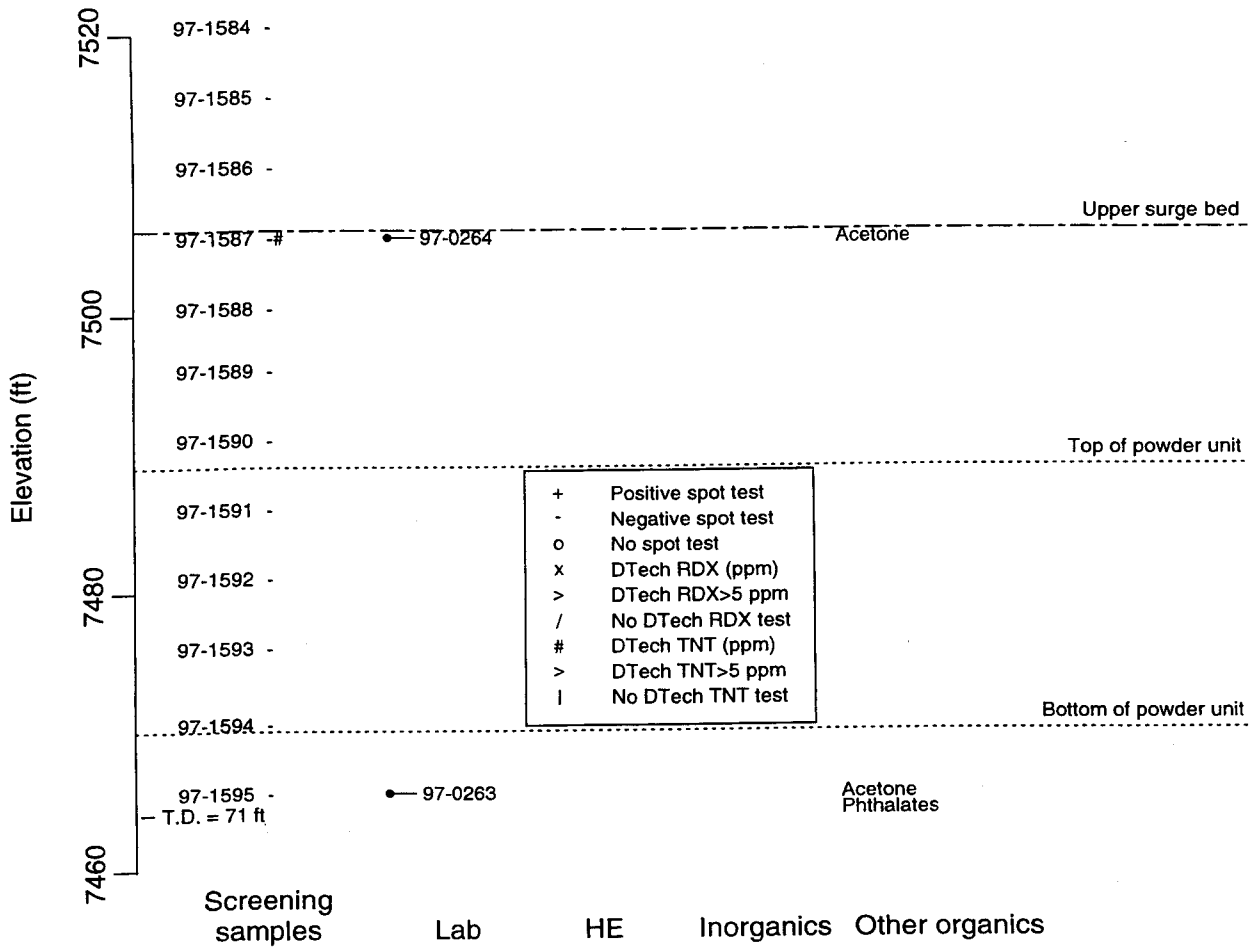


Figure 2.4-10. Screening and laboratory results above DLs and BVs for BH 16-2701



INDEX MAP TO BOREHOLE LOCATIONS

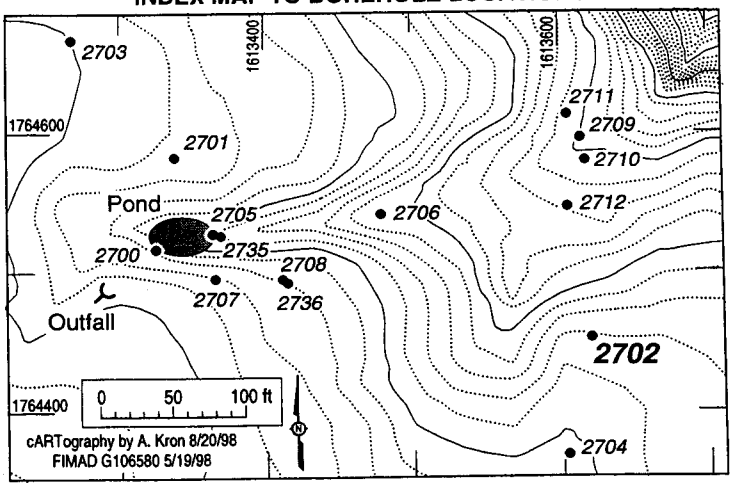
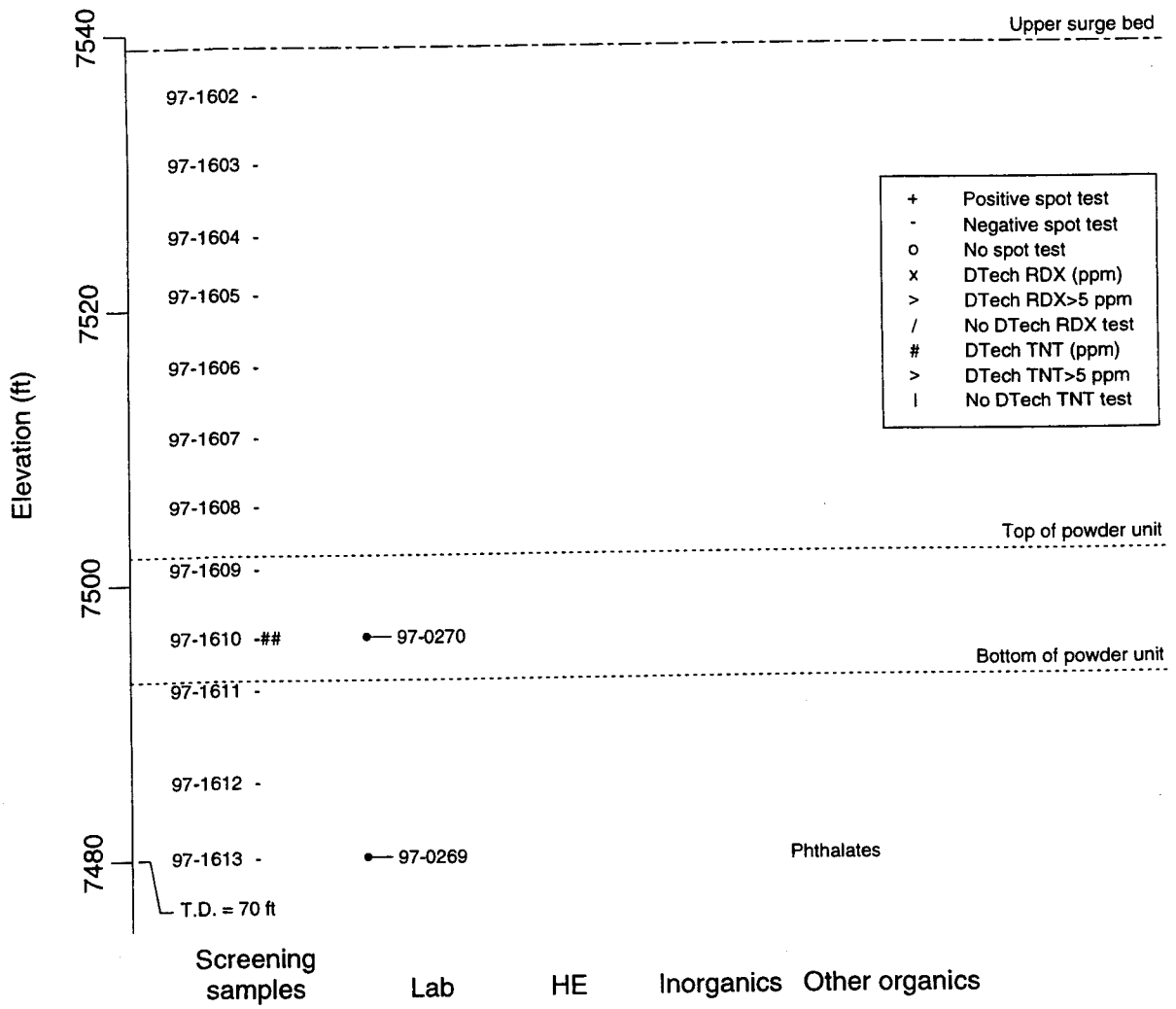


Figure 2.4-11. Screening and laboratory results above DLs and BVs for BH 16-2702



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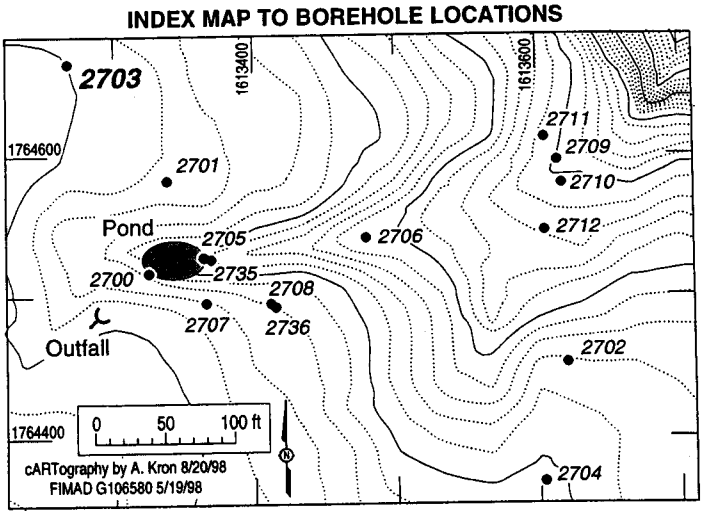
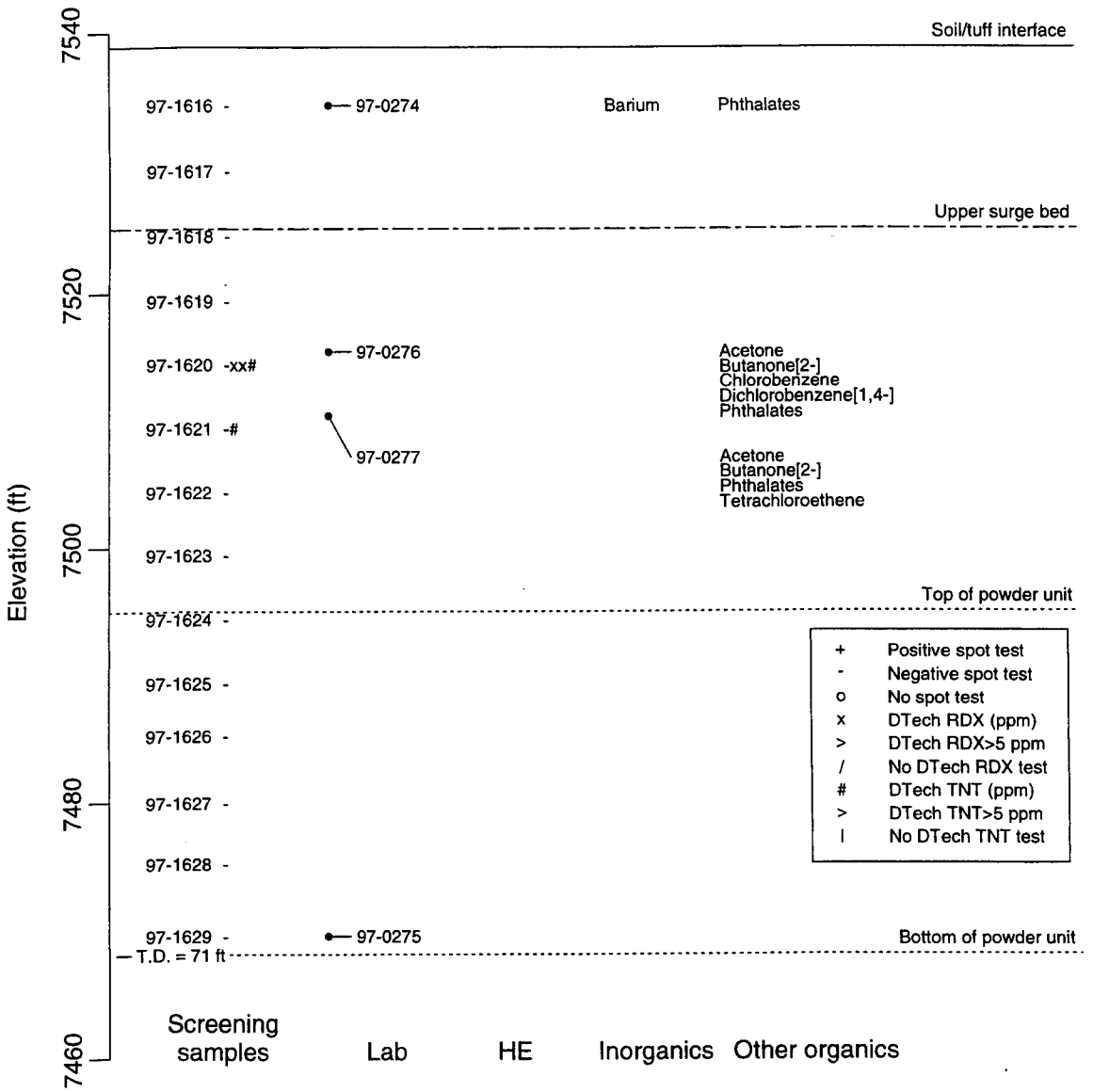


Figure 2.4-12. Screening and laboratory results above DLs and BVs for BH 16-2703



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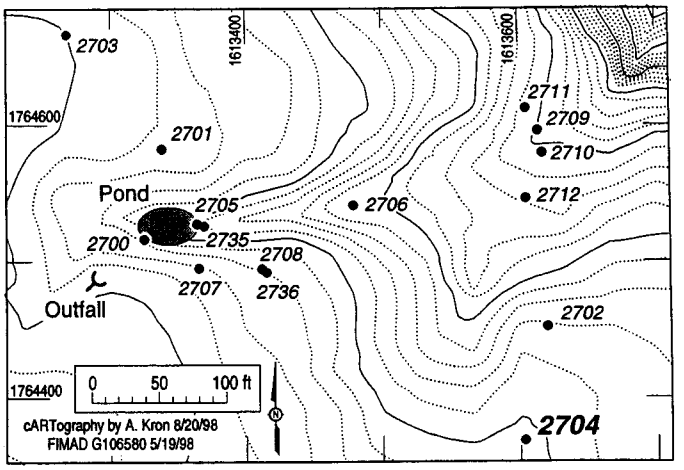
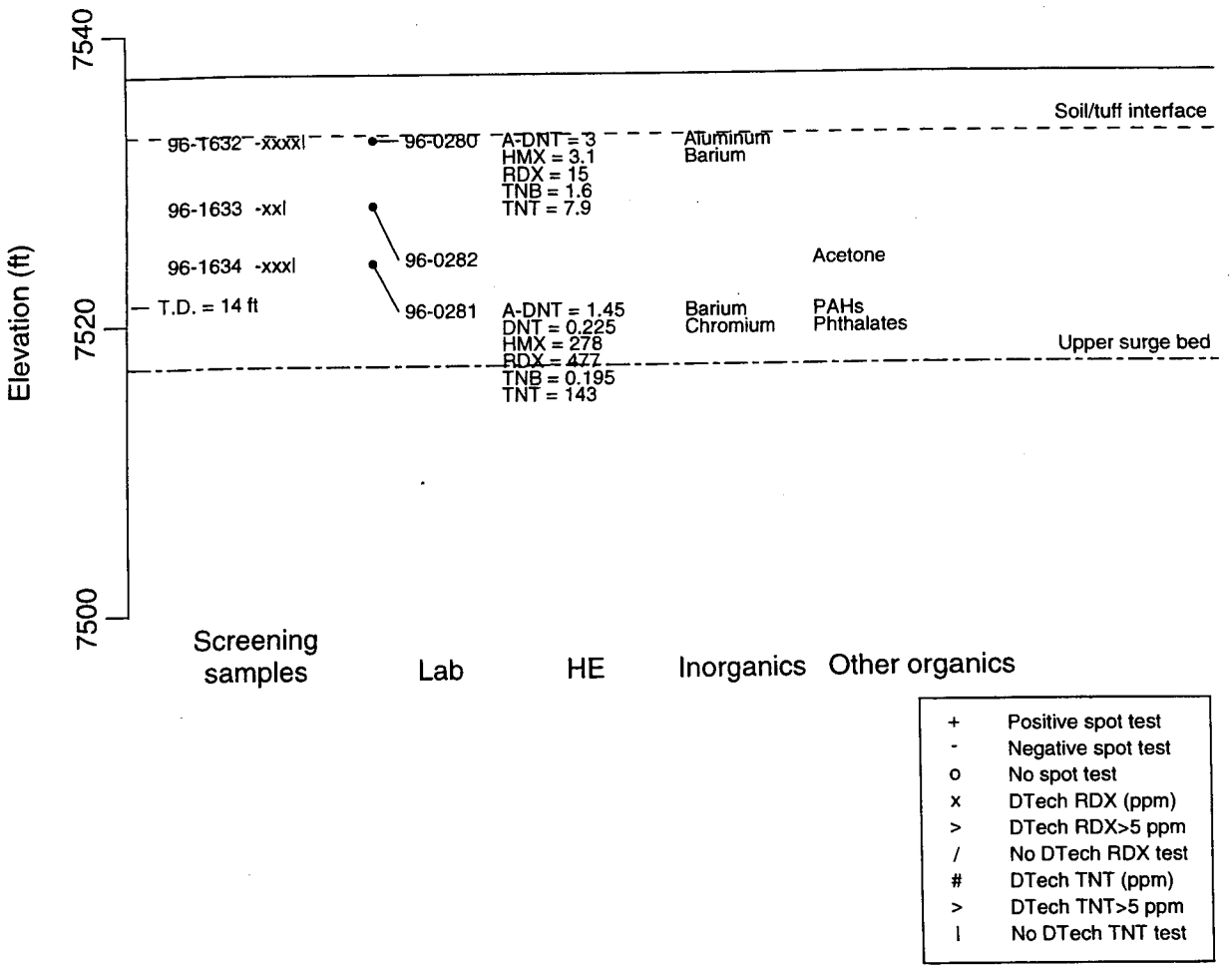


Figure 2.4-13. Screening and laboratory results above DLs and BVs for BH 16-2704



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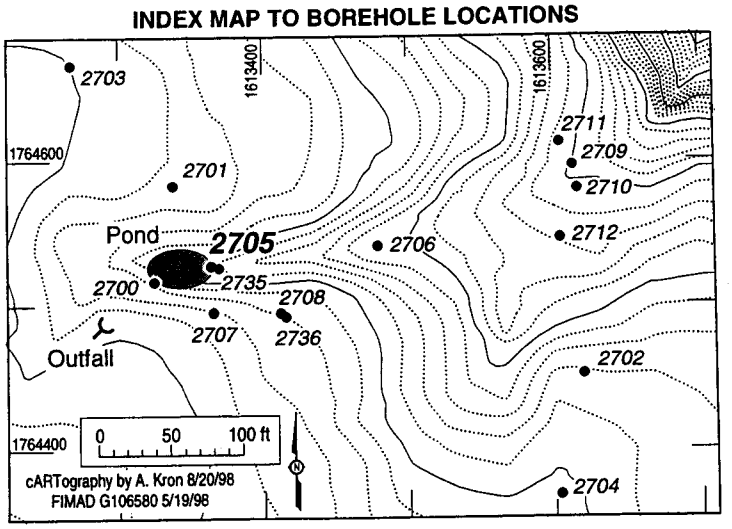


Figure 2.4-14. Screening and laboratory results above DLs and BVs for BH 16-2705

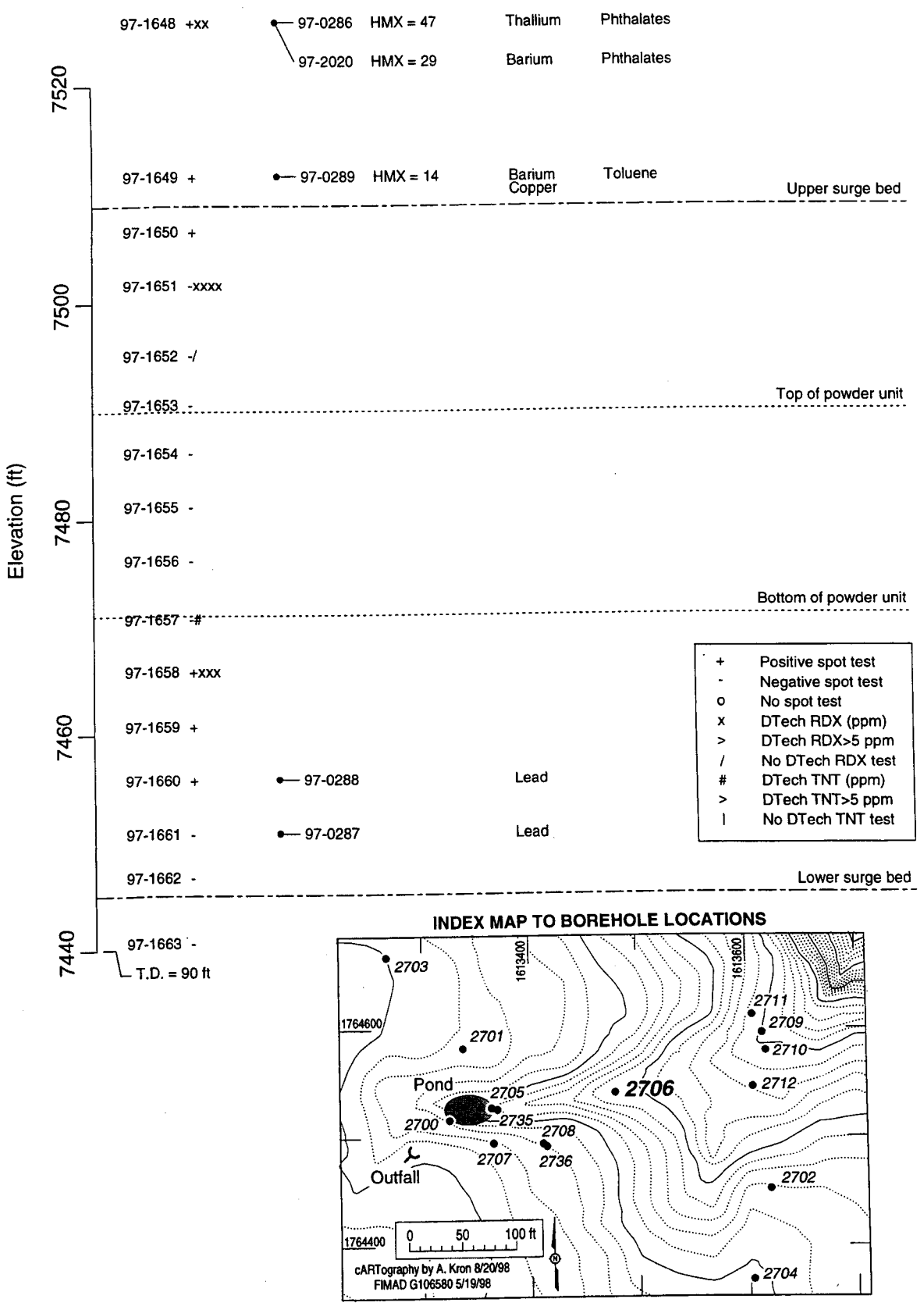


Figure 2.4-15. Screening and laboratory results above DLs and BVs for BH 16-2706

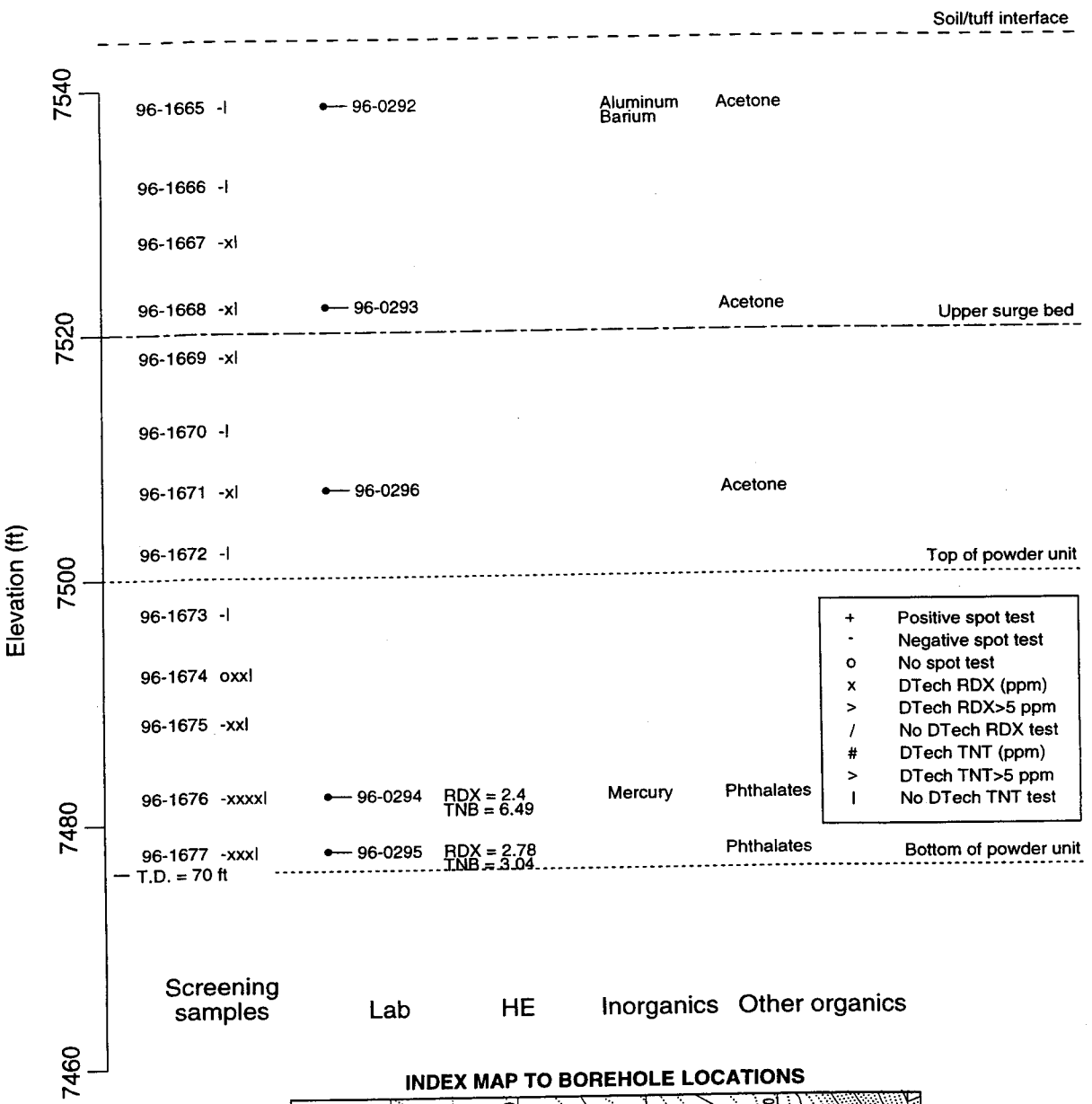
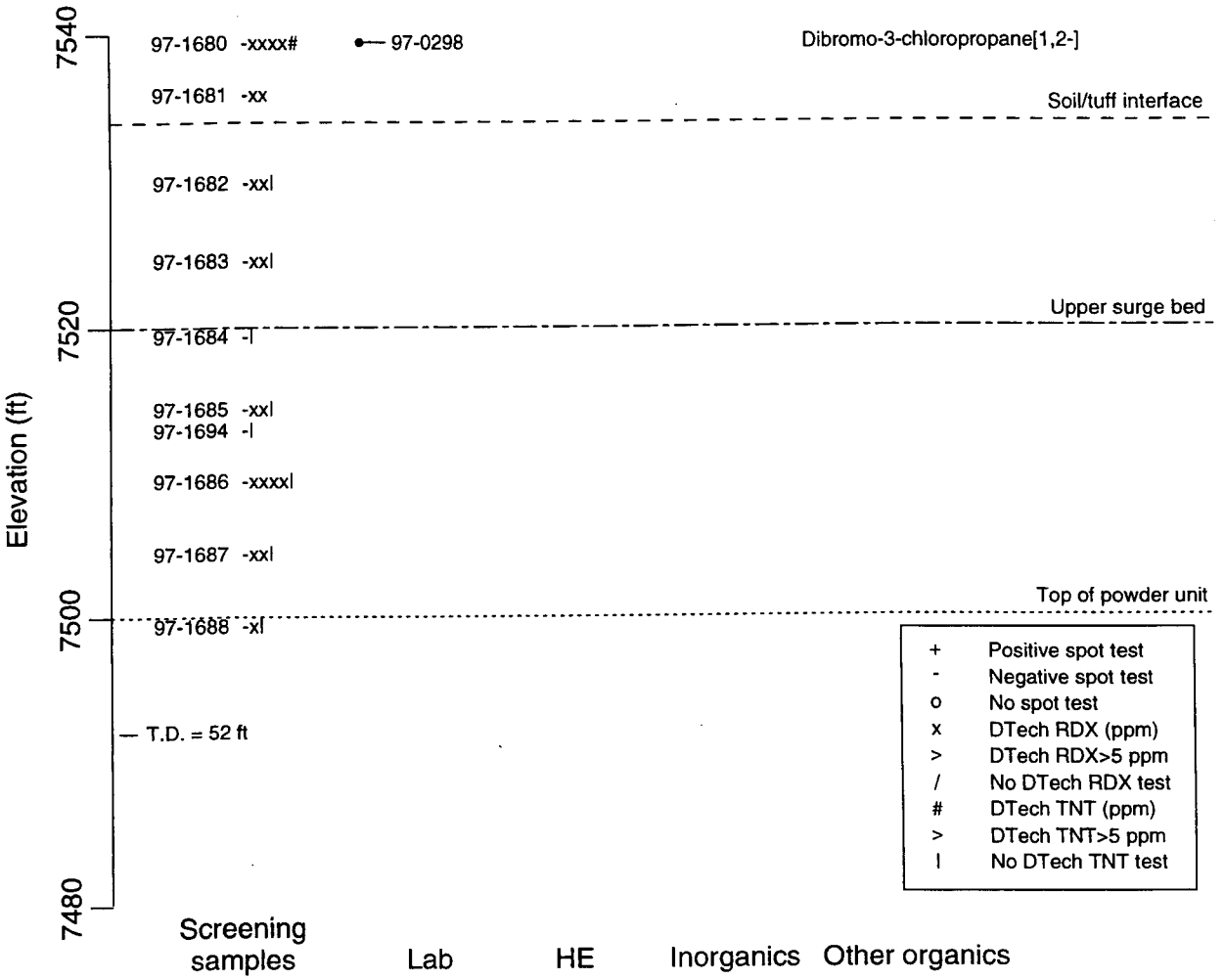


Figure 2.4-16. Screening and laboratory results above DLs and BVs for BH 16-2707



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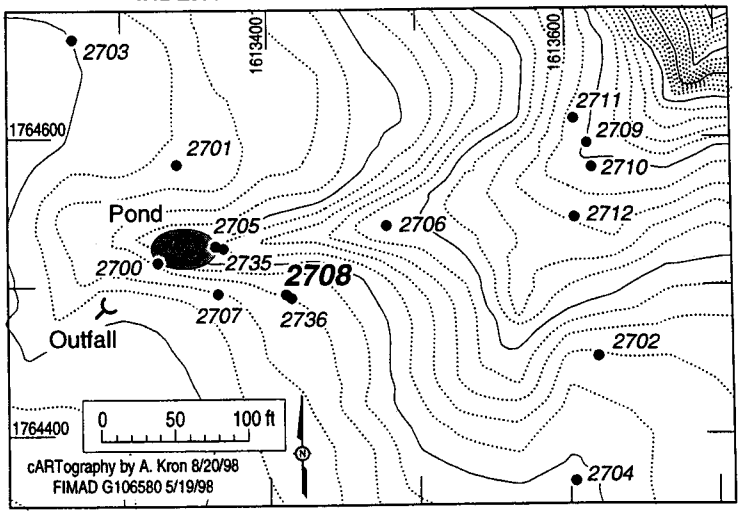
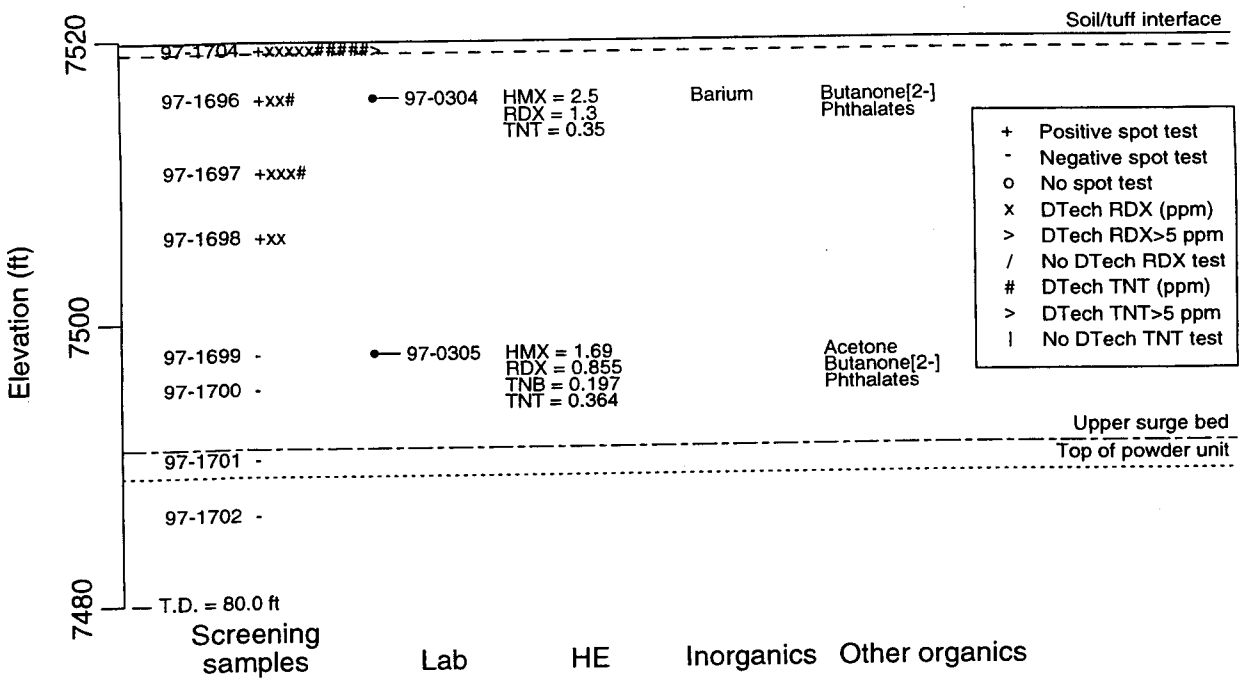


Figure 2.4-17. Screening and laboratory results above DLs and BVs for BH 16-2708



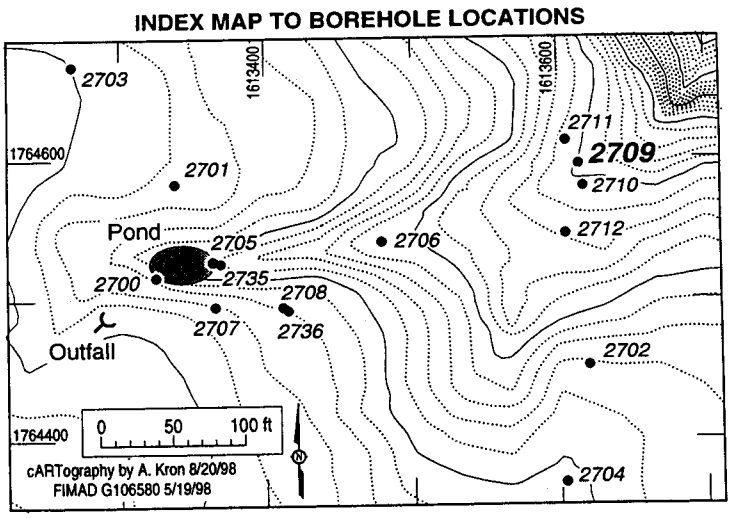
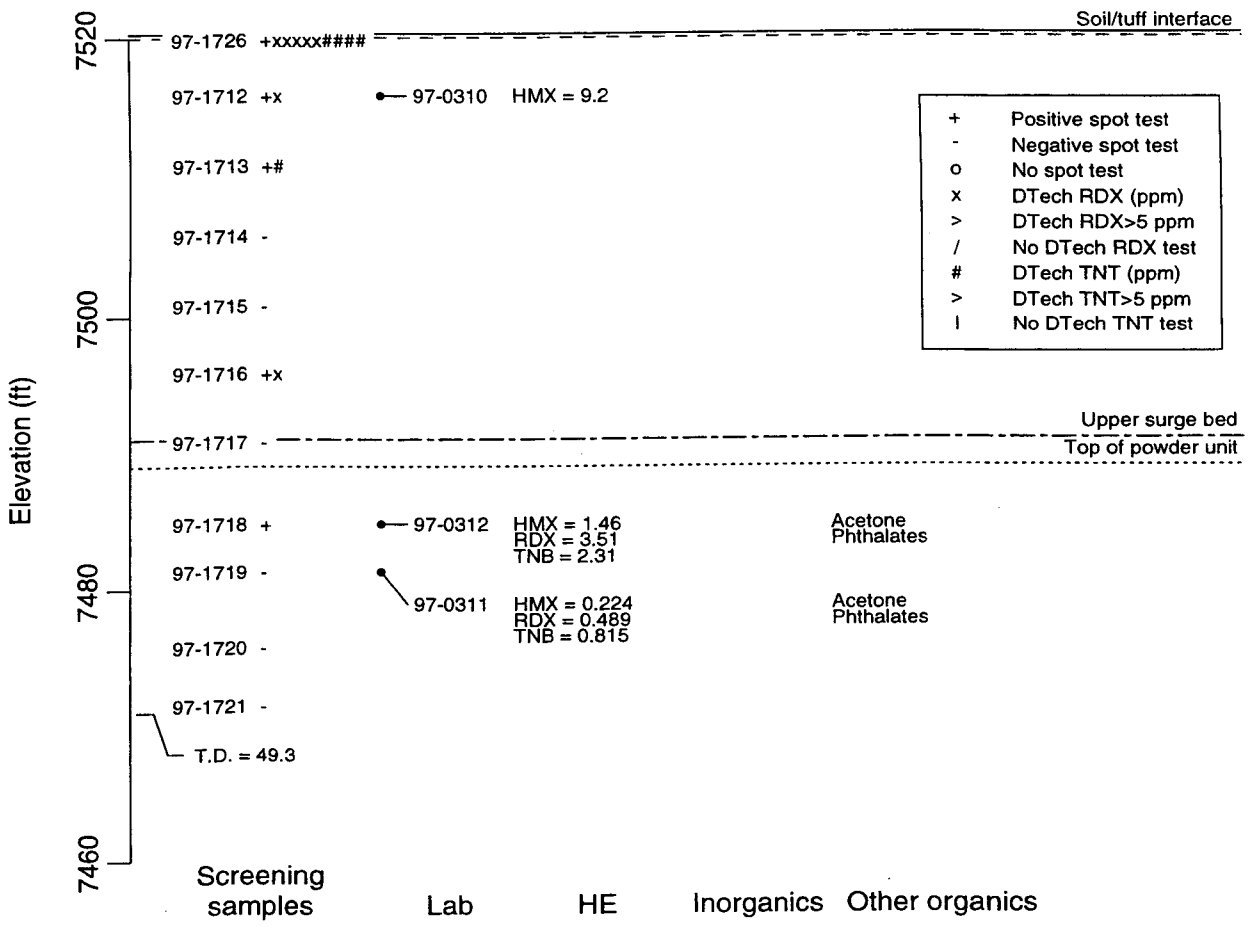


Figure 2.4-18. Screening and laboratory results above DLs and BVs for BH 16-2709



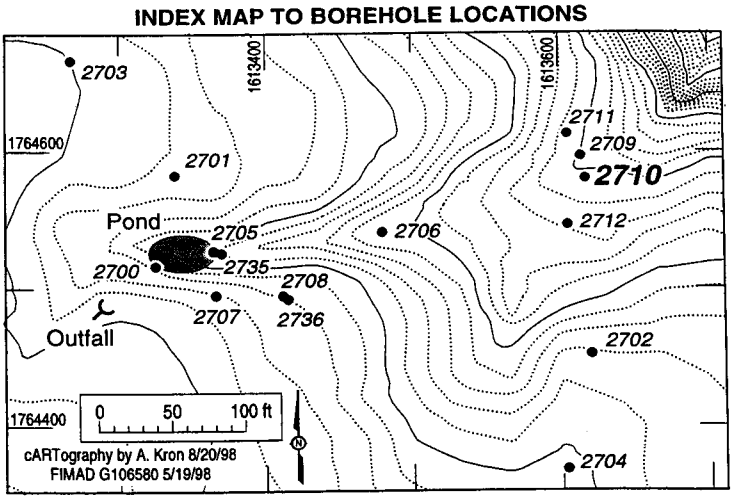
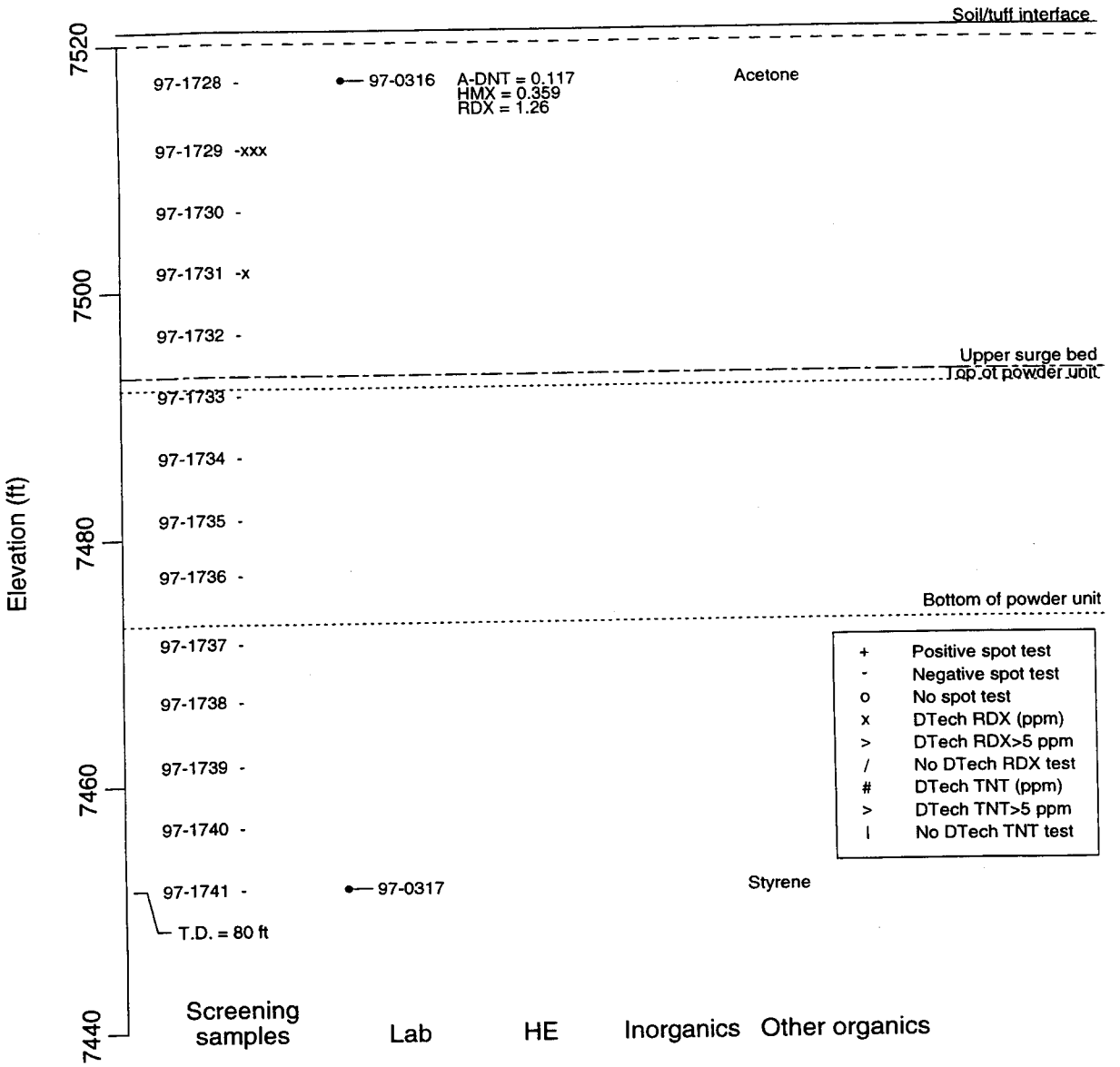


Figure 2.4-19. Screening and laboratory results above DLs and BVs for BH 16-2710



INDEX MAP TO BOREHOLE LOCATIONS

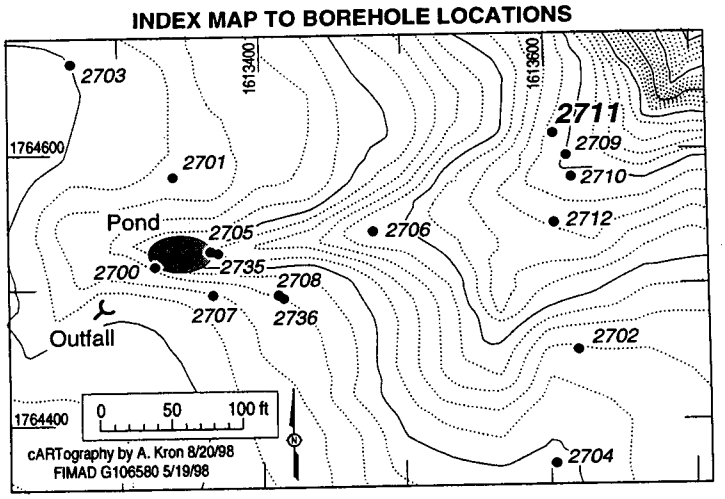


Figure 2.4-20. Screening and laboratory results above DLs and BVs for BH 16-2711

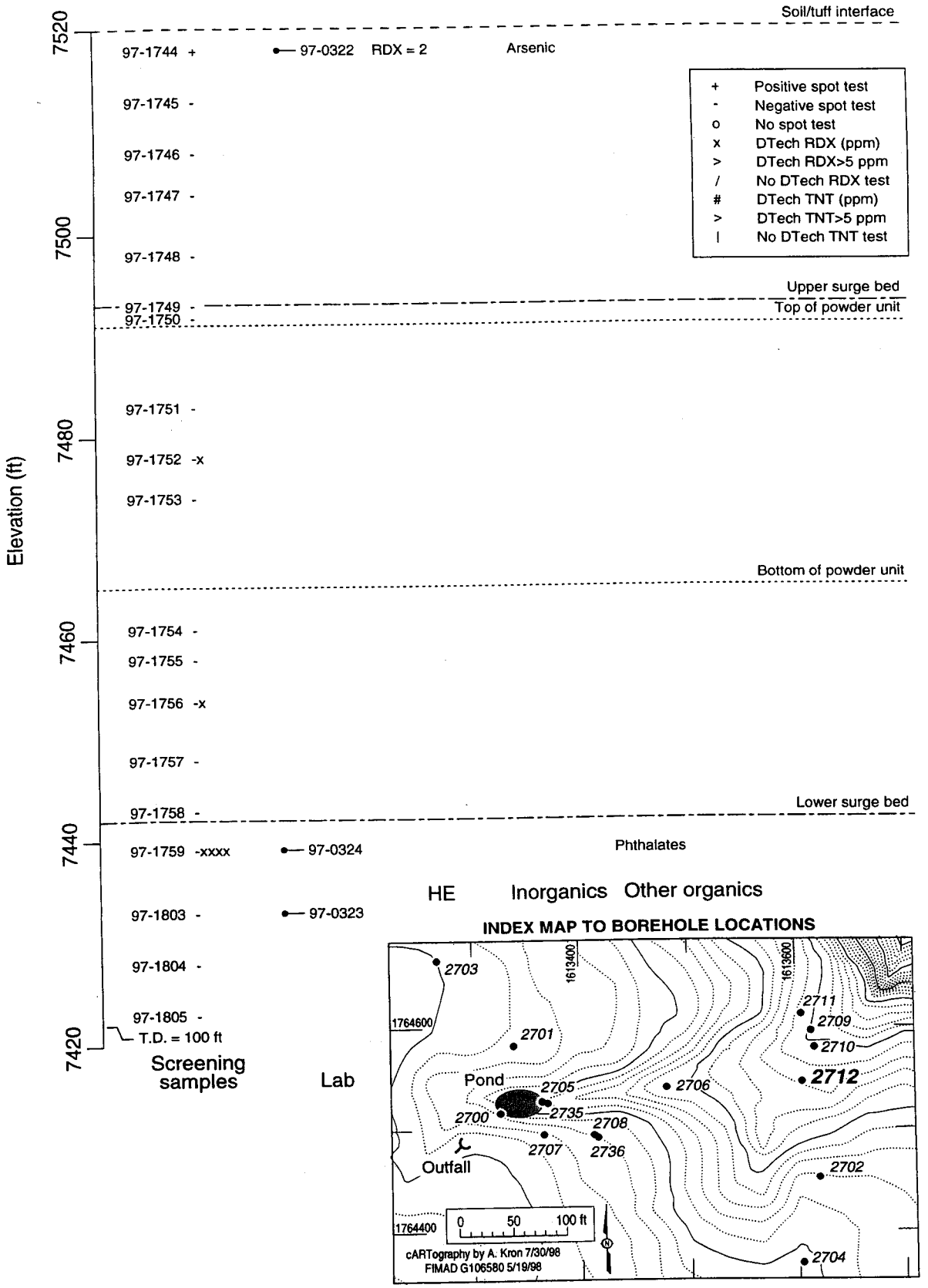


Figure 2.4-21. Screening and laboratory results above DLs and BVs for BH 16-2712

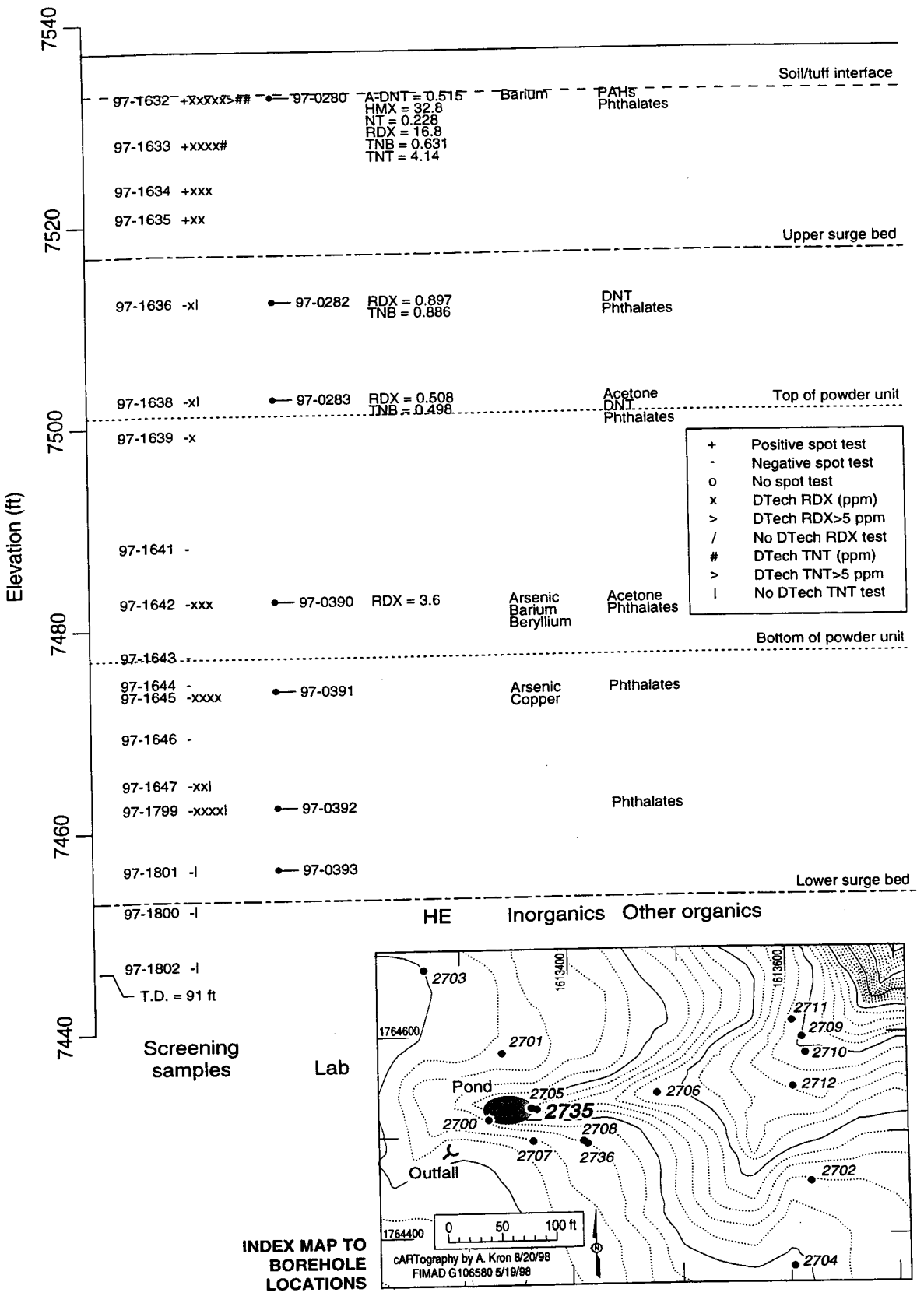
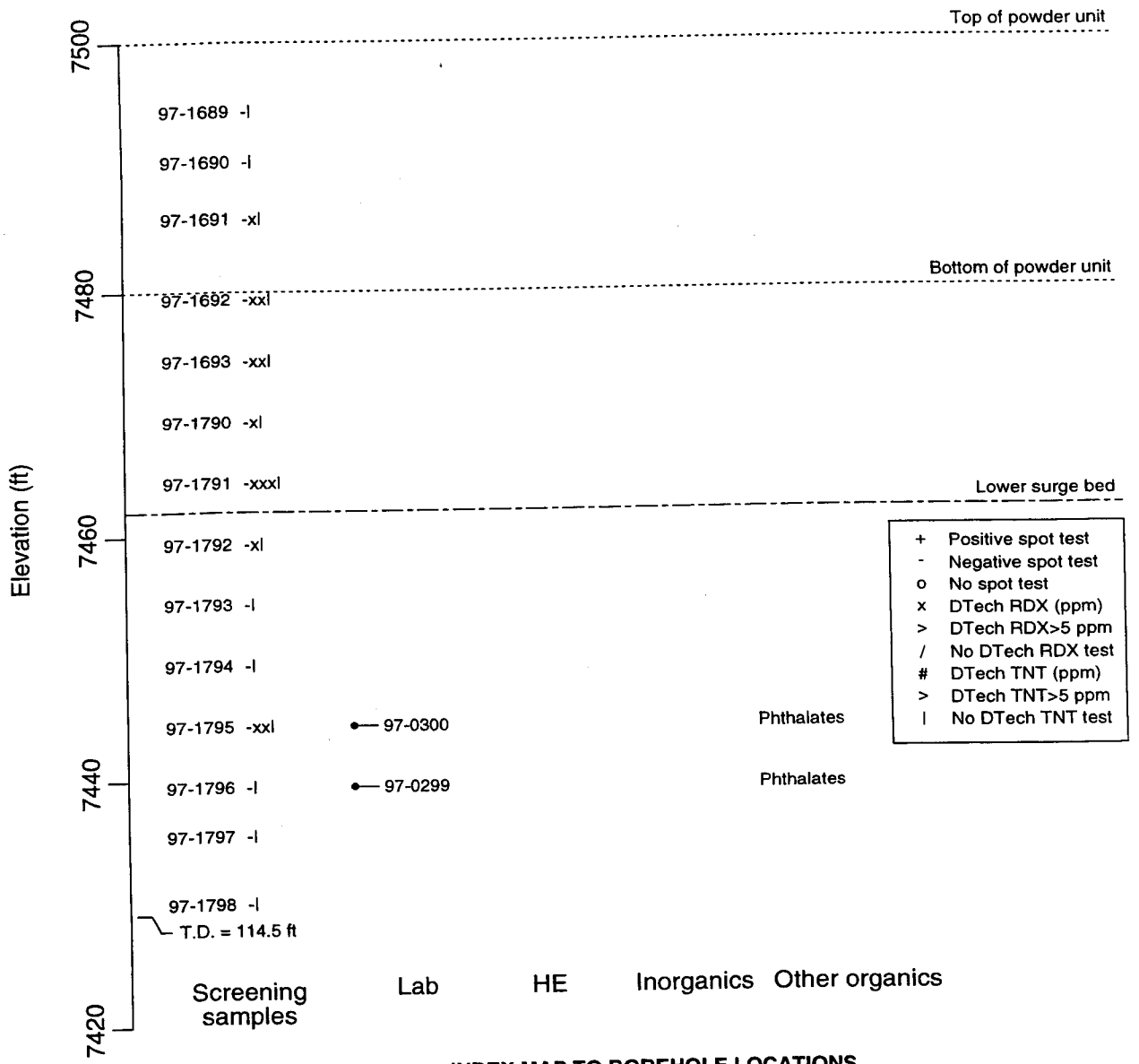


Figure 2.4-22. Screening and laboratory results above DLs and BVs for BH 16-2735



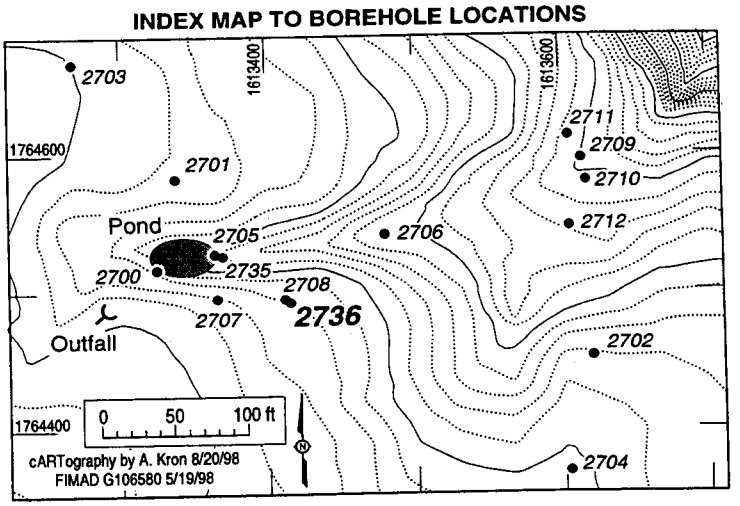


Figure 2.4-23. Screening and laboratory results above DLs and BVs for BH 16-2736

The screening samples provide the most complete set of downhole observations, although, as mentioned previously, the results are only semiquantitative and exhibit a fairly high false-positive rate. Overall, in Figures 2.4-9 through 2.4-23, however, the screening samples present a moderately consistent picture, suggesting:

- significant levels of HE contamination between the soil/tuff interface and the upper surge bed in the six BHs within the drainage: 16-2700, 16-2705/16-2735, 16-2706, 16-2709 and 16-2710 (see Figure 2.4-24, which shows the screening results for these six BHs on a single page);
- some contamination below the upper surge bed, both within the drainage and in some of the holes to the south and east of the pond (particularly in BH 16-2708, about 40 ft south of the drainage);
- relatively few positive readings in the powder unit, even in the drainage BHs;
- a rise in contamination at the base of the powder unit, again in holes outside of the drainage as well as in the two holes within the drainage that penetrated to this depth; and
- clean screening samples at the bottom of most BHs.

Note that, in these figures, nondetected DTech RDX and TNT are represented by the absence of the symbols x or #, respectively. Unavailability of DTech data, by contrast, is indicated by the symbols / or I, respectively. In particular, the DTech TNT test was not performed on the samples from the early BHs (16-2700, 16-2705, and 16-2707). Refer to the key on Figure 2.4-9.

Where paired laboratory samples are available, they do not always confirm the DTech screening hits (see Appendix E for screening vs. lab sample correlation). Conversely, laboratory RDX values up to 3.51 mg/kg (in sample 0316-97-0312 from BH 16-2710) were found in four laboratory samples for which the RDX screening result was negative. About 4 mg/kg of DTech RDX was reported in two screening samples collected below the lower surge bed in BH 16-2712. Unfortunately, the corresponding laboratory HE data, which were reported below DLs, were rejected, so this result can neither be confirmed nor refuted.

The six BHs within the drainage account for the majority of detected laboratory results, both HE and other contaminants, that are presented in Tables 2.4-12, 2.4-15, 2.4-18, and 2.4-19. One important exception to this statement is the observation of HE and butylbenzylphthalate, as well as mercury slightly above its DL, in samples collected near the bottom of the powder unit in 16-2707, located about 30 ft south of the pond. RDX and butylbenzylphthalate were also found in a sample from a comparable depth in BH 16-2735, to the north, within the drainage. (The depth of the base of the powder unit in 16-2707 as shown on Figure 2.4-16 is an estimate, as core from this hole was not available to be logged.) In the laboratory data set, these observations provide one of the main indications of stratigraphic control of lateral migration at depth.

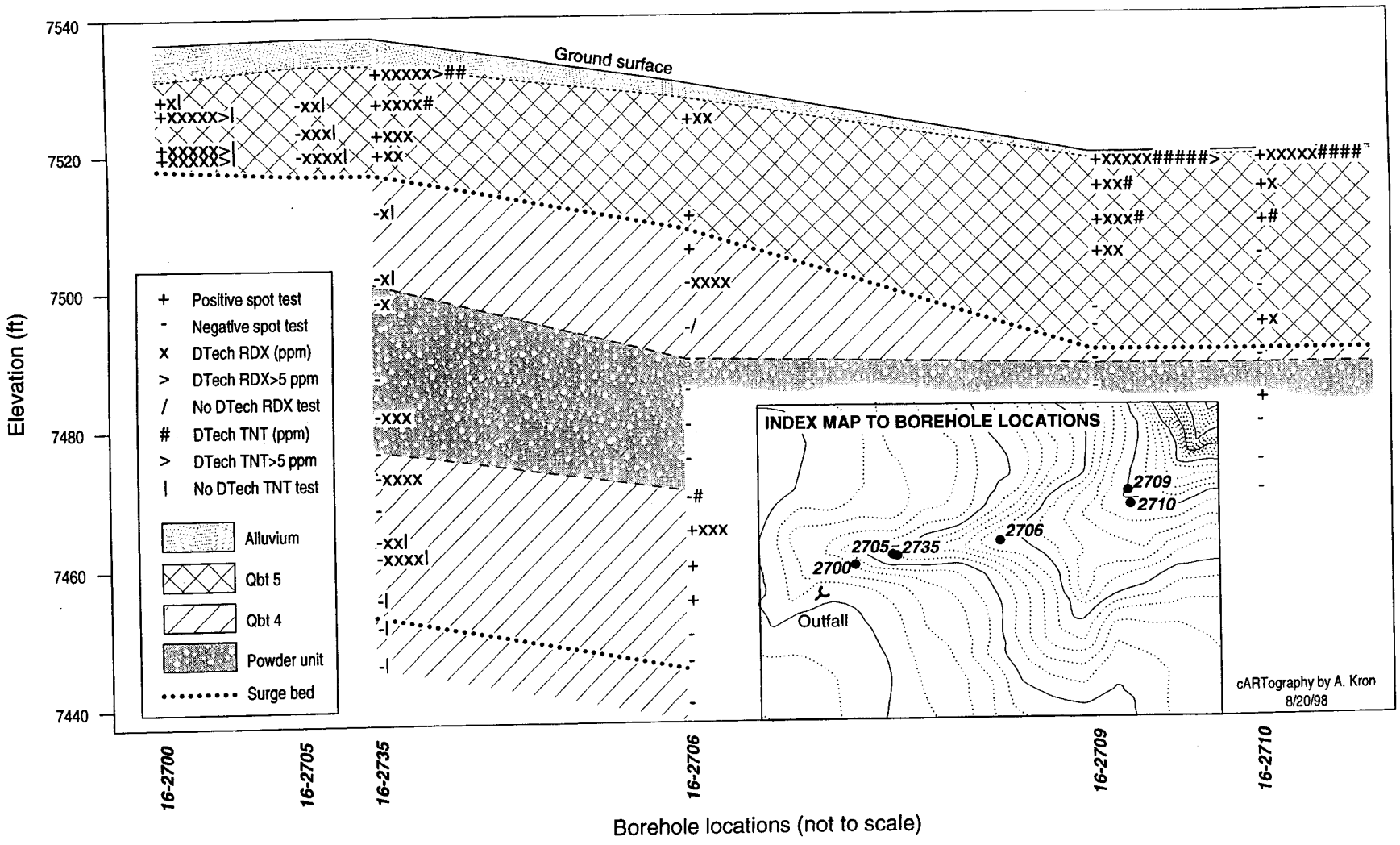


Figure 2.4-24. HE screening results in tuff below drainage channel

Samples collected near the soil/tuff interface in the drainage (0316-96-0280 from 16-2705, 0316-97-0280 from 16-2735, 0316-97-0286 and collocated 0316-97-2020 from 16-2706, and screening samples without laboratory confirmation from 16-2709 and 16-2710) are, in general, moderately contaminated. HE at up to 50 mg/kg, and barium at twice the background level for tuff, are reported in these samples, as well as some of the other contaminants for which there is evidence of release in the surface data, including phthalates (bis[2-ethylhexyl]phthalate as well as others that were not detected in the surface and near-surface samples). HE was also measured at 1–2 mg/kg in two soil/tuff interface samples from BHs 16-2711 and 16-2712. Although these two holes are about 30 ft north and south of the center of the drainage, respectively, the drainage at this point is broad and fairly level. The presence of HE near the soil/tuff interface in BHs 16-2711 and 16-2712 might be the result of either surface transport or interflow along the soil/tuff boundary.

Laboratory evidence of HE contamination, like the screening results, persists down to the upper surge layer in the BHs within 300 ft of the outfall, although at lower levels. One laboratory sample from a depth of 13 ft in BH 16-2705 (0316-96-0281) contained HMX, RDX, and TNT at concentrations of several hundred mg/kg. Two samples that appear to come from the surge layer itself (0316-96-0252 and 0316-96-0254 from BH 16-2700 in the ponded area) are highly contaminated. Another sample in BH 16-2706 (0316-97-0289) may come from the same stratum; it is moderately contaminated (less than 50 mg/kg). No other laboratory samples appear to have been collected from this important geological interface, which is represented in most of the logged BHs by a gap in the core rather than any actual surge material.

By contrast, laboratory HE levels do not exceed 5 mg/kg either below the upper surge bed in the drainage holes within 300 ft of the outfall or deeper than about 5 ft below the soil/tuff interface in the eastern BHs (16-2709 and 16-2710). However, only two of the six drainage holes (16-2735 and 16-2706) reached the bottom of the powder unit at a depth of about 60 ft. In 16-2735, a deep hole just east of the pond, several screening hits at depth were not confirmed in the corresponding laboratory samples, but 3.6 mg/kg of RDX was reported in one sample from the base of the powder unit. In 16-2706, lead was reported above the background level in two samples collected in tuff 15–20 ft below the bottom of the powder unit, but no HE was reported in these samples; in particular, a positive HE spot test result in one of these samples was not confirmed by laboratory analysis.

Almost all the inorganic chemicals reported above background are in the drainage BHs, but organic chemicals were reported in other BHs, particularly in BH 16-2704, which is approximately 200 ft to the south of the drainage. The presence of these chemicals at a depth of approximately 30 ft in BH 16-2704, above the powder unit, cannot be explained. Phthalates were the only contaminants found in the only two laboratory samples from Qbt_3 tuff (from the bottom of BH 16-2736, located approximately 40 ft south of the drainage).

2.5 Implications for the TA-16 Hydrogeologic Conceptual Model

The major contaminants that were released at the TA-16-260 outfall and are still present at very high levels in the drainage sediments are HE—particularly HMX, RDX and TNT—and barium. A number of other inorganic chemicals are found in the drainage sediments, including copper, lead, nickel, vanadium, uranium, and zinc. Of the phthalates, only bis(2-ethylhexyl)phthalate was reported in the drainage sediments, but based on data from the BHs, it is likely that other phthalates were also released at the outfall; their presence is being masked by the very high levels of HE in the sediment samples. Anthracene also appears to have been released.

The available evidence suggests that HE and other contaminants have generally penetrated the upper layer of tuff (above the upper surge bed) below the drainage, but at concentrations that are an order of magnitude smaller than observed above the soil/tuff interface. Sporadic hits below the upper surge bed both under and south of the drainage indicate that further distribution of contamination may be occurring along pathways determined by vertical fractures and dense horizontal strata. While laboratory evidence is quite limited, there is nothing in the data to suggest the presence of pockets of high levels of contaminants in the deep subsurface. Rather, each of the densely welded layers of tuff underlying the pond—within Qbt_5 and above and below the powder unit in Qbt_4—appears to correspond to a decrease in levels of contamination of at least one order of magnitude.

Overall, the trends seen in these data suggest that a removal action that targets the drainage sediments, plus up to 20 ft of tuff beneath the pond, would be highly effective in removing the bulk of the HE contamination, as well as most of the contamination associated with other organic and inorganic compounds. The numbers in Table 2.4-21 are approximate, but they show that 80–95% of the total contamination at the TA-16-260 outfall resides in the sediments between the outfall and the 15-ft cliff where the drainage drops into Cañon de Valle, approximately 420 ft below the outfall. Most of the remaining barium and HMX is in the sediments on the slope of Cañon de Valle, while the remaining RDX and TNT is largely in the tuff below the pond.

Table 2.4-21

Average Concentration and Percent of Total Contamination in the TA-16-260 Outfall Drainage, by Section and Medium

	Barium		HMX		RDX		TNT	
	Average	%	Average	%	Average	%	Average	%
Sediments: Outfall to pond	8700	5.4	4700	1.1	20 400	9.9	9500	10.4
Sediments: Pond to 260 ft from outfall	15 100	57.8	60 300	88.3	27 500	83.2	11 600	79.0
Qbt_5: Pond to 260 ft from outfall	240	2.8	270	1.2	660	6.0	510	10.4
Sediments: 260–420 ft from outfall	16 200	19.4	9800	4.5	550	0.5	70	0.1
Qbt_5: 260–420 ft from outfall	90	0.8	2	0.0	1	0.0	0	0.0
Sediments: More than 420 ft from outfall	10 300	13.9	9600	5.0	350	0.4	21	0.0

Attachment B

Section 5 of the RFI Report for PRS 16-021(c)

5.0 CONCEPTUAL MODEL DEVELOPMENT

5.1 Summary

TA-16 is one of the most complex sites at the Laboratory in terms of hydrologic behavior and contaminant fate and transport. The combination of relatively wet mesa and canyon conditions, different geological units with varying properties, multiple flow paths, different types of flow behavior, and multiple source areas results in a conceptual model that has to consider many different pathways and processes. Large uncertainties associated with aspects of the conceptual model are the result of the complexity of the TA-16 system. Sections 5.2 and 5.3 focus on the TA-16 geology, hydrology, and contaminant chemistry. Sections 5.4 and 5.5 focus on human health and ecological risk pathways, respectively. The major features of the TA-16 conceptual model are shown in Figure 5.1-1 and are briefly described below.

- The model describes key aspects of the hydrology and geology of a roughly triangular area that is bounded by Cañon de Valle on the north, Water Canyon on the south, the Pajarito Fault zone on the west, and the confluence of Cañon de Valle and Water Canyon on the east (Figure 5.1-2.).
- Saturated flow systems occur in different forms, including the alluvial aquifer in Cañon de Valle; SWSC Spring, Burning Ground Spring, and Martin Spring; and the 90's Line Pond. Additional saturated flow systems may also be present and are discussed below.
- The saturated systems that feed the springs are hypothesized to be ribbon-like structures within the mesa.
- The ribbons appear to predominate at or above the Unit 4/Unit 3 contact where there is a transition from poorly welded to strongly welded tuff. The three springs flow from or near the Unit 3/4 contact.
- The ribbons feed the springs via localized fracture zones. The area around the Cañon de Valle springs appears to be more fractured than the surrounding tuff. The area around Martin Spring is covered by colluvium.
- No permanent zones of saturation have been identified during drilling, so the existence of the ribbons is only hypothesized. Transient saturated zones have been found near the Unit 3/4 contact, which supports the saturated ribbon hypothesis. In addition, alternative hypotheses on the source of the spring water (i.e., alluvial water or artesian conditions) do not appear to be viable.
- Recharge of the saturated ribbons may occur via various sources and processes including the Pajarito Fault zone, the Steam Plant drainage, and the 90's Line Pond. Recharge may also occur via transient saturated flow (described below).

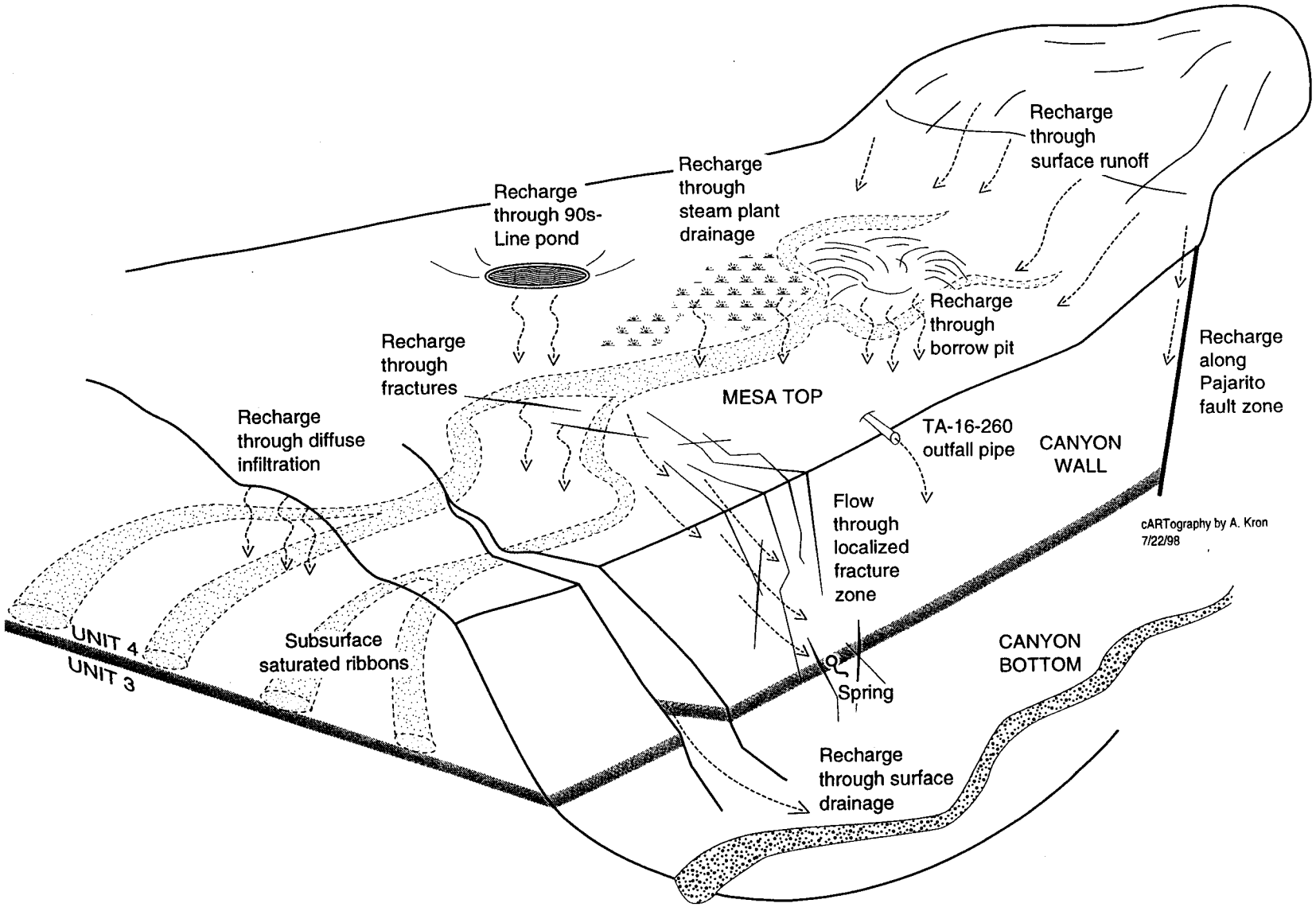


Figure 5.1-1. Major features of the TA-16 hydrogeologic conceptual model

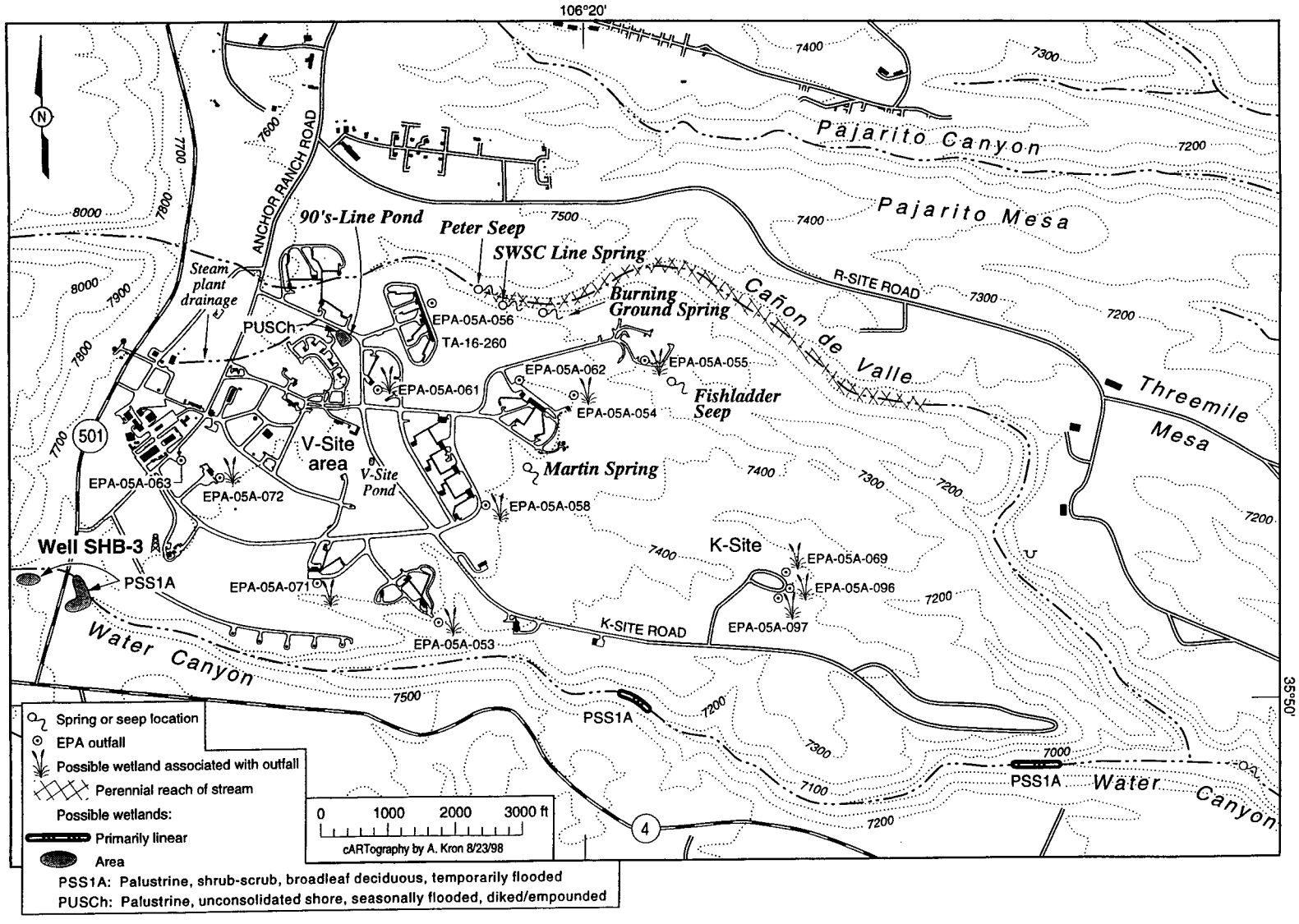


Figure 5.1-2. Boundaries of the TA-16 conceptual model—the area of interest is bounded by Cañon de Valle on the north, Water Canyon on the south, the Pajarito Fault zone on the west (approximated by highway 501), and the confluence of Cañon de Valle and Water Canyon on the east

- Transient recharge can occur via flow through fractures or other preferential flow pathways (this process is sometimes referred to as diffuse recharge because it is episodic and can occur at various, oftentimes difficult to identify, locations). The borrow pit located on the west end of TA-16 is an area where transient recharge might occur.

- The 260 outfall is a source of contamination for SWSC and possibly Burning Ground springs. Bromide tracer deployed at the outfall has been observed at SWSC spring. It may have also reached Burning Ground Spring (see Section 4.4). Because the tracer reached SWSC in a relatively short time (about 4 months) under generally unsaturated conditions, transient flow along fractures appears to be an important pathway for contaminant movement from the outfall. Matrix or porous media flow may be important as well based on the presence of contaminants in surge beds and the powder unit. However, the wet conditions needed to verify matrix flow with the tracer have not yet developed.

- Other pathways provide the bulk of the recharge to the springs. The 260 outfall has been decommissioned, yet the springs are still flowing. The outfall may have been volumetrically an important contributor to Cañon de Valle spring flow in the past, but this is no longer the case. However, this does not preclude the outfall area from being a significant contributor of contamination to the spring system.

- Contaminants in Martin Spring may be from another source than the 260 outfall. Martin Spring chemistry and flow behavior is substantially different than the Cañon de Valle springs.

- Surface runoff, erosion, and spring flow contribute contaminants to the Cañon de Valle alluvial aquifer. However, the effect of the springs is to dilute contamination in the alluvial aquifer. Subsurface flow may also contribute contaminants to the alluvial aquifer, however this has not yet been determined. Many of the processes that contribute contaminants to Cañon de Valle also contribute contaminants to the Martin Spring Canyon. Within the two canyons, surface runoff, subsurface flow, and erosion can redistribute contaminants to downstream locations and ultimately to Water Canyon.

- Human health and ecological risk estimates are based on the pathways and affected media identified in the hydrogeologic conceptual model.

5.2 Contaminant Fate and Transport

Because this report focuses on the 260 outfall, contaminant fate and transport from the outfall will be discussed first. A schematic of the outfall drainage stratigraphy and potential flow paths is shown in Figure 5.2.-1. As explained in Section 2, substantial inventories of contamination exist in the near surface of the outfall drainage, and contamination also exists at depth in the subsurface. The "spotty" contamination observed at depth in the outfall drainage boreholes indicates that contaminants are probably moving along preferential flow paths. The subsurface geology promotes preferential flow because of the large variation in hydraulic properties between and within tuff units (Figures 4.4-3, 4.4-4, and 4.4-5) and also because of the fractured nature of some of the tuff units.

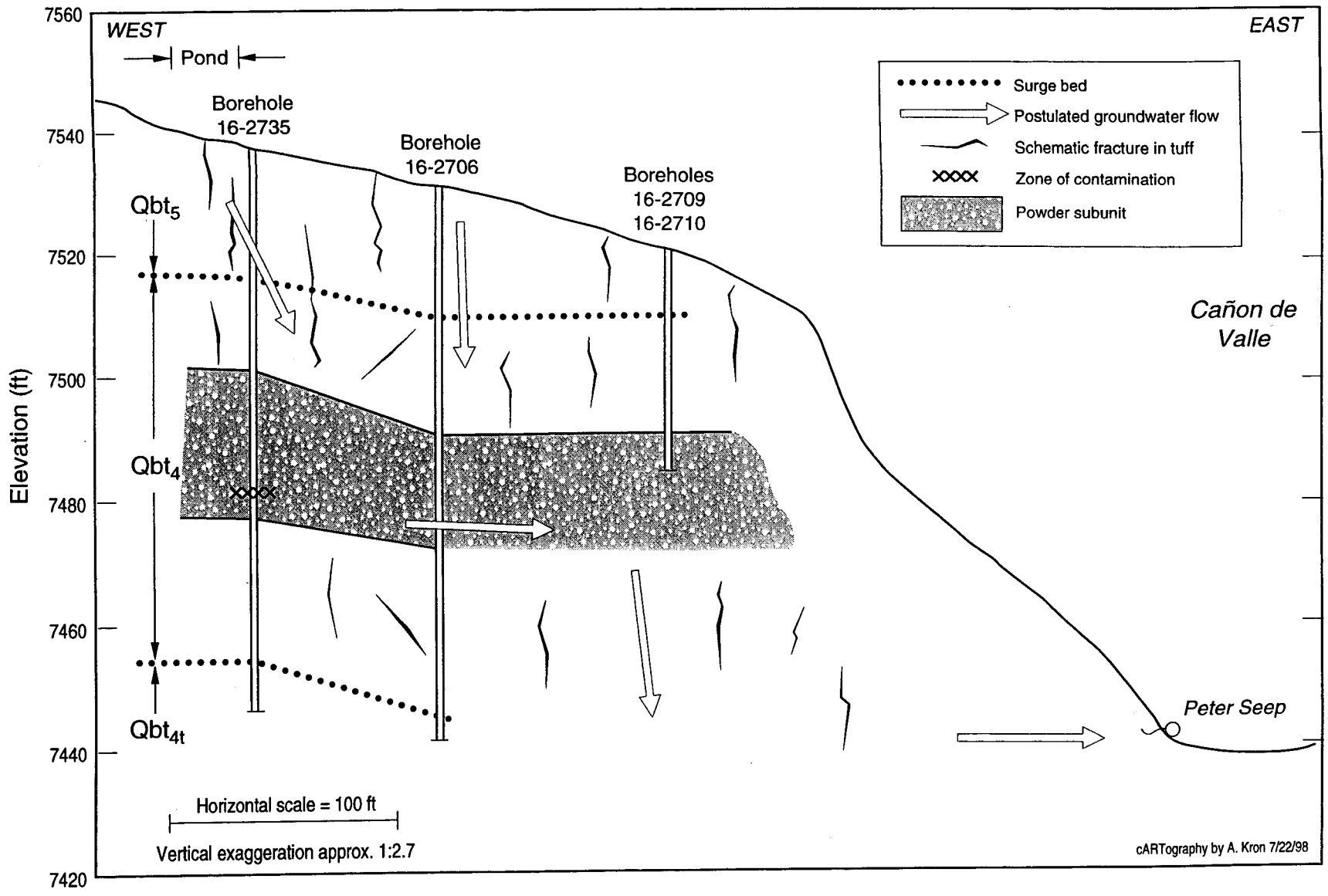


Figure 5.2-1. Conceptual hydrologic model for the TA-16-260 outfall area

The borehole data and tracer results also support the importance of transient flow events in controlling the fate and transport of contaminants from the outfall area into the deeper subsurface and into Cañon de Valle (pathways are shown in Figures 5.1-1 and 5.2-1). Transient saturated flow can occur in two main forms. First, fractures can act as intermittent fast flow pathways, even when the rock matrix is not saturated. The application of the bromide tracer at the 260 outfall was made on unsaturated tuff, yet in a few months bromide appeared in SWSC spring. This type of rapid transport is unlikely under unsaturated matrix flow conditions and strongly supports the idea that transients (episodic localized saturated flow) are important in controlling contaminant transport and distributions. The "spikey" appearance of the bromide breakthrough curve in SWSC spring (Figure 4.4-12) also supports fracture-controlled flow from the outfall.

A second type of transient saturated flow can occur when large inputs of water (e.g., spring snowmelt) temporarily saturate localized zones of the subsurface resulting in matrix flow, as opposed to fracture flow. For example, there is evidence that surge beds near the mesa edge become saturated at certain times. A saturated surge bed with an RDX concentration of 908 mg/kg was encountered at 16 ft in borehole 2700. The zone subsequently dried up. A saturated zone also appeared in borehole 2712 several months after it was drilled. It is possible that future transient flow events may create saturated zones in these and other boreholes again. However, because the outfall has been shut off (representing a loss of a million or more gallons of water per year), transient saturated zones may not develop as frequently or persist as long as they have in the past. Thus, contaminant transport may not occur as rapidly as it has in the past. The consequence of transient saturated flow events is that they can connect with the permanent saturated zones, providing both recharge and contaminants to the springs and possibly to Cañon de Valle directly via subsurface pathways that connect to the alluvial aquifer (Figures 5.1-1 and 5.2-1). Because transients are so difficult to characterize, they add a level of complexity that makes it difficult to understand contaminant fate and transport at TA-16 in a spatially detailed way.

The impact of the outfall contamination on Cañon de Valle is substantial. The bromide tracer results show that the outfall is supplying contaminants to SWSC spring and possibly to Burning Ground Spring (see Section 4). Both of these springs contribute contaminants to the alluvial system in Cañon de Valle. In addition, unidentified subsurface flowpaths, overland flow, and lateral subsurface flow (interflow) may also transport contaminants from the outfall to the alluvial aquifer. Overland flow occurs mainly by the infiltration excess mechanism (Wilcox et al. 1997, 57577), and is most active during intense summer thunderstorms and spring snowmelts. Bromide tracer has been observed in runoff from the outfall, indicating that contaminants may be moving along this pathway. BMPs are in place to reduce runoff into the canyon, but they mainly limit sediment transport and do not capture all of the surface runoff.

Lateral subsurface flow is a near-surface runoff process where localized saturated zones or macropore systems generate flow in a horizontal or lateral direction. The importance of lateral subsurface flow is suggested by the occurrence of groundwater during drilling at TA-16 and by the discontinuous appearance of contamination in borehole samples (Section 2). In addition, the similarity between TA-16 and the Los Alamos Ponderosa Pine Experimental Hillslope (where lateral subsurface flow is know to be important) suggests that lateral subsurface flow is a critical hydrologic process at TA-16. Other evidence for the importance of lateral subsurface flow comes from moisture content measurements at MDA-P. Nyhan (1989, 06890) discuses volumetric moisture content profiles that show saturated conditions in the soil zone and a dramatic decrease in moisture content at the soil/tuff interface. This type of moisture profile is characteristic of systems that generate lateral subsurface flow (Wilcox et al. 1997, 57577).

The 260 outfall may not be the only source of contamination to Cañon de Valle however. Both MDA-R and MDA-P may be contributing contaminants to the canyon. Monitoring data near MDA-P suggests that its impact on the canyon is minimal. The impact of MDA-R, however, is currently unknown. High concentrations of barium at Peter Seep, upgradient from the 260 outfall, suggest that MDA-R may be a source of contamination. The steam plant drainage is adjacent to MDA-R and could be recharging the springs and alluvial aquifer. If the steam plant flow is also reaching MDA-R, then contaminants may be transported from the MDA. However, it is also possible that the contamination at Peter Seep comes from the 260 outfall area, given the dip of the tuff units in that direction (Figures 4.4-3, 4.4-4, and 4.4-5) or because of fracture flow. Because Cañon de Valle has both surface and subsurface flow, and because the 260 outfall and other potential contaminant sources drain into Cañon de Valle, this is the most important pathway for redistribution of contaminants away from TA-16 and into downgradient locations such as the lower part of Water Canyon.

The fate and transport of contaminants from the alluvial aquifer are unknown. During large runoff events, contaminants will move into Water Canyon. The disappearance of the Cañon de Valle alluvial aquifer down-canyon from MDA-P suggests the possibility that there may be some subsurface transport to deeper units. The alluvial aquifer disappears shortly after it encounters Tshirege Unit 2, which is typically well fractured. This observation raises the possibility that alluvial aquifer waters recharge a deeper flow system. Drilling of deep boreholes R-25 and R-27 may shed some light on this uncertainty; subsequent investigations in collaboration with the Canyons Operational Focus Area will be required to resolve the subsurface recharge issue.

Contaminant movement in Cañon de Valle (and Martin Spring Canyon, as discussed later) can also occur by sediment transport. Sediment analyses reported in Section 3 indicate a variety of COPCs exist in the canyon sediments. The contaminants can move downstream as adsorbed phases on organic and inorganic materials during flood events, or if they enter the active channel in the perennial reach. Some contaminants, barium in particular, may also be transported as solid phases (e.g., barite and witherite; barium chemistry is discussed in Section 5.3). The residence time of contaminated sediments in the canyon is mainly governed by the magnitude and frequency of runoff and flood events, and the proximity of sediments to the active channel. Thus, sediment transport is not a steady-state process; instead, episodic events will control the rate of movement of contaminated sediments. In addition to sediment transport, the sediments can act as contaminant sources to canyon-bottom waters. Changes in chemistry can cause contaminants to desorb, or dissolve in the case of solid phases, contributing additional contamination to surface and alluvial aquifer waters. The observations of temporal and spatial variability of contaminant concentrations in alluvial waters (Section 3) suggest that contaminated sediments may be acting as a contaminant source (this idea is discussed further for barium in Section 5.3). Because of the limited sediment data it is difficult to quantitatively assess the relative importance of contaminated sediments versus contaminated waters and the relationship between them. The data do indicate that sediments could be important, and additional sampling (conducted in collaboration with the Canyons Focus Area) will be required to estimate contaminated sediment inventories.

In addition to the fate and transport of contaminants at the 260 outfall and Cañon de Valle, there are other parts of the TA-16 system that need to be addressed. One of the most important is Martin Spring. This spring has the highest HE contamination of the three springs at TA-16 and it discharges into a small canyon that drains into Water Canyon. It appears that Martin Spring flows from a different saturated ribbon system, or at least a different part of the system than the Cañon de Valle springs. There are two main pieces of evidence that suggest that Martin Spring contaminants are from an as yet unidentified source,

and that the flow system is different than the Cañon de Valle springs. First, Martin Spring has anomalously high boron concentrations (approximately 2000 µg/L). The Cañon de Valle springs do not have boron concentrations close to that level, which suggests another contaminant source on the mesa: one in which boron compounds (e.g., boracitol or boron-containing soaps) were used. In addition, discharge measurements at the three springs show that the flow dynamics at Martin Spring are distinctly different than the Cañon de Valle springs (see Section 4 for more detail on the Martin Spring boron and flow data). Because the spring contributes contaminants to Martin Spring Canyon, runoff and sediment transport processes will move contaminants down the canyon and into Water Canyon. However, information on Martin Spring Canyon is very limited and additional work will be required to assess contaminant inventories and mobility.

Another important part of the TA-16 hydrologic system is the 90's Line Pond (Figure 5.1-2). It is contaminated with HE and barium and may provide recharge to the springs system. It does not appear that the pond is a volumetrically important recharge source, although it may be an important contaminant source. The pond appears to be too small to support the flow that is observed in the springs, and stable isotope compositions of the pond and spring waters are substantially different (LANL 1996, 55077). If the 90's Line Pond was providing a substantial amount of water to the springs system, the springs waters would be isotopically much heavier (more positive) than they are now.

The last components of the TA-16 hydrologic system are upper Water Canyon, the Fish Ladder Seep, and K-site areas (Figure 5.1-2). Only limited information is available on the upper reaches of Water Canyon and the south side of the TA-16 mesa, and future investigations will be needed to understand the canyon system and contaminant transport. One item of interest is that the Water Canyon gallery is no longer diverting water from the canyon above TA-16. This means that Water canyon may become wetter than it has been during the last few decades. Fish Ladder Seep is an intermittent HE-contaminated seep that drains into a small subdrainage of Cañon de Valle. It might be part of the same saturated ribbon system that supplies SWSC and Burning Ground Springs, although it could be impacted by different contaminant sources. It has also received inadequate study and future investigation is needed to more fully understand the role it plays in contaminant fate and transport. K-site has been impacted by three outfalls and is the subject of a separate investigation.

5.3 Contaminant Persistence and Chemistry

The principal COPCs for the 260 outfall include HE species and barium. Each of these will be discussed separately because different processes govern their mobility and persistence. Additional COPCs are discussed briefly at the end of this section.

A summary of the physical and chemical properties of HE species that govern environmental fate are provided in Table 5.3-1. HE species can be transported into and within the canyons as solid pieces by erosion of soil and sediment. HE is also mobile in the aqueous phase where it can move either as a dissolved phase (solubilities are shown in Table 5.3-1) or as a colloid. The HE species tend to have low adsorption, except in organic rich environments (Layton et al. 1987, 14703). The different HE species have some variation in the degree that they adsorb, which is reflected in the variation in K_{oc} values in Table 5.3-1. HE species are also susceptible to different degrees of microbial decay (Layton et al. 1987, 14703). At this time, some microbial decay may be occurring at TA-16. However, the effect of microbial decay is probably minimal, given the inventory and the amount of HE in chunk form (which is resistant to microbial decay). Microbial decay will become more important in the long term when concentrations are lower and

the chunk HE has been removed. Microbial decay occurs mainly under anaerobic conditions for RDX and HMX, while TNT can undergo breakdown by a variety of aerobic and anaerobic microorganisms (Layton et al., 1987, 14703). In addition to the microbial breaking down of HE, plants can also process HE. It is currently unknown, however, what amount of phyto-uptake occurs around the TA-16 outfall or in Cañon de Valle. Photolysis is another process that can breakdown HE contaminants. This process may only be important for surface HE and HE in the stream channel of Cañon de Valle where ample sunlight is present.

Table 5.2-1

Solubility and Sorption Characteristics of HE and HE By-products

Constituent of Potential Concern	Water Solubility (mg/ll)	Log K_{oc}	Henry's Constant (atm-m^3/mol)	Environmental Fate	Primary Location in Environment
2-amino-4,6-DNT	2800	0.15	~4 E-9	Gradual movement through soils and groundwater, should bind to humic acids and other organic matter	Subsurface soils and groundwater
4-amino-2,6-DNT	2800	0.26	~1 E-9	Gradual movement through soils and groundwater, should bind to humic acids and other organic matter	Subsurface soils and groundwater
1,3-DNB	533	1.56	1.8 E-7	Gradual movement through soils and groundwater	Subsurface soils and groundwater
2,4-DNT	280	2.4	1.86 E-7	Gradual movement through soils and groundwater, diffusion of both vapor and aqueous phases through soil in soils receiving limited water infiltration	Subsurface soils and groundwater
2,6-DNT	206	1.89	4.86 E-7	Gradual movement through soils and groundwater, diffusion of both vapor and aqueous phases through soil in soils receiving limited water infiltration	Subsurface soils and groundwater
HMX	2.6 or 5.0	2.11	1 E-16	Leaching through soils	Subsurface soils and groundwater
PETN	2 or 32	1.83	4 E-10	Leaching through soils	Subsurface soils and groundwater
RDX	42.2	0.89 to 2.43	6.58 E-12	RDX does not strongly adsorb to soils and sediments, soil adsorption affects RDX migration only in soils with an organic content >0.25 wt %	Subsurface soils and groundwater
Tetryl	75	2.43	2.0 E-12	Leaching through soils	Subsurface soils and groundwater
1,3,5-TNB	385	2.82	9 E-8	Gradual movement through soils and groundwater	Subsurface soils and groundwater
TNT	123	2.67 to 3.2	2.6 E-9	Migration of TNT is affected in soils with a cation-exchange-capacity (CEC) >10 meg/100 g, vapor-phase diffusion only important in soils where water infiltration is low	Subsurface soils and groundwater

Source: Adapted from RFI Work Plan for OU 1082, Addendum 1 (LANL 1994, 52910, Appendix D)

Barium is not susceptible to microbial breakdown, and its behavior is more influenced by inorganic geochemical processes than HE. Cation, anion, and pH analyses for the springs and alluvial waters were used as inputs to the PHREEQEC V. 1.6 (Parkhurst 1995, 54555) geochemical code to examine the geochemical controls on barium. PHREEQEC calculates aqueous speciation and mineral saturation indices from the chemical input data. The results suggest that the spring and alluvial aquifer waters are supersaturated with barite ($BaSO_4$) (Details of the modeling runs are included in Appendix F). This result is consistent with the common occurrence of barite in sediment samples from Cañon de Valle (Appendix F). The other solid phase that controls barium distributions at TA-16 is witherite ($BaCO_3$). PHREEQEC results indicate that the spring and alluvial aquifer waters are undersaturated with witherite (Appendix F). However, witherite has been found in a few of the Cañon de Valle sediment samples. Some witherite in the canyon may come from eroded mesa top sediments (such as the MDA-P area), but more likely, witherite is precipitating in Cañon de Valle. PHREEQEC calculations suggest that increasing pH and carbonate concentrations will cause witherite to precipitate. Simple dewatering could cause these conditions to be met, and so we would expect to find witherite along the margins of the alluvial aquifer where evaporation or transpiration are most evident. It is interesting to note that if alluvial aquifer waters resaturate an area containing witherite, witherite would dissolve, and barium concentrations would rise. This idea is consistent with the observation of dissolution features in witherite samples from Cañon de Valle (Appendix F). Thus, witherite may play an important role in controlling the spatial and temporal variation in barium concentrations in Cañon de Valle. The PHREEQEC results indicate a consistent distribution of ionic species in both the spring and alluvial aquifer waters (Appendix F). The ionic species distribution is, in decreasing concentration order, Ba^{2+}, $BaSO_4$, $BaHCO_3^+$, $BaCO_3$, and $BaOH^+$. Ba^{2+} is the dominant aqueous species, with molalities between 10 to 100 times that of $BaSO_4$.

Because barium concentrations are high enough that barite and sometimes witherite precipitate, residence times in the vicinity of the 260 outfall and TA-16 should be greater than for HE. In addition, because most of the dissolved barium is in a divalent cationic form ($^{2+}$ ion), barium will be highly retarded because of sorption processes on immobile inorganic and possibly organic phases.

Other COPCs at TA-16 are metals and organic compounds (see Sections 2.4.3 and 3.4). The metals of concern include antimony, arsenic, cadmium, chromium, copper, cyanide, lead, manganese, mercury, nickel, selenium, silver, uranium, vanadium, and zinc. Metals can be transported both as colloidal and dissolved phases. However, because of sorption and precipitation, metals can have long residence times. The mobility of the metals is governed largely by the Eh and pH conditions in the waters, soils, sediments, and tuff at TA-16. The Eh and pH conditions are strong controls on the speciation of metals which affects the solubility and sorption of the metal phases. For example, hexavalent (+6) chromium is more mobile than trivalent (+3) chromium. Because the metals may encounter varying Eh and pH conditions in the 260 outfall/Cañon de Valle environments, mobility of the metals may change depending on what part of the TA-16 hydrologic system the metals are in. Cañon de Valle contains many of the same metals as the 260-outfall drainage, which suggests that some transport of metals has occurred from the outfall. However, the outfall may not be the only source of metals to the canyon.

The volatile organic COPCs include acetone, benzene, butylbenzene, dichlorobenzene, isopropyltoluene, toluene, trichloroethane, and trimethylbenzene. The semivolatile COPCs include anthracene, benzoic acid, bis(2ethylhexyl)pthalate, dichlorobenzene, dinitrotoluene, hexachlorocyclopentadiene, nitrosodimethylamine, nitrosodiphenylamine, phananthrene, and pyrene (see Sections 2 and 3 for a more complete discussion of organic COPCs). The organics are subject to the same degradation processes as HE and some are also subject to volatilization. The mobility of an organic

phase is a function of whether the compound is a light or dense non-aqueous phase liquid (sometimes referred to as LNAPL or DNAPL), its solubility (generally, solubilities are low), and its hydrophobicity. Like the metals, organics have been found above background in Cañon de Valle, which suggests that some transport has occurred from the outfall. Because of the various degradation processes, the residence time of organics at TA-16 should generally be less than the metals.

5.4 Implications of Conceptual Model for the Human Health Pathways Exposure Model

Based on discussion presented throughout this section the following media are identified as those for which exposure to human receptors is possible: soil, surface water from springs, surface water from seeps, and sediment. Exposure to subsurface soils and groundwater are not considered viable pathways at TA-16, as will be more fully discussed in following sections.

The choice of appropriate receptors for consideration at TA-16 is realistically based on land use at the site. Based on negotiations with NMED's Hazardous and Radioactive Materials Bureau (HRMB) personnel and LANL's documentation of the future, industrial land use at this PRS and study area (LANL 1998, 59173), a strategy to approach human health risk-based decision making for the CMS process at the 260 outfall site has been developed. This strategy involves evaluating only the industrial exposure scenario for decision making, rather than integrating residential exposure scenarios into the analysis. The use of this strategy more accurately reflects the projected future land use of the site.

This strategy is based on the following justification:

1. TA-16-260 is an active, HE-machining facility located in the heart of the High Explosives R&D and Testing Area of the Laboratory. This area of the Laboratory is industrial, and the land use for this property is slated to be continued Laboratory operations as the High Explosives R&D and Testing Area.

2. The future land use of the site is described in the Land Use Master Plan and Future Land Use Map for the Laboratory. The Master Plan and Future Land Use Map are a part of the 1990 LANL Site Development Plan and Annual Update 1995 (LANL 1995, 57224). The Site Development Plan is a master planning document covering a 20-year period. The Master Plan and Future Land Use Map represent the Laboratory's plan for the future use of the site. These documents demonstrate that no change in the industrial land use designation for this area of the Laboratory is expected.

3. The potential for human exposure to contaminants in the environment at this site is very low. This is a highly secure area of the Laboratory and access to the public is not allowed. Access for a worker is also very restricted. Due to safety restrictions, actual access behind the 260 HE machining building is not allowed during machining operations. LANL believes that the worker with the highest potential for exposure at this site is the environmental worker obtaining samples in support of the RFI/CMS process.

Therefore, the industrial exposure scenario evaluation is most realistic as a decision-making tool for human health risk-based decisions at this site. The following industrial exposure scenarios are proposed for evaluation during the RFI process:

- environmental worker
- worker trail user, and
- industrial/construction worker.

Each of these receptors is potentially exposed to one or more contaminated media as discussed previously in this section. The pathways and exposure routes quantified for the screening assessment in Section 6 are shown in Figure 5.4-1. Further discussion of exposure pathways and routes evaluated is provided in Section 6.

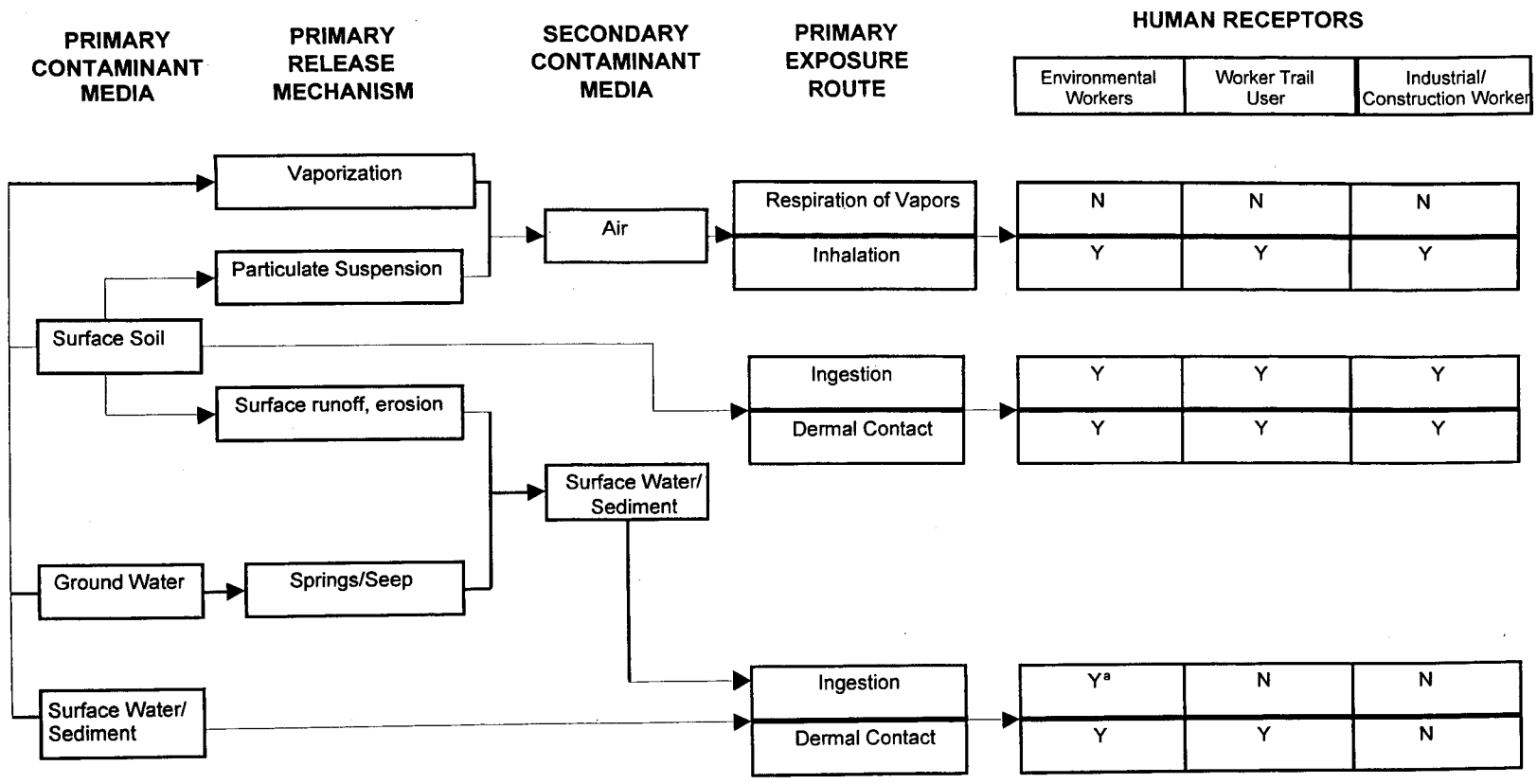
5.5 Implications of Conceptual Model for the Ecological Pathways Conceptual Exposure Model (EPCEM)

Based upon the site conceptual model developed thus far, media that are likely to be encountered by biotic organisms in the area of PRS 16-021(c) (260 outfall) include soils, aquatic (channel) sediments, surface water (including springs and seeps), and shallow (<5 feet) alluvial water. Deep alluvial water (groundwater) and buried tuff are highly unlikely to reach, or be reached by ecological receptors. The Ecological Pathways Conceptual Exposure Model (EPCEM) follows from the site conceptual model and is a detailed treatment of the potential pathways that contaminants may reach ecological receptors. The EPCEM is presented in Appendix D-3.1 and is discussed in detail in Section 6.3.5 of this report. The general concept of media exposure to ecological receptors is characterized in Figure 5.1-1.

The 260 outfall site is part-and-parcel an integral section of Cañon de Valle. There is no distinction, in terms of its ecology or biotic associations, that can be made for the site that might set it apart from the rest of Cañon de Valle.

Receptors for the ecological screening assessment were chosen (Kelly et al. 1998, 57916) to be broadly representative of organisms found in a functional food chain in the greater Los Alamos area. Nine terrestrial receptors have been chosen for ecological screening purposes at LANL; however, there are currently no aquatic ecological receptors identified for screening. The nine terrestrial receptors include a "generic" plant, a soil-dwelling invertebrate (an earthworm), an American robin (avian invertebrate eater), an American kestrel (avian invertebrate/flesh eater), a peregrine falcon (the American kestrel with a 100% flesh diet as a surrogate), a deer mouse (mammalian omnivore), a vagrant shrew (mammalian invertebrate eater), an desert cottontail (mammalian herbivore), and a gray fox (mammalian flesh eater).

Decision-making, with respect to ecological risk, is evaluated here based upon the site conceptual model, the EPCEM, and the methods set forth in Kelly et al. (1998, 57916). Both terrestrial and aquatic exposure pathways are considered in Section 6.3. Section 6.3 details the ecological scoping and screening processes. No site-specific ecological risk assessment will be performed for this RFI report, as these methods have not yet been developed.



[a] for sediment only

Figure 5.4-1. Human health pathways conceptual exposure model

Attachment C

Section 3 of the CMS Plan for PRS 16-021(c)

3.0 CORRECTIVE MEASURES OBJECTIVES AND SCOPE

3.1 Setting

3.1.1 Areal Extent and Administrative Boundary

The administrative boundary for the CMS is shown in Figure 3.1-1. The boundary runs along State Route 501, which coincides with the Pajarito Fault to the west, and follows the basin divides between Water Canyon and Cañon de Valle to the south, as far as Martin Spring Canyon and Pajarito Canyon, and Cañon de Valle to the north. These basin divides converge at the confluence of Cañon de Valle and Water Canyon. This area will be referred to as the Cañon de Valle basin. The areal extent of the study includes all of the surface and subsurface terrain within the boundary except (1) individual PRSs and associated downgradient areas to the edge of Cañon de Valle and (2) Fish Ladder Seep and its sub-basin. These potential contaminant sources are being addressed within the scope of other ER Project activities.

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

3.1.2 Four Component Conceptual Model

The conceptual model used in the CMS is composed of four components: the contaminant source area, the subsurface, the transport pathways and springs, and the alluvial system in the canyon bottom (Figure 3.1-2). Sources of recharge to the mesa, springs, and canyon alluvial system are inputs to the model. Structuring the conceptual model in this manner identifies and separates the parts of the physical system that warrant individual remediation or monitoring approaches. For example, approaches to addressing the contaminant source area are different from approaches to addressing contaminants in the springs. The four components are combined into one conceptual model because transport mechanisms result in interactions among the components. Contaminants in the source area impact the unsaturated subsurface, which impacts the springs and seep, which impact the alluvial system. As the conceptual model shows, anything that affects one component of the model is also likely to affect other downgradient components.

The source area will be addressed by the IM proposed in the Phase II RFI report that is being submitted concurrently with this CMS plan. The details of the IM will be provided in a separate IM plan to be submitted during FY99. The IM will require removal of all highly contaminated soil and tuff in the TA-16-260 outfall, pond, and drainage and characterization of low levels of contamination present in the residual soil and tuff. The subsurface consists of the volume of the mesa that connects the source area to the seep, springs, and the canyon alluvial system. This is a physically complex system including multiple geologic units, fracture sets, and porous media. Phase II drilling results show that there are low levels of HE (less than 10 mg/kg) in this part of the system. These data suggest that transport occurs along preferential flow paths controlled by stratigraphy and fractures rather than through a large plume in porous media.

The transport pathways and springs component of the conceptual model specifically addresses contaminant transport in the subsurface from source areas and the unsaturated subsurface. Sources of

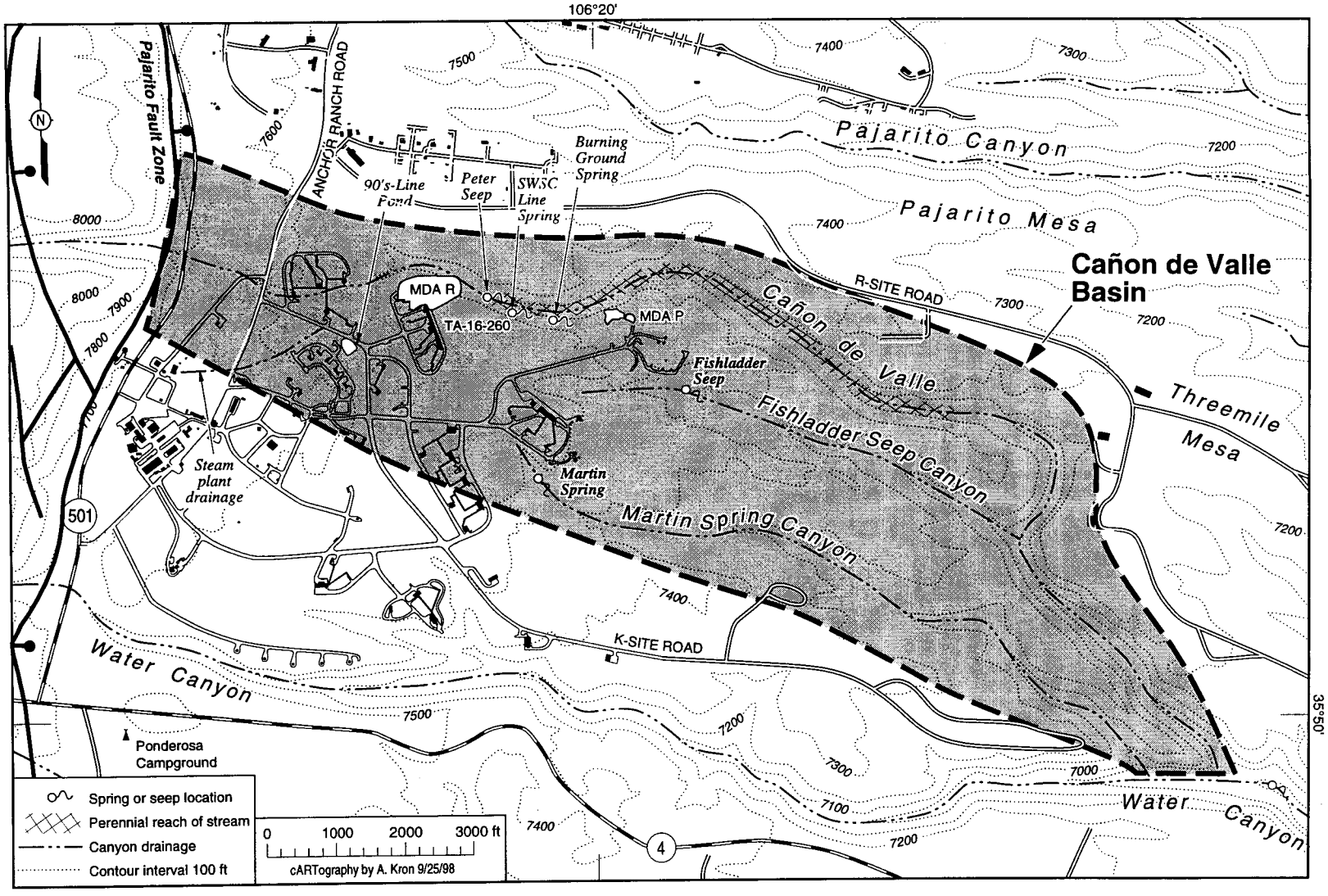


Figure 3.1-1.Administrative boundaries for PRS 16-021(c) CMS/CMI.

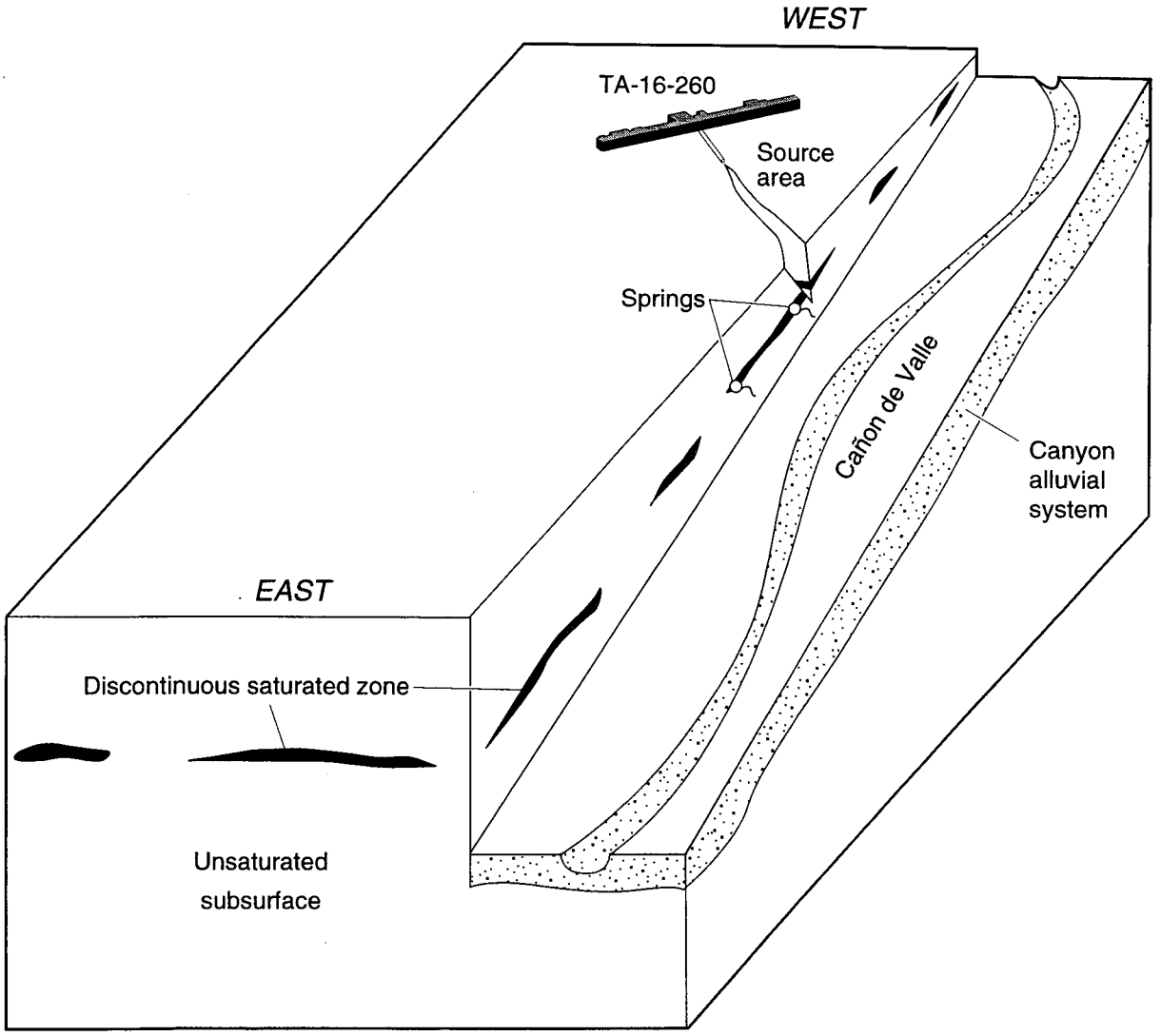


Figure 3.1-2 Simplified conceptual model for TA-16-260, PRS 16-021(c) contaminant dispersal.

recharge to these pathways and the interactions between recharge and primary or secondary contaminant sources are essentially unknown. Data from the Phase II RFI show that these pathways are highly dynamic. Rates of spring flows range over 1 order of magnitude. The hydrographs show multiple responses to individual storms, as well as changes in base flow rates with season. Contaminant abundances and types also change as discharge changes. The alluvial system is presently considered a receiving system for contaminants transported from the mesa. Concentrations of contaminants vary among the different components of the alluvial system: surface water, alluvial aquifer, and sediments.

The connection between the alluvial system, the deeper perched aquifer(s), and the regional aquifer is an important issue that is in part being addressed by the site-wide hydrogeologic investigation (LANL 1996, 55430). Well R-25 will be drilled approximately 2000 ft to the east of the TA-16-260 outfall during late FY98 and early FY99. Well R-27 is currently scheduled to be drilled at the confluence of Cañon de Valle and Water Canyon during FY2000. Both wells could potentially provide useful information on subsurface transport phenomena near PRS 16-021(c) and may identify other perched aquifer systems. LANL will include a detailed discussion of results from these wells in a future report focused on PRS 16-021(c), either the Phase III RFI report or the CMS report. The results of R-25 and R-27 drilling could potentially drive further sampling of the deeper subsurface system in association with the CMS/CMI for PRS 16-021(c).

3.2 Remedial Approach

The proposed remedial approach for the TA-16-260 outfall is to perform a CMS/CMI for the residual contamination left in the source area and the remainder of the hydrogeologic system contaminated by discharges at PRS 16-021(c). The source area is contaminated at levels up to 20% HE by weight and 3% barium by weight. It is estimated that removal of approximately 2500 $yd^3$of material in the source area would eliminate 80–95% of the contaminated media in the 260 outfall region. Conducting a SSRA to justify the IM removal is not useful or necessary.

The IM will be performed according to what is feasible in terms of engineering rather than to remediation concentration goals because the contaminant concentrations drop quickly with depth. To achieve the best possible results, remedial approach evaluations conducted in the CMS will support selection of waste treatment options used in the IM. There are known to be low levels (less than 10 mg/kg) of contaminants at depths to 70 ft below ground surface. These contaminated locations cannot be reliably predicted and will be left in the unsaturated subsurface when the IM is complete. The CMS treatability studies and the CMS Phase III sampling will focus on evaluating remediation options for the remainder of the hydrogeologic system. Remediation for other components of the physical system will depend upon monitoring results for transport pathways, including the springs, seep, surface water, and alluvial water. Decisions to remediate water will depend upon concentrations, potential exposures, observable biological effects, and applicable relevant and appropriate regulations (ARARs). Methods to be considered will include active and passive treatment systems, phyto-remediation, and natural monitored attenuation.

3.2.1 Parallel Tracks of Action and Monitoring

The physical system addressed by the CMS consists of four components that are related by transport pathways (see Subsection 3.1.2). Changing the contaminant mass in one component of the system eventually affects the contaminant mass in other components downstream. Routine monitoring will be established for the springs and alluvial system before remedial actions are taken. This monitoring will make it

possible to evaluate trends in the types and levels of contaminants present over time and to assess the efficacy of the remediation, particularly the impact of the IM on contaminants in the remainder of the hydrogeologic system. Analysis of the baseline monitoring data will be used to finalize the long-term monitoring program.

3.3 Objectives of the Corrective Measures Study

The overall objective of the CMS and subsequent CMI is to ensure that contaminant concentrations within the four components of the site conceptual model (as discussed in Section 3.1.2) meet acceptable levels relative to human health and ecological criteria. The primary objective of the CMS is to select the remedial technologies that will be used to achieve media cleanup standards (MCSs) in each of the four components of the site conceptual model. A fundamental component of this selection process will be the evaluation of candidate technologies in bench-scale and pilot-scale studies. An additional objective of the CMS is to define preliminary MCSs for each of the four conceptual model components. These cleanup standards will be based extensively on human health and ecological risk criteria. The CMS will also define regulatory points of compliance (POCs) for the four components of the site conceptual model. POCs are developed and negotiated with the AA as monitoring locations to determine if MCSs have been achieved. Preliminary POCs are proposed in Section 3.4.2 of this CMS plan.

Existing data from previous investigations and additional site characterization data will be used to meet the objectives of the CMS outlined above. This plan discusses in the following subsections the fundamental data objectives, the adequacy and source of existing data, and the need for additional data for each component of the site conceptual model. Chapter 6 of this plan also presents PRS 16-021(c) RFI Phase III sampling investigations for collecting the majority of the required additional data.

3.3.1 Investigation Objectives

The objectives of investigation to support the CMS are (1) to define the extent of contamination, and (2) to characterize the behavior of active transport pathways for specific components of the site conceptual model. Sufficient data generated in previous investigations may already meet one or both of these objectives for certain components of the site model. For example, the nature of contamination has been adequately addressed in previous RFI reports. The following subsections discuss the existing data and the need for additional data relative to these two objectives for each model component. The sections also discuss explicitly how the additional objectives support the CMS. The individual objectives are numbered investigation objective (IO) 1 , IO2, etc. This numbering scheme is then used in Chapter 6 to show the correlation of the investigation objectives presented here to the site investigations presented in Chapter 6.

3.3.1.1 The Contaminated Source Area

Nature and Extent, IO1

As stated previously, an IM will be implemented at the source area prior to the CMS. The extent of residual contamination remaining in the source area will require characterization. This investigation will be designed in conjunction with the IM plan and is, therefore, not included in the RFI Phase III investigation presented in this report. The data generated in the post-IM investigation will be used to support the selection of a remedial technology for the post-IM source area. The nature of contamination has been adequately characterized by previous investigations.

The post-IM sampling plan will focus on determining the mean contaminant concentrations remaining in the area. This data will then be used to support the risk-based contaminant concentrations proposed as MCSs in the CMS report. The sampling plan will also focus on identifying points of maximum contaminant concentration to support the definition of the POC for the source area.

Transport Pathways, IO2

The drainage channel associated with the source area will remain a potential surface contaminant transport pathway following the IM. The extent data generated during the post-IM sampling, along with existing extent data, will be used to estimate contaminant inventories remaining in the drainage channel and will be used to support the selection of remedial technologies for the drainage channel and POCs for the entire source area. The surface transport pathway within the source area is well understood and the nature and extent data should be sufficient to make meaningful calculations of future risk to potential receptors.

The subsurface transport pathways are discussed in subsection 3.3.1.3

3.3.1.2 Unsaturated Mesa Subsurface

Nature and Extent of Contamination, IO3

The nature and extent of subsurface contamination in the unsaturated subsurface has been evaluated in both the source area and the intermediate-depth subsurface phases of the PRS 16-021(c) RFI Phase II investigation. An additional borehole will be drilled in the source area to a total depth of 80 ft as part of the post-IM investigation. Data from this borehole and previous investigation data are expected to be sufficient to finalize the evaluation of the unsaturated mesa system. This data will support the remedial technology decision for this component of the site conceptual model. It is currently anticipated that due to the low expected contaminant concentrations and the lack of a viable exposure route to receptors, MCSs and POCs will not need to be defined for this conceptual model component.

Transport Pathways, IO4

Transport pathways connecting the unsaturated subsurface to groundwaters, such as intermediate perched aquifers or the regional aquifer, will be evaluated following the same phased approach proposed in Section 3.4.2.3. The phased approach will be used to support decisions on whether remediation of deeper groundwater is necessary and, if so, the selection of remedial technologies for this component of the site conceptual model.

3.3.1.3 Transport Pathways and Associated Springs

Nature and Extent of contamination, IO5

Dynamics in the physical behavior of the springs are expected to have significant impacts on contaminant concentrations and fluxes observed at the springs. As a result, the physical behavior of the springs and the relationships between flow rate and contaminant concentration must be understood in order to evaluate the nature of contamination observed at the springs and the short- and long-term trends in springs contaminant data. Understanding trends in spring contaminant data, in turn, directly effects all three objectives of the CMS. Trends in springs' contaminant data must be evaluated in order to assess the viability of natural attenuation as a remedial alternative. Furthermore, trend data must be understood in order to assess the effectiveness of the

source removal. This has implications for establishing MCSs at the source area. MCSs at the springs themselves may also be based on a set of data that more accurately measure maximum expected contaminant concentrations or fluxes. In addition, the physical behavior of the springs must be understood in order to establish an effective monitoring strategy. This, then, is of paramount importance for demonstrating compliance with MCSs.

The nature and extent of contamination as observed at the springs has been evaluated in several investigations, most recently in association with the PRS 16-021(c) Phase II investigation. Significant additional investigations are proposed in Chapter 6 that primarily focus on establishing the physical behavior of the springs.

Transport Pathways, IO6

Understanding the transport pathways connecting the source area to the seeps and springs is necessary for evaluating exposures to potential receptors at the seeps and springs. This information will then be used directly to support the CMS objective of selecting an appropriate remedial technology for the seeps and springs. Source-to-springs transport pathways are currently being evaluated in an ongoing potassium bromide tracer study. The results of the study to date are discussed in the Phase II RFI (LANL 1998 in preparation). However, because only a small mass of tracer has been observed in the springs, additional sampling in support of the tracer study is presented in Chapter 6.

3.3.1.4 Alluvial System Surface and Groundwaters

Nature and Extent of Contamination, IO7

The nature and extent of contamination in surface and groundwaters in both Cañon de Valle and Martin Spring Canyon is needed to support the remedial technology decision for this component of the site conceptual model. This data is also necessary to define the groundwater POCs for both Martin Spring Canyon and Cañon de Valle. In addition, the nature of the physical system and the interactions between the surface water and groundwater component of this system need to be defined. This will provide the basis for developing long-term monitoring strategies for the alluvial surface and groundwater systems that will be required for demonstrating compliance with MCSs.

Cañon de Valle has been sampled several times, most recently as part of the PRS 16-021(c) RFI Phase II investigation. Martin Spring Canyon has not been sampled to date. Current data does not adequately define the nature and extent of contamination in this component of the conceptual model. This plan describes additional sampling to be conducted as part of the RFI Phase III investigation presented in Chapter 6.

Transport Pathways, IO8

Transport pathways connecting alluvial groundwaters to other groundwaters, such as intermediate perched aquifers or the regional aquifer, will be evaluated following the same phased approach proposed in Section 3.4.2.3. The subsurface transport pathways between the source region and the alluvial system and deeper groundwaters will probably be indistinguishable, given the scale of hydrogeologic processes. The phased approach will be used to support the selection of remedial technologies for this component of the site conceptual model. Some preliminary information on the potential impacts of the alluvial groundwater systems on deeper systems will be generated in the water mass balance studies proposed in Chapter 6.

Alluvium

Nature and Extent of Contamination, IO9

The nature and extent of contamination present in canyon alluvium is necessary to select the appropriate remedial technology for this component of the site conceptual model. The data will also be used to perform risk assessments to establish MCSs and establish compliance with the negotiated cleanup standards.

The alluvium in Cañon de Valle has been investigated previously, most recently during the PRS 16-021(c) RFI Phase II sampling campaign. The existing data is not sufficient to determine the mass of contaminants stored in the alluvium; sampling proposed in Chapter 6 is designed to address this concern.

Transport Pathways, IO10

Interactions between contaminants stored in canyon alluvium and surface and groundwaters is not currently understood. It is not known if a large mass of contaminants stored in alluvium can act as a continual source impacting the surface water and groundwater transport pathways. The alluvium contaminant inventory investigation proposed in Chapter 6 will provide data that can be used to predict the impacts of stored contamination on these transport mechanisms.

3.4 Institutional Considerations

3.4.1 Land Use

TA-16 is planned for continued operation as an HE production and machining facility. Consequently, the area within the administrative boundary is subject to controlled access. Industrial land use is being used as the driver for exposure scenarios in human-health risk assessments, as documented in a letter from DOE to the NMED Hazardous and Radioactive Materials Board (HRMB), {"Request To Use Industrial Exposure Scenarios In Lieu Of Residential Scenarios For Human Health Risk Assessment In 260 Outfall [PRS 16-021(c)] RFI/CMS Process (Former OU 1082, FU 3).(LANL:1998, 59173).

3.4.2 Establishment of Media Cleanup Standards

MCSs will be developed as part of the CMS and recommended to the AA in the CMS report. Following the CMS, MCSs will be included in the LANL permit modification as constituent concentrations in soil and water that must be achieved for successful completion of the corrective action [proposed 40 CFR 264.525(d)] unless a determination is made under proposed 40 CFR 264.525(d)(2) that remediation to MCSs is not required.

As stated in *The General Standards for Corrective Measures* [proposed 40 CFR 264.525(a)], there are several types, and uses, of MCSs that need to be clarified. Target MCS s are not cleanup goals or action levels, but "...are preliminary cleanup goals established during the CMS to provide a benchmark for evaluating the effectiveness of the alternatives for the corrective measure." The final MCSs are actual remediation goals that must be attained for release of the site from the RCRA corrective action process. Section 3.4.3.1 describes the derivation and identification of target MCSs. Final MCSs, recommended to the AA, will be determined in the CMS process following completion of the IM, Phase III investigation, and the site-specific human and ecological risk assessments. This process is discussed briefly in Section 3.4.3.2.

Site constituents for which MCSs will be developed were identified in the Phase II RFI report (FY98) as COPCs to be carried forward into the CMS. These COPCs were determined from the following activities:

- a human-health screen to site-specific action levels (SSALs),
- an ecological screen to ecological benchmark values, and
- other applicable regulations (where appropriate).

3.4.2.1 Target MCSs

Target MCSs are generally derived by calculating concentrations in specific media that are protective of human health. These calculations are performed according to standard approved methodology provided by EPA and NMED. This approach was used to calculate SSALs for screening purposes in the Phase II RFI report (LANL 1998, in preparation). Therefore, it is proposed that these SSALs be used in the CMS as target MCSs. Complete details on derivation of these levels are provided in the Phase II RFI report.

Table 3.4.3-1 provides a list of constituents, by medium, that were identified as COPCs, based on human health screening, to be considered in the CMS along with the target MCS. The site-specific persistent bioaccumulators are also listed in this table.

Table 3.4.3-1

TARGET MCSs FOR COPCs BASED ON HUMAN HEALTH RISK SCREENING

COPC	Target MCS
Soil	mg/kg
Barium	5320
Bis(2-ethylhexyl)phthalate	48.7
HMX	639
RDX	6.19
2,4,6-Trinitrotoluene	227
Water	µg/L
Barium	1620
Lead	[a]
RDX	72.6

[a]No risk-based MCS for lead in water has been determined at this time.

3.4.2.2 Final MCSs

The CMS report will propose final MCSs for each site conceptual model component, media, and COPC. Many factors will be taken into consideration when establishing final MCSs during the CMS. These include the results of SSRAs for human health and ecological receptors, exposure issues specific to TA-16, and applicable regulations or promulgated standards. Other issues that will be considered, as set forth in proposed 40 CFR 264.525(d), include:

- effects of multiple contaminants in each environmental medium,
- environmental receptors that are threatened by the release,
- evaluation of the cumulative risk when populations may be exposed to multiple sources or through multiple pathways, and
- factors specific to the corrective measure under consideration, including reliability, effectiveness, practicality, and other factors.

The CMS report will also provide a petition to the AA to make a determination that remediation to a site conceptual model component-, media-, and contaminant-specific MCS is not required if:

- there is no threat of exposure to the contamination,
- remediation to MCSs will not result in any significant reduction in risk to humans or the environment, or
- remediation to MCSs is technically impracticable [proposed 40 CFR 264.525(d)(2)]

This petition will provide a careful evaluation of the technical circumstances involved and clear and convincing information supporting this recommendation.

3.4.3 Points of Compliance

Under 40 CFR 264.525(e)(1)(i)-(v) of the proposed Subpart S rule, the POC is the point(s) or area(s) where a facility must demonstrate compliance with MCSs. The location of the POC is medium-specific and depends on factors such as the potential for exposure of human or ecological receptors, the potential for migration, the potential for impact to sensitive ecosystems, and accessibility. In the absence of final corrective action regulations specifically addressing points of compliance, POCs are developed on a site-specific basis. It should be noted that a POC can be defined as an area with the potential for exposure to receptors (CFR 1995, 56034). Specific locations within these areas that are representative of the exposure to specific receptors are then selected as sampling locations to demonstrate compliance with the MCS.

Four preliminary POCs are proposed in this CMS plan. Each POC covers a different medium or system. The preliminary POCs will be refined during the CMS as additional information is obtained and remedial approaches are selected. Final POCs will be proposed to the Administrative Authority (AA) in the CMS report.

3.4.3.1 Soils and Alluvium

The preliminary POC for soils is any point where direct contact with a receptor may occur. This will extend within the 260 outfall drainage from the outfall to the confluence with Cañon de Valle. The preliminary POC for alluvium is any point in Cañon de Valle and Martin Spring Canyon within the area of contamination defined in Chapter 2 where direct contact with a receptor may occur. The POCs for the soils and alluvium are distinct because they have different exposure scenarios due to very different topography and ecosystems. EPA has established that the POC for soils (and by extension, alluvium) is limited to near-surface soils because subsurface soils have limited likelihood of exposure to receptors.

3.4.3.2 Surface Water

The preliminary POC for surface water is any point in Cañon de Valle and Martin Spring Canyon within the area of contamination defined in Chapter 2 where direct contact with a receptor may occur. This includes water from Burning Ground Spring, SWSC Spring, Martin Spring, and Peter Seep. EPA has established that the POC for surface water is generally the point where releases enter the surface water. However, in Cañon de Valle and possibly Martin Spring Canyon, contamination may enter by way of Burning Ground Spring, SWSC Spring, Martin Spring, Peter Seep, alluvial sediments, and surface runoff from sources other than the TA-16-260 outfall (i.e., MDA-P, MDA-R, and the Burning Ground). EPA recognizes that the point may not be clearly defined and the POC reflects the uses of the water and the environmental and ecological importance of the water body. Hence, a POC that is downgradient from all sources to alluvial water will also be considered during the CMS. Defining such a POC will require a detailed understanding of sources and sinks of water in Canon de Valle, which will be investigated in Phase III studies outlined in Chapter 6.

3.4.3.3 Groundwater

For the purposes of this CMS, the preliminary POC for groundwater will be defined as the alluvial water in Cañon de Valle and Martin Spring Canyon within areas of contamination defined in Chapter 2, or as indicated by results from the Phase III investigation. Under the Subpart S rule, the POC for remediation of groundwater generally will be the entire region of contaminated groundwater, or plume. EPA recommends consideration of the following factors when developing site-specific groundwater POCs:

- Proximity of sources of contaminants,
- Technical practicability of groundwater remediation,
- Vulnerability of groundwater and its uses, and
- Exposure and likelihood of exposure.

Other groundwaters, such as intermediate perched aquifers or the regional aquifer, will be evaluated under the following phased approach. The CMS will evaluate the potential risk to the nearest human and ecological receptors under the following conservative scenarios.

1. That the alluvial groundwater, subsurface saturated areas, and unsaturated flow through the mesas flow directly to the main aquifer and subsequently to the nearest human or ecological receptor.

2. That the alluvial groundwater and subsurface saturated areas flow directly to the nearest downgradient spring or seep to the human or ecological receptors at that location.

Should these conservative risk assessments indicate the potential for unacceptable human or ecological risk, an additional investigation will be designed and implemented that will provide the information necessary to refine the risk assessments. Such investigations will probably require detailed modeling of the hydrogeologic system at TA-16.

Another consideration for selecting POCs is sensitivity of biological systems in the canyon to contaminants in the seep, springs, and alluvial system. The ecological screening assessment for surface and alluvial waters in the Phase II RFI suggests that these biological systems are not seriously disturbed by the contaminants (LANL 1998, in preparation). If this is the case, then monitoring, treatment, and remediation to achieve compliance should be designed to minimize the impacts these engineered components may have on the natural system.

3.4.4 Risk-Based Decision Approach

The corrective measures study and implementation process is risk based. This is consistent with the HRMB's risk-based decision tree, EPA's 40 CFR Chapter 1, Subpart S, Part V, and DOE Order 5400.1, which includes the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and RCRA by reference for environmental remediation of hazardous wastes.

3.4.5 Applicable Regulation and Requirement Evaluation

This section presents an overview of laws and regulations that may apply to the PRS 16-021(c) CMS under the proposed EPA Subpart S and Module VIII of LANL's Hazard Waste Facility Permit. The medium (e.g., surface water or soil) that each relevant regulation applies to is also discussed.

Generator and Transporter Requirements Any action resulting in the generation of hazardous and solid wastes under the CMS will comply with the regulations under 40 CFR Part 260 et seq. for hazardous waste management. These requirements will also apply to the hazardous and solid wastes generated during the treatment of soils and water. These requirements will apply to the IM and will be addressed in the IM plan.

Land Disposal Restrictions The restrictions on the land disposal of hazardous wastes address the mitigation of hazards posed by waste constituents. All PRS 16-021(c) activities that generate hazardous waste as part of the RCRA corrective action will comply with the land disposal restriction (LDR) requirements of 40 CFR Part 268. If a media is treated in situ and a waste is not generated, the LDRs do not apply, as stated in the Federal Register Volume 63, pages 28556-28634, published May 26, 1998. However, any ex-situ CMS treatment (soil or water) that generates a waste will comply with LDR requirements, pending approval of these requirements by NMED.

Public Participation and Community Relations RCRA § 7004 encourages public participation in the development, revision, implementation, and enforcement of any regulation, guideline, information, or program activities. The Public Participation and Community Relations regulation is currently implemented in the LANL ER Project through community meetings and meetings with stakeholders in the community such as the Northern New Mexico pueblos, the County of Los Alamos, and officials of the community. LANL currently complies with the DOE public participation policy that is outlined in *Public Participation Policy for Environmental Restoration and Waste Management, US DOE (October, 1992).* Public Participation activities specific to PRS 16-021(c) are included in the CMS/CMI schedule found in Appendix B.

The National Environmental Policy Act Section 102(2)(c) of the **National Environmental Policy Act** (NEPA) requires that all federal agencies prepare an environmental impact statement (EIS) for all major federal actions significantly affecting the quality of the human environment. The DOE has established a procedure for compliance with NEPA defined in 10 CFR 1021 and 40 CFR 1500–1508. Before implementing the IM and the CMS, all NEPA procedures will be completed. The environmental safety and health (ESH) questionnaire will be completed and reviewed by the LANL Environmental Assessments and Resource Evaluations Group, ESH-20, NEPA team. All NEPA concerns will be addressed before implementing intrusive activities.

The Clean Water Act The Clean Water Act requirements apply to the CMS and IM at PRS 16-021(c) if additional discharges, impacts to stormwater, or lease of treatment agents result from implementing the IM or CMS.

The Clean Air Act The Clean Air Act is not applicable for the CMS or the IM at PRS 16-021(c) because there are no anticipated air releases. Dust will be mitigated for health and safety reasons during field activities, and the air will be continuously monitored with Miniram™ personal air monitors.

The Toxic Substances Control Act The Toxic Substances Control Act (TSCA) is not applicable to the CMS at 16-021(c) because no TSCA constituents will be released or removed from any soil or water treated.

The New Mexico Water Quality Control Commission and Drinking Water Regulations The New Mexico Water Quality Control Commission (NMWQCC) standards and The New Mexico Drinking Water standards for barium are applicable to the corrective action at PRS 16-021(c). Barium is the only COPC present at the site that exceeds human health, domestic water supply, wildlife habitat, or irrigation use standards that have been set under these regulations. The New Mexico Drinking Water Standard (2 000 µg/L) and the NMWQCC Ground Water Standard for Human Health for Barium (1 000 µg/L) will be applied to the nearest drinking water well under the groundwater evaluations described in Section 3.4.2.3. The NMWQCC Surface Water Standard for domestic water supply does not apply to the PRS 16-021(c) corrective action because the surface waters are not, and will not, be used for domestic water supply purposes.

4.0 IDENTIFICATION AND SCREENING OF TECHNOLOGIES

This section of the CMS plan presents the identification and screening of remediation alternatives under consideration for the 260 outfall and Cañon de Valle. Remediation technologies will be identified and screened and will address each compartment comprising the conceptual model: the contaminant source area, the unsaturated subsurface, the transport pathways and springs, and the alluvial system in the canyon bottom. The discussion of each potentially viable remediation approach will include:

- how the alternative works,
- results from previous usage under similar site conditions,
- anticipated technology limitations of the alternative, given waste characteristics,

Attachment D

Stormwater Pollution Prevention Plan
OU 1082, TA-16
Remedial Actions Focus Area
High Explosives Production Sites Team

ENVIRONMENTAL RESTORATION PROGRAM

STORM WATER POLLUTION PREVENTION PLAN

OU 1082, TA16
Remedial Actions Focus Area
High Explosives Production Team

Environmental Restoration Project Activities
Fiscal Year 2000

LOS ALAMOS NATIONAL LABORATORY

LOS ALAMOS, NEW MEXICO

February 2000

TABLE OF CONTENTS

INTRODUCTION 3

1.0 SITE DESCRIPTION 3

1.1 Site History 3

1.2 Site Activities 3

1.2.1 Site Mobilization and Preparation 5

1.2.2 IM Stormwater Control Practices 6

1.2.3 Excavation 6

1.2.4 Sampling and Drilling 7

1.2.5 Waste Treatment 8

1.2.6 Site Restoration 8

2.0 POLLUTION PREVENTION TEAM 9

3.0 DESCRIPTION OF POTENTIAL POLLUTANT SOURCES 9

3.1 Drainage Map 10

3.2 Inventory of Exposed Materials and Risk Identification 10

3.3 On-Site Waste Disposal Practices 11

3.4 Spills and Leaks 11

4.0 MEASURES AND CONTROLS 11

4.1 Good Housekeeping 12

4.2 Preventative Maintenance 12

4.3 Sediment Control 13

4.4 Stabilization Practices 13

4.5 Structural Practices 13

4.6 Stormwater Run-off Management 13

4.7 Other Controls 13

4.8 Spill Prevention and Response Procedures 14

5.0 IMPLEMENTATION 14

5.1 Inspections 14

5.2 Employee Training 14

5.3 Record Keeping and Internal Reporting 14

5.4 Non-Storm Water Discharges 14

5.5 Consistency With Other Plans 15

5.6 Keeping Plan Current 15

INTRODUCTION

This Stormwater Pollution Prevention Plan (SWPP) has been prepared for the TA-16 Interim Measure activities that will be conducted at the TA-16-260 outfall by the Environmental Restoration (ER) Project beginning January 2000. In addition to the IM project, this SWPP also includes the TA-16 springs and well sampling that is part of an ongoing project conducted by the ER field crew.

1.0 SITE DESCRIPTION

1.1 Site History

TA-16 was established during World War II to develop explosives 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. Current use of this site is essentially unchanged, although facilities have been upgraded and expanded as explosive and manufacturing technologies have advanced.

Building TA-16-260 is a HE machining facility that processes large quantities of HE. Machine turning and HE wash water are collected as waste in the building's 13 sumps. Historically, sump discharge was routed to an outfall, approximately 200 ft east of TA-16-260, which the Environmental Protection Agency (EPA) permitted under the Laboratory's National Pollutant Discharge Elimination System (NPDES). As a result of waste discharge from TA-16-260, sediments and soil within the outfall and drainage channel are contaminated HE waste and barium. The NPDES outfall was deactivated in November 1996, and its NPDES permit (EPA 05A056) was deleted in January 1998. The sumps, drain lines, and troughs of this facility have been designated as PRS 16-003(k), and the outfall, pond area, and drainage as PRS 16-021(c), which were proposed to be consolidated into PRS 16-021(c)-99 in 1999.

1.2 Site Activities

Site activities at TA-16 consist of both ongoing activities and specific sampling and remediation campaigns, such as RCRA Phase I sampling, or Voluntary Corrective Actions. The ongoing site activities at TA-16 consist of the hydrogeological study being conducted as part of the Corrective Measures Study (CMS

Hydrogeological activities include sample collection from three springs using ISCO™ autosamplers. Samples are automatically collected every other day from each spring. Bottles are collected every two weeks and brought out of the canyons. One seep (Peter Seep in Cañon de Valle) is sampled at the same time the autosamples are collected. Figure 1 shows the location of all the springs and seeps sampled at TA-16.

Five alluvial wells are sampled quarterly, and tested for water-quality parameters (i.e., pH, conductivity, temperature) every two weeks. There are a total of 6 wells located within Cañon de Valle, and five of these are sampled regularly. The sixth alluvial well is part of a "well pair" and only one of the two wells is sampled. Three alluvial wells will be located within Martin Springs

Canyon, and once complete will also be sampled during the quarterly sampling rounds. Figure 2 shows the location of all the current and proposed alluvial wells at TA-16.

PRS 16-021(c)-99

IM activities at PRS 16-021(c)-99 will include: mobilization, site preparation, excavation, surface and subsurface soil sampling, drilling, waste treatment, and site restoration. The implementation of best management practices (BMP) will be used during site activities.

PRS 16-021(c) consists of the outfall and the drainage associated with PRS 16-003(k), the 13 HE sumps on the northeast side of TA-16-260 (Figure 3). HE/barium-contaminated water from the outfall tended to pool at the head of the drainage channel in an area referred to as the "pond" (approximately 55 ft long by 30 ft wide, bound downstream by a rock dam 95 ft from the outfall). The longitudinal axis of the former pond is oriented east to west, with flow in the easterly direction. A cobble/rock dam, constructed for sediment catchment, is approximately 3 ft high by 15 ft wide, and is located on the eastern boundary of the pond. This dam is no longer functional and water is no longer contained within the pond.

The areas of highest contamination at PRS 16-021(c)-99 are the pond area and the upper drainage channel. These areas are shown on Figure 3.

At present there is no perennial water in the pond, although the soil and sediment are intermittently saturated in response to precipitation. Rainwater from the roadway on the northeast side of TA-16-260 used to flow into the pond before interim actions were performed in 1995, 1996, and 1998 to divert all run-on into the pond area.

A series of best management practices (BMPs) were instituted at PRS 16-021(c)-99 during 1995 and 1996 as an Interim Action (LANL 1996, 53838). These BMPs were implemented after inorganic and HE contamination was detected among CDV surface and spring waters. The BMPs consist of three engineered controls:

- a sandbag dam and diversion pipe up-gradient from the former HE pond,
- geotextile fabric matting in the former HE pond area, and
- straw-bale check dams within the PRS drainage between the rock dam and the 15-ft-high cliff.

In 1998, additional BMPs were instituted at PRS 16-021(c)-99 to minimize run-on over the pond. The BMPs installed in 1998 consist of three engineered controls:

- a concrete curb along the east end of the asphalt behind TA-16-260, which prevents water run-off from flowing freely onto the PRS boundaries,
- HDPE sheeting sealing the steel plates that cover the troughs associated with PRS 16-003(k), and
- a 4 in PVC diversion pipe installed from the outfall to the drainage's confluence with CDV.

All BMPs currently in place at TA-16 are inspected quarterly, have been maintained, and are in good condition.

Cañon de Valle

As part of the ongoing Corrective Measures Study at TA-16, three springs are sampled daily. Two of the springs (SWSC and Burning Ground) are located in CDV and one spring is located in Martin Canyon. One seep is located in CDV and is sampled bi-weekly. Stream profile and alluvial well sampling is conducted quarterly, and this activity involves collecting samples from the Cañon de Valle stream, and from five alluvial wells located in CDV (Figure 2).

1.2.1 Site Mobilization and Preparation

Equipment that will be mobilized to the site for the TA-16-260 IM include: excavators, a front-end loader, a bulldozer, drill rig, water truck, lights, Spoils-Vac, a grizzly screen unit, and roll off containers. Following equipment mobilization to PRS 16-021(c)-99, the IM infrastructure components will be installed. These include a site support facility, a trailer for robotics remote control, an access road, waste management facilities and storage area, and a waste composting area. The locations of all activities covered by this plan are shown in Figure 4.

Equipment that is mobilized to the site but not in use will be stored at the staging area behind Building TA-16-260. Two staging areas will be designated at the site, one will be just east of the asphalt road behind building 260, within the extended PRS boundary, and the other staging area will be on the asphalt road behind building 260.

The HEPS field trailers (one office trailer, two storage trailers, and a field analysis trailer), located near former Building 27, will be used for site-support: field screening analyses, data management, administrative functions, project coordination, personnel decontamination, and waste treatment support (Figure 5). During HAZWOPER operations, equipment and personnel transported to and from the PRS from the HEPS trailers will be conducted using a golf cart, which is considered a mobile exclusion zone while en route.

The Mobile Control Center (MCC) trailer, which contains the base station and controls for the remote excavation system, will be located on the south bank of the drainage, approximately 200 ft below the TA-260 out-fall and 100 ft from the center axis of the channel. A 32-ft telescoping mast will be used to raise the base station antennas above most of the local obstructions.

A decontamination pad will be constructed within the PRS boundary for the decontamination of the heavy equipment and excavated cobbles. This will be located in the northeast portion of the extended PRS boundary. The 30-by-30 ft pad will be constructed of a double HDPE liner laid over a bermed 6-in. deep sand bed. All excavated material piles will be stored on bermed HDPE liners.

A heavy-equipment access road will be established on the north side of the drainage channel in order to enhance site access and minimize tree removal. If possible, tree thinning for road construction will coordinate with scheduled LANL fire protection operations.

If necessary, an additional empty roll-off staging area will be located in a previously disturbed area southwest of former Building 27. A Less-Than-90-Day Storage Area may be established in this same area for storage of expected RCRA waste soils, if additional storage space is needed. (Figure 5)

A pad will be constructed for constructed for the soil composting and will be located in the area of the former 90's Line (Figure 5).

The Acker II drill rig will be mobilized to the drainage, after the site restoration is complete in order to drill the final 80-foot borehole within the former pond boundary.

Prior to commencing excavation, the screen plant and Grizzly shaker unit will be mobilized into the drainage, near the pond area. Soil separation activities will be conducted within the drainage boundary. The contamination of aggregates in the outfall drainage channel is expected to be predominantly surficial. Material greater than 3 in. in diameter will be washed with water to remove any contaminated fine material that has adhered to the aggregate surfaces. This will be accomplished by pressure washing the aggregates removed via the grizzly and by equipping the screen plant with spray bars to wash the intermediate size aggregates.
Segregation of fine material from aggregates will be performed directly in the drainage or in watertight rolloffs or tanks within the AOC boundary. Excess water will be captured directly in from the beneath the screen plant. The zero-discharge dam provides a secondary catchment to ensure that no water can enter the CDV drainage. The captured water will be allowed to settle. The fine material recovered following settling will be collected and managed with the bulk material removed from the corresponding area of the PRS.

1.2.2 IM Stormwater Control Practices and BMPs

During large-scale excavation and soil-size separation activities surface water discharges will be prevented from entering the lower drainage channel. This will be accomplished by constructing an earthen berm and swale, which will be lined with HDPE (ore equivalent), immediately up-drainage from the cliff's edge. The earthen berm and swale will be constructed in accordance with LANL's "Storm Water/Surface Water Pollution Prevention Best Management Practices (BMP) Guidance Document" (LANL 1998, 62458.1).

The berm and swale will be constructed during the initial phases of upper drainage channel excavation. The area immediately up-drainage from the cliff's edge will be scraped clean of contaminated sediments with a conventional excavator. A depression will then be excavated and lined. The earth berm will be constructed immediately down-drainage from the swale and will slightly overlap the swale liner. Figure 6 presents a schematic of the zero-discharge BMP at the cliff's edge. Figure 4 shows the location of the dam in the channel.

The swale will be pumped periodically (as necessary) to prevent discharge into the lower drainage channel. Any water removed from the swale will be managed similarly to other IM-produced and containerized water. Sediments that settle out into the swale will also be removed periodically and managed with other IM excavation materials. No additional BMPs in the upper drainage channel are anticipated to be necessary to maintain zero discharge into the lower drainage channel.

1.2.3 Excavation

Excavation activities will include: remote, robotic excavation of the pond area and upper drainage; non-remote excavation of the drainage channel below the remote excavated area to the cliff area; and non-remote excavation of the lower drainage channel.

Pond Excavation

Remote excavation of the pond will extend from slightly downgradient of the present rock dam (depending on the extent of locales with HE greater than 5%) upstream to approximately 30 ft below the outfall. The bank/drainage channel interface will define the lateral limit. Excavation will proceed beyond the soil/tuff interface to a maximum depth of 20 ft below present grade using a hydraulic hammer. The Spoils-Vac will be used to remove any remaining loose material in the drainage channel.

Once material has been excavated from the pond area, it will be placed in the hopper of the screen plant for size fractionation. Segregated fines will be deposited into a roll-off and transported to the storage area north of the drainage. Oversized material will be sprayed with a high-pressure wash. Material greater than 3 in. in diameter will be washed with water to remove any contaminated fine material that has adhered to the aggregate surfaces. Water will be captured either directly in rolloffs or tanks. The captured water will be allowed to settle. The fine material recovered following settling will be collected and managed with the bulk material removed from the corresponding area of the PRS.

The wash water will be stored in tanks within the AOC boundary and may be reused for dust suppression and for soil wetting during soil treatment. Any excess water will be sampled and disposed of at the HE liquid waste treatment plant at TA-16.

Upper Drainage Channel Excavation

Sediment removal in most of the upper drainage will not require remote excavation, thus a front-end loader and excavator will be used. Sediment removal will be limited to the material above the soil/tuff interface. Materials from the upper drainage channel will be excavated and placed in the wide, flat area in the drainage, adjacent to where the screen plant will be located, to ease processing through the unit. Excavation will remove soil by working progressively up drainage from lowest to highest contamination.

Lower Drainage Channel Excavation

Sample data suggests that RDX is the only constituent present above cleanup levels within sediment traps in the lower drainage channel. A geomorphologic survey and sample screening effort will define the extent of RDX contamination. Removals will be done manually or using the Spoils-Vac.

1.2.4 Sampling and Drilling

Drilling will be conducted at Martin Springs Canyon in order for three alluvial wells to be established. Drilling will be conducted using the Acker ADII drill rig. Boreholes will be cored to a depth of 10 feet. Once the wells are making water, they will be sampled and characterized, and the sampling activities will continue as part of the CMS. The proposed alluvial wells are shown in Figure 2.

In order to verify that the IM is complete, verification samples will be collected following the excavation of the pond and drainage channel. Approximately 27 surface samples will be collected from the remaining tuff in the upper drainage and the pond area. Approximately 10

surface and near-subsurface samples will be collected from the tuff and remaining sediments in the lower drainage channel. Samples will also be collected during the excavation process for the bromide profile sampling. Bromide profile samples will be collected from trenches in the pond area that extend to the soil/tuff interface.

After the IM has been completed and the excavation has been sealed and backfilled, a borehole will be drilled in the center of the (former) pond. The borehole will be drilled to a depth of 80 feet using the Acker ADII drill rig. The borehole will be continuously cored and sampled at 5-foot intervals.

Waste characterization samples will be collected from each roll-off container filled during the excavation process.

1.2.5 Waste Treatment

It is currently planned that excavated wastes will be treated using standard industry composting technology (pending NMED approval and any required permitting). Waste material to be treated will be placed in piles on top of the sand base on the treatment pad. The treatment pad will be located in the area of the former 90s Line buildings (Figure 5). The treatment pad will be constructed of a double HDPE liner laid over a bermed 6-in. deep sand bed. The waste will be placed on the sand base in a manner that creates a windrow that is approximately 6 ft tall by 16 ft wide at the base. The composting piles may be covered with a sprung-structure building (similar to those at TA-55), or they may be covered with heavy-duty tarps and stormwater collection sumps to capture run-off from storm events.

Possible composting amendments include nitrogenous fertilizer such as ammonium sulfate, manure, alfalfa or straw, and other ingredients selected based upon the waste treatability study. Compost piles will be turned using a mechanical turner. Moisture levels must be maintained at capacity levels and no dust will be generated from compost activities.

1.2.6 Site Restoration

Following excavation and confirmatory sampling, an impermeable cap will be installed at the bottom of the excavated pond area in efforts to limit future migration of residual HE. The impermeable layer will be located directly above and overlapping the surge bed, at approximately 17 ft below pre-excavation grade. The proposed impermeable layer will consist of a crushed tuff mixture amended with 4% bentonite. Bentonite will be placed using 2.5% dry and 1.5% wet via an 8% slurry. The minimum compacted thickness of the layer will be 18 in. The saturated permeability of the cap is estimated to be lower than 1×10^{-7} cm/sec.

Following placement of the impermeable layer, excavation will be backfilled in 8 in. lifts with ASTM D2487 certified clean, crushed tuff to the required 90% maximum dry density. The pond and other areas of extensive soil removal will be backfilled to pre-excavation contours. The recontoured banks of the drainage channel will have a maximum slope of 2:1 (horizontal:vertical). Lower reaches of the drainage excavated to tuff and within 2 ft of the original contours will not be backfilled. Approximately 3 to 5 in. of loose topsoil will be applied to disturbed areas in preparation for permanent seeding. During backfilling and restoration

activities, temporary silt fencing and straw bale check dams will be maintained and inspected as required in the approved SWPPP.

After the backfilling activities, one rock dam will be constructed at the edge of the cliff upstream from the confluence of Canyon de Valle in the same location the zero-discharge dam was located. The dams will be constructed of 2-15 in. aggregate rock, stacked to a maximum height of 4 ft. Decontaminated rocks from the excavation will be incorporated into the rock dams.

All disturbed areas, including the area disturbed during soil treatment, will be reseeded with a seed mixture and application rate as specified in Section 222.7 of the LANL Architectural Standards Manual, Volume 4, and as approved by ESH-18 and ESH-20. If reseeding occurs after September 15th, a dormant seed will be applied by broadcast spreading, and water will be applied at the discretion of ESH-18. If reseeding occurs during the spring prior to September 15th, the approved mixture will be applied with a hydroseeder. Following reseeding, the reseeded areas will be covered with approximately 2 in. of mulch obtained from the Los Alamos County Landfill. In the event that long-term storage of excavated soils is required, stockpiles will be seeded in the interim to prevent erosion, and storage areas will also be reseeded after stockpile removal.

There has not been any stormwater-specific sampling conducted at PRS 16-021(c)-99. Sediments within the drainage channel have been extensively sampled during RFI investigations. Once the IM has been completed future stormwater sampling of the TA-16-260 drainage channel will be conducted as part of the LANL Watershed Management Program.

2.0 POLLUTION PREVENTION TEAM

Field Team Members	Role(s)	Organization
Peter Gram	Field Project Manager	IT
Lynn Kidman	Field Project Manager	IT
Scott Wimer	Site Safety Officer, (SSO)	IT
Robert Monsalve-Jones	SSO	IT
Randy Johnson	Field Team Leader (FTL), SSO	IT
Elmer Alcon	Alternate FTL, Field Personnel , RSP	IT
Kristi Beguin	Alternate FTL, SSO, Field Personnel	IT
Dale Lyons	Field Personnel, Rad. Screening personnel (RSP)	IT
Louie Romero	Field Personal, RSP	IT
Donna Sharp	Alternate FTL, Field Personnel	IT

3.0 DESCRIPTION OF POTENTIAL POLLUTANT SOURCES

The main contaminants identified at PRS 16-021(c)-99 through previous sampling efforts are barium, the major constituents of HE (HMX, RDX, and TNT), and HE degradation products (DNT, amino-DNT, and TNB). Other inorganic contaminants in sediments included copper, cadmium, chromium, cobalt, lead, nickel, silver, vanadium, uranium, zinc, arsenic, mercury, and manganese. Non-HE organics detected among surface/near-surface sediments were bis(2-ethylhexyl)phthalate and anthracene, while other phthalates and polycyclic aromatic hydrocarbons (PAHs) were detected at much lower levels in subsurface samples where detection levels were lower due to lower concentrations of HE.

The bulk of contamination is concentrated within the pond area. Other contaminants were found within the upper drainage channel, with concentrations decreasing with distance from the outfall and with depth below the surface.

Sources that could potentially add pollutants to storm water drainages include the following:

- unleaded and diesel fuel, and motor oils; and
- hydraulic lines

Controls to decrease the likelihood of adding these pollutants to the drainage include storing all fuel containers within secondary containment units and conducting daily equipment inspections on all pieces of heavy equipment used on site. Equipment operators are responsible for inspecting and maintaining the heavy equipment, and inspections greatly increase the ability to detect leaks or weak seals prior to having a spill occur.

3.1 Drainage Map

Figure 3 displays the outfall channel. Figure 4 shows the location of where the activities will be taking place within the PRS boundaries.

3.2 Inventory of Exposed Materials and Risk Identification.

The types of materials/equipment that may be exposed to precipitation include:

- Heavy machinery (drill rig, excavator, bulldozer, front end loader, backhoe, and spoils-vac);
- Stockpiled soils;
- Roll-off bins full of excavated material;
- Drums full of other investigation derived wastes (decon fluids, PPE, etc.);
- Drilling augers;
- Waste Treatment area;
- Soil processing area (area within the drainage channel where the Grizzly will be employed); and the
- Decontamination pad.

Heavy equipment will be used and stored at the TA-16-260 outfall area, or adjacent to the field trailers by former building 16-27.

Non-RCRA soils may be transported to a stockpile area located north of the drainage within the PRS boundaries, or taken directly to the waste treatment pad and stockpiled. All excavated material piles will be stored on bermed HDPE liners.

RCRA material will be collected from the shaker plant outlet in roll-off containers and moved to the <90 Day-Storage-Area, or stockpiled within the PRS boundary according to their waste code.

A Less-Than-90-Day Accumulation Area will be established for all RCRA hazardous waste streams with volumes greater than 55-gallons near the field trailers. All liquid wastes will be stored on a secondary containment pad. All RCRA hazardous wastes will be stored in appropriate containers, and will be inspected, labeled, and posted in accordance with the governing regulations.

A Satellite Accumulation Area has been established for all RCRA hazardous waste streams with volumes less than 55-gal. at the field storage trailers. All wastes will be stored in enclosed containers that are appropriate and approved for the particular waste type and that meet transportation requirements. Inspections and documentation of the storage area will be conducted in accordance with the governing regulations.

Drums containing non-hazardous industrial waste will be stored near the work zone or near the field trailers, and will be labeled and packaged appropriately. They may be stored on secondary containment, if necessary, or on pallets.

Drilling augers may be stored adjacent to the boreholes. Only decontaminated augers would be stored within the work zone. Potentially contaminated augers will be transported to the decon pad, or stored in decon containers.

The waste treatment area will likely be located at the former 90s Line, and all treated wastes will be covered with tarp material or with a sprung-structure building.

The soil processing area will be located within the outfall drainage. Excavated material will be deposited into the hopper of the grizzly shaker. Segregation of fine material from aggregates will be performed directly in the drainage or in watertight rolloffs or tanks within the AOC boundary. A roll-off bin will be placed at the outlet of the shaker plant in order to capture the segregated fractions. Roll-offs will be stored under the shaker plant until they are full.

A decontamination pad will be established within the extended PRS boundary. A temporary decontamination pad for the heavy equipment and excavated cobbles will be located in the northeast portion of the PRS boundary. The 30-by-30-ft decontamination pad will be constructed of a double HDPE liner laid over a bermed 6-in deep sand bed.

3.3 On-Site Waste Disposal Practices

In accordance with LANL-ER-SOP 1.06 . borehole cuttings and samples residues may be returned to the PRS from which the sample was taken immediately upon completion of sampling. This method of disposal will be used whenever possible to minimize the amount of wastes needing storage and disposal. Sampled spring water is returned back to the springs from which it was collected. Small volumes of bailed water from well sampling (less than 1000 ml) will be deposited on the ground adjacent to the alluvial wells.

3.4 Spills and Leaks

There has been one documented spill at the TA-16-260 outfall. PVC Primer Compound was spilled approximately 5 feet south east of the outfall exit, in November, 1998. Approximately 5 ounces of compound was spilled onto the dirt. More than 35 gallons of soil was excavated to remove the soil that came into contact with the compound. (Figure 7)

4.0 MEASURES AND CONTROLS

Storm water management controls will include the use of sealed bulk storage containers, HDPE matting and tarping, and the use of secondary containment at the storage areas and for all fuel containers. Run-on controls have been implemented at the Interim Measure locations. Straw-bale

dams have been installed to prevent surface contamination migration down the outfall channel. Concrete curbing was installed behind building 260 to prevent storm water from flowing across the road area and entering the PRS boundary. The sump drainage troughs have been sealed with heavy-mil plastic in order to prevent storm water from entering the troughs and draining potentially-contaminated water to the outfall. A 4-in PVC pipe was installed from the outfall exit to divert storm water to the bottom of Cañon de Valle, in order to prevent the water from flowing over the PRS. The concrete curbing along the roadway behind TA-16-260 and the BMPs covering the trenches associated with the TA-16-260 sumps (PRS 16-003[k]) will be maintained throughout the project duration. The PVC pipe will be removed during the IM to allow for the entry and exit of heavy equipment.

BMPs will not be removed from the drainage channel until the zero-discharge dam has been constructed. Once constructed, straw bale dams and the PVC piping will be removed so that work may commence.

In efforts to limit erosion impact to Cañon de Valle during drilling and excavation within the pond area, an additional straw bail/rock dam and silt fence may be constructed at the cliff edge within the drainage. Existing straw bail BMPs within the drainage will be maintained until it is necessary to remove them for soil excavation activities.

Waste treatment will be conducted on a pad built for the waste treatment activity. This pad will be designed to collect decon water and storm water, and run-off from the site will not occur.

4.1 Good Housekeeping

Good housekeeping will be practiced at all storage and work areas. Good housekeeping will be implemented by ensuring that all wastes are immediately packaged and stored in appropriate, sound containers; ensuring that all spoils piles are placed on bermed HDPE liners and are covered with tarping to prevent migration of sediments and contaminants; and storing all fuel containers in secondary containment to prevent the likelihood of leaks. Other practices include keeping the site free of trash, decontaminating sampling equipment each day, and managing all wastes upon generation.

4.2 Preventive Maintenance

In addition to the zero-discharge dam, the only storm-water management controls that will be in place during the IM activity are the concrete curb and the seals over the troughs. These BMPs are inspected every three months. The zero-discharge dam will be inspected every few weeks to ensure that it is in operable condition. During heavy storm events, the dam area will be inspected more frequently to determine when pumping the water is necessary. The field team leader will be responsible for inspecting the storm water controls. These inspections will be documented in the project field logbook that is maintained by the field team leader.

Equipment is inspected daily by the heavy equipment operators. This ensures that leaks and old or worn parts are repaired or replaced quickly.

In the event that long-term storage of excavated soils is required, stockpiles will be seeded in the interim to prevent erosion, and storage areas will also be reseeded after stockpile removal. The

field team members would inspect these areas, and the inspections would be document in the project field logbook.

4.3 Sediment Control

As described in Section 1.2.2, the zero-discharge dam is designed to prevent any discharge of water and sediments over the cliff edge and into the lower drainage (Figure 6). Water that accumulates at the dam area will be pumped into drums and managed as waste and disposed of appropriately, or used as dust control during excavation of the heavily contaminated areas within the upper drainage or the pond. The zero-discharge dam will be installed during the site-preparation activities. Sediment and erosion control structures currently in place within the drainage will not be removed until the dam is installed. The dam will effectively control all sediments from migrating into the lower reaches of the drainage. No other areas of the site have a high potential for soil erosion.

4.4 Stabilization Practices

All field activities will be conducted so that impacts to surface vegetation will be limited, as much as possible. Tree removal will be coordinated with the LANL fire protection operations, if possible. Stabilization and re-seeding practices will implemented upon job completion. All disturbed areas, including the soil treatment area, will be reseeded with a seed mixture and application rate specified by and approved by ESH-18. The Ecology Group (ESH-20) contact, David Keller (667-7037), will be also be contacted to determine appropriate measures. Following reseeding, the reseeded areas will be covered with approximately 2 in. of mulch obtained from the Los Alamos County Landfill.

4.5 Structural Practices

The structural techniques to control erosion currently in use at the site are sediment traps constructed of straw bales wrapped with Poly Jute™ erosion control blanketing. The traps have been reinforced with rocks. These sediment and erosion control objects will be removed during the course of the IM, but not until the zero-discharge dam is in place (Section 1.2.2). They will not be re-installed upon completion of the IM.

4.6 Storm Water runoff Management

The drainage channel at TA-16-260 outfall area is only slightly graded, preventing high velocity water runoff from the site. Dams were built in the drainage channel to create holding ponds during periods of high rainfall and runoff. For the IM project, a zero-discharge dam (described in Section 1.2.2) will be installed in the drainage channel just above the cliff located 600 ft downstream. This dam is designed to prevent any water or sediments from entering the lower reaches of the drainage. Water that collects in the holding area will be pumped and containerized.

Run-on controls include the concrete curb located behind building TA-16-260, and the sealing of the sump troughs that lead to the outfall outlet. The curb prevents storm-water run-on from

flowing freely over the PRS boundaries, and the seal over the troughs prevents stormwater from entering the troughs and draining from the outfall outlet.

4.7 Other Controls

- No solid materials will be discharged to a watercourse.
- Dust generation will be minimized through the use of water mister. All dust generation activities are continually monitored with a mini-ram for health and safety reasons.
- The plan will comply with the LANL's permits and requirements for waste disposal, sanitary sewer, and septic system regulations.

4.8 Spill Prevention and Response Procedures

Areas where spills could occur include the diesel and unleaded fuel storage area and the refueling areas for the drill rig and the golf cart. All fuels will be stored in DOT approved containers and placed in secondary containment. Care will be taken when re-fueling machinery to ensure that no spills occur. Small pieces of HDPE can be placed beneath the refueling area to capture any drips of spills that could occur. If a spill or leak occurs, procedures outlined in the TA-16 Spill Prevention Control and Countermeasure (SPCC) Implementation Plan will be followed.

5.0 IMPLEMENTATION

5.1 Inspections

Field team personnel will inspect all waste storage areas and areas where structural controls were implemented for the IM. Storage areas will be inspected monthly and structural controls may be inspected more frequently, especially during times when storms are more frequent. Inspections will be documented in the project field logbook. The field team will conduct inspections. Any off-road areas where vehicles enter and exit will be inspected to ensure that sediment tracking and erosion do not occur.

Annual evaluations of BMPs in place at PRS 16-021(c)-99 will be conducted to provide information for the Annual Comprehensive Site Compliance Evaluation Report. These evaluations will be coordinated by Steve Veenis of ESH-18 Water Quality. The field team will coordinate site evaluations with him to ensure they are conducted in a timely manner.

5.2 Employee Training

Employee training will include briefing on spill response, good housekeeping, and material management practices. This training will be conducted at the pre-job briefing and periodically throughout the project during the tailgate safety meetings.

5.3 Record Keeping and Internal Reporting

A description of incidents (such as spills, or other discharges), inspections, maintenance activities will be documented and recorded by the field team. All project files are maintained on-site by the field team while work is being conducted in the field. Once the project is completed, a copy of all field documents will be forwarded to the Records Processing Facility. Another copy will be maintained by IT's Central Records office.

5.4 Non -Storm Water Discharges

The sources of non-storm water that might be discharged on-site include:

- Potable water used for dust control;
- Potable Hand and face wash water;
- Small volumes of returned spring water;
- Small volumes of bailed well water from alluvial wells;
- Water collected from the meteorological station (located near field trailers);
- Air conditioning condensate.

5.5 Consistency with Other Plans

The SWPP will be consistent with guidelines presented in the IM Plan and the SPCC Plan.

5.6 Keeping Plan Current

The SWPP will be amended whenever there is a change in design, project activity, operation, or maintenance, which has could have a significant effect on the potential for the discharge of pollutants to the waters of the United States, or if the plan proves to be ineffective in eliminating or significantly minimizing pollutants from the source identified in the potential pollutants sources of the plan, or in otherwise achieving the general objectives of controlling pollutants in storm water discharges. Amendments to the plan should be reviewed by ESH-18 and will be forwarded to NMED.

FIGURES

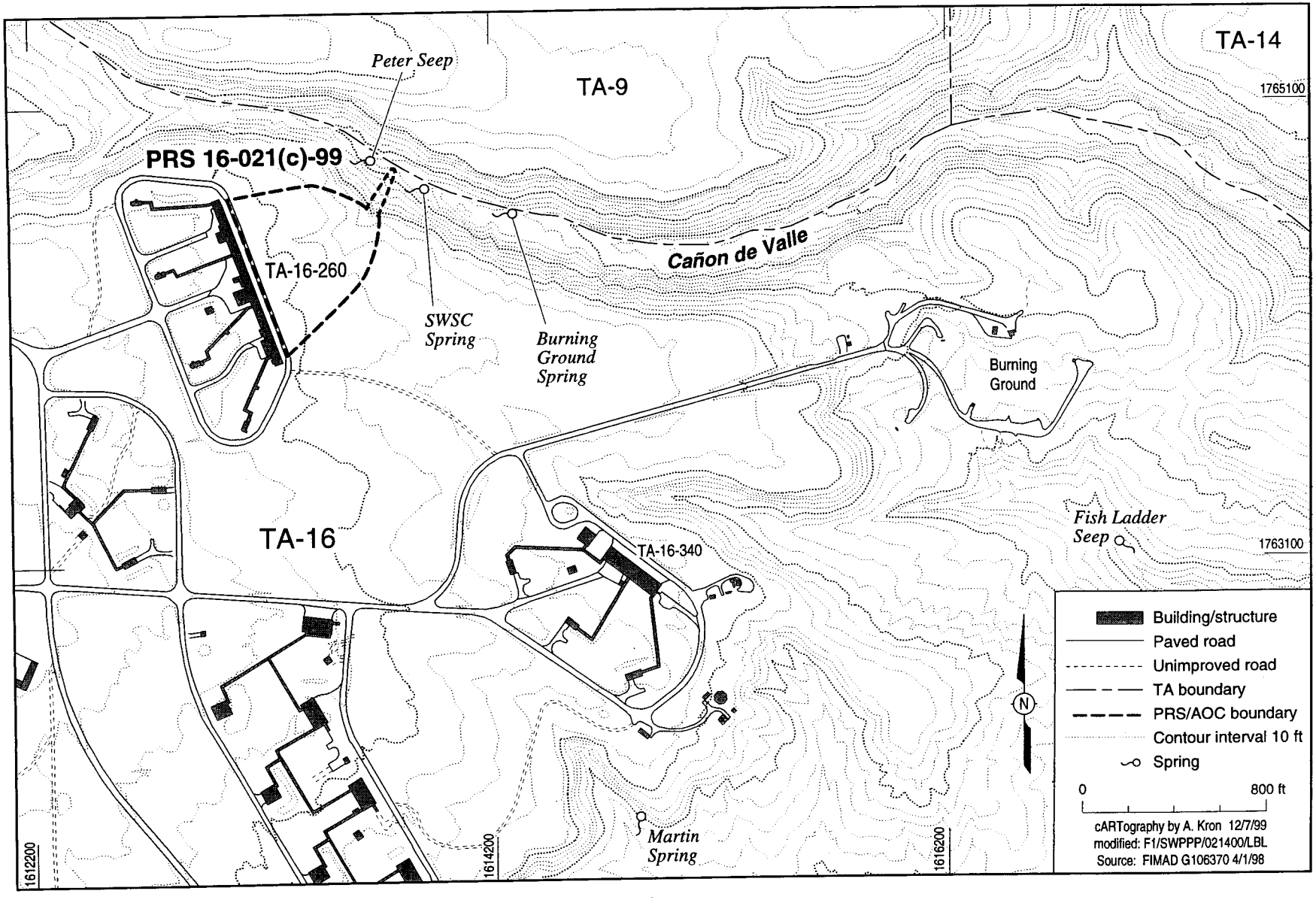


Figure 1. Location of PRS 16-021(c)-99 and all five springs and seeps

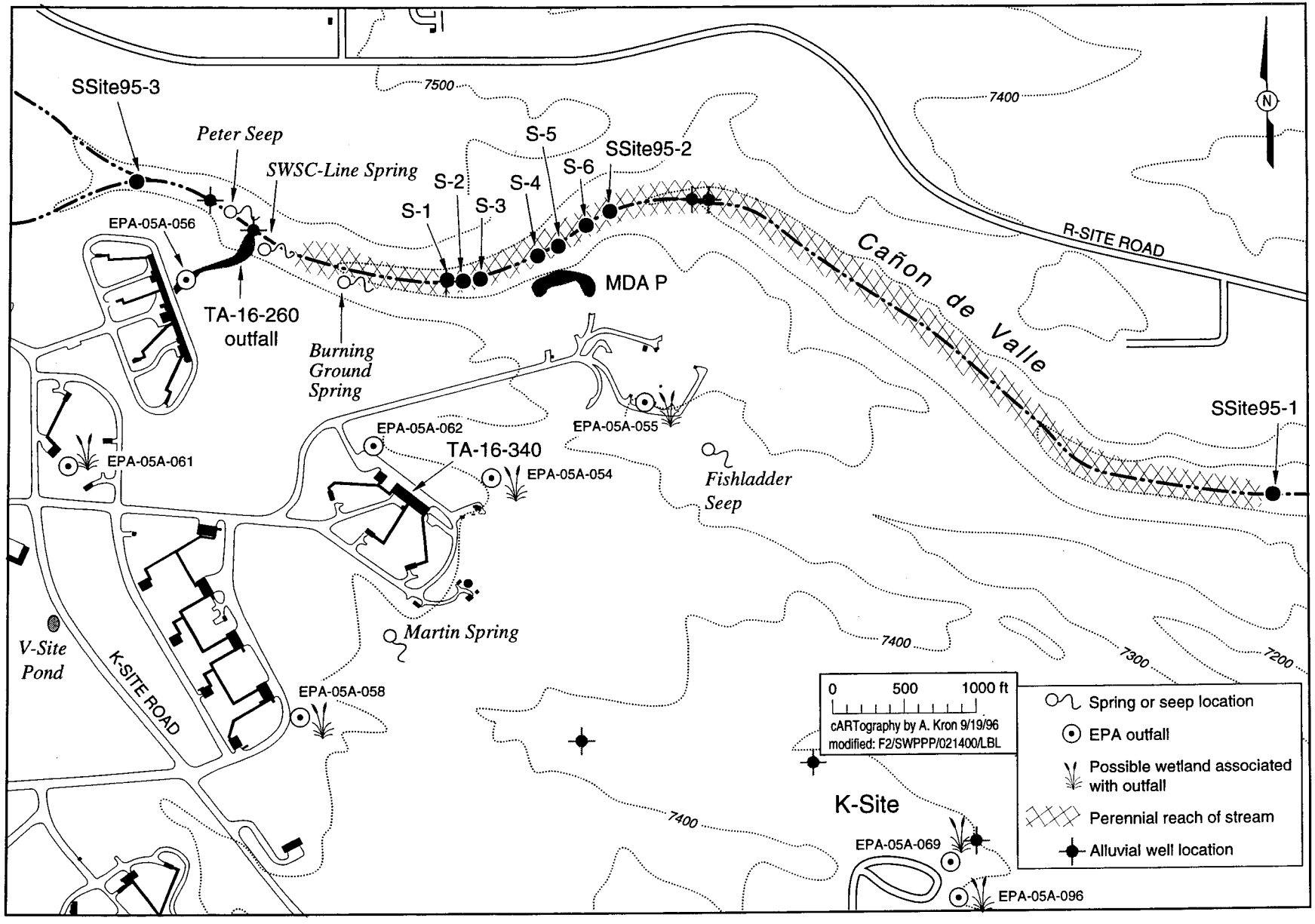


Figure 2. Locations of all current and proposed alluvial wells

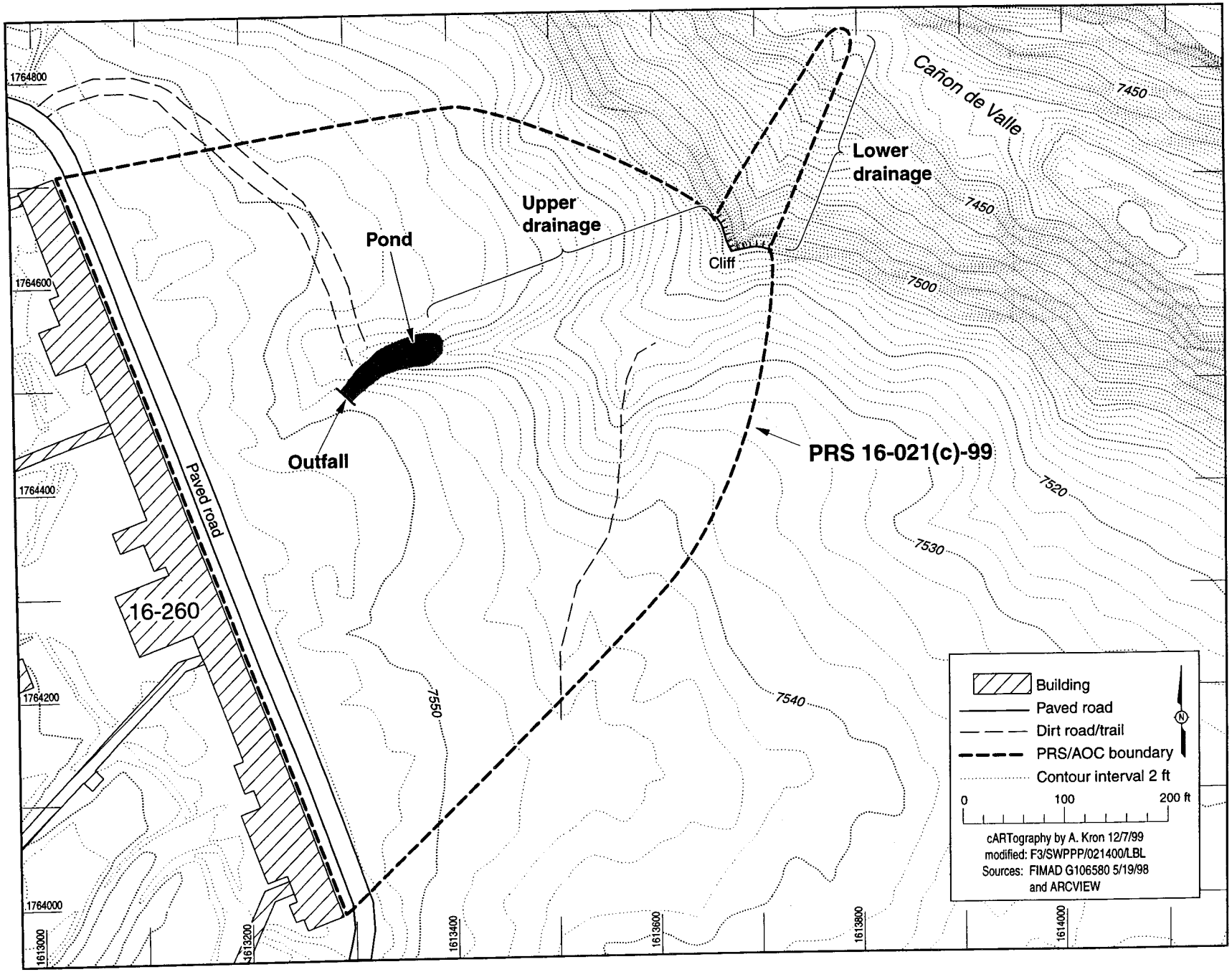


Figure 3. Location of the TA-16-260 outfall

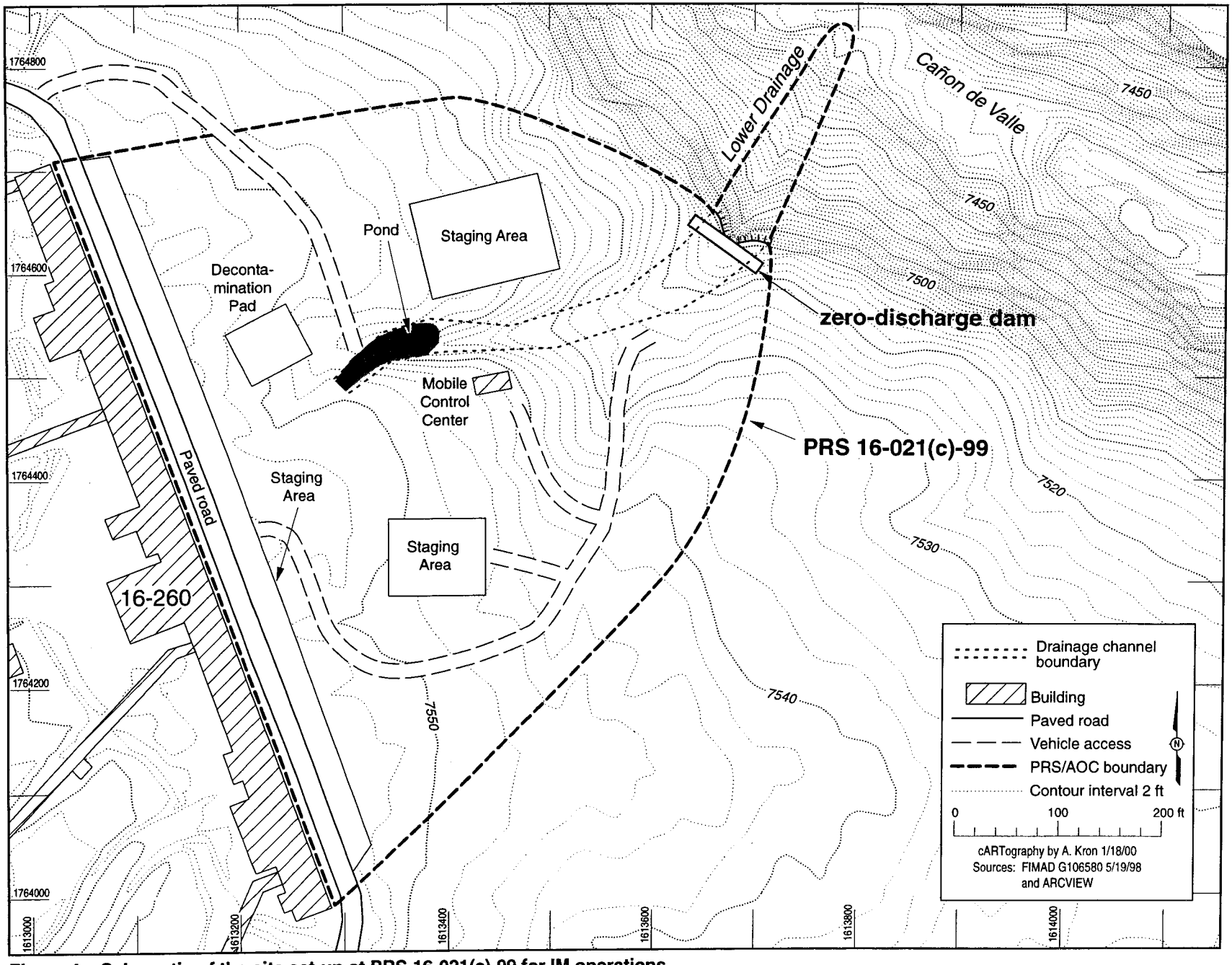


Figure 4. Schematic of the site set-up at PRS 16-021(c)-99 for IM operations

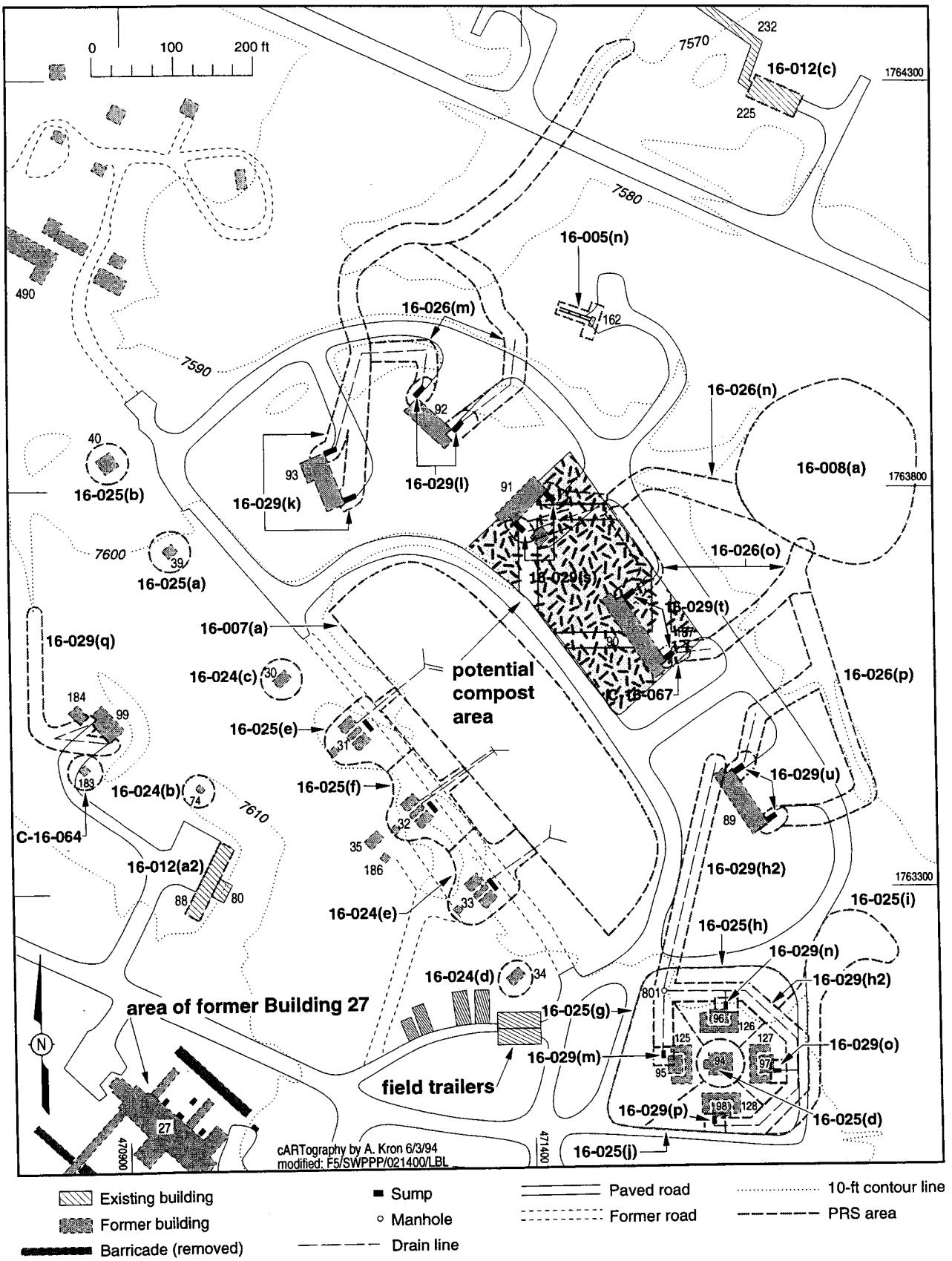


Figure 5. Area of former Building 27 may be used to store empty rolloffs; if needed, it would also be used as a < 90-day storage area.

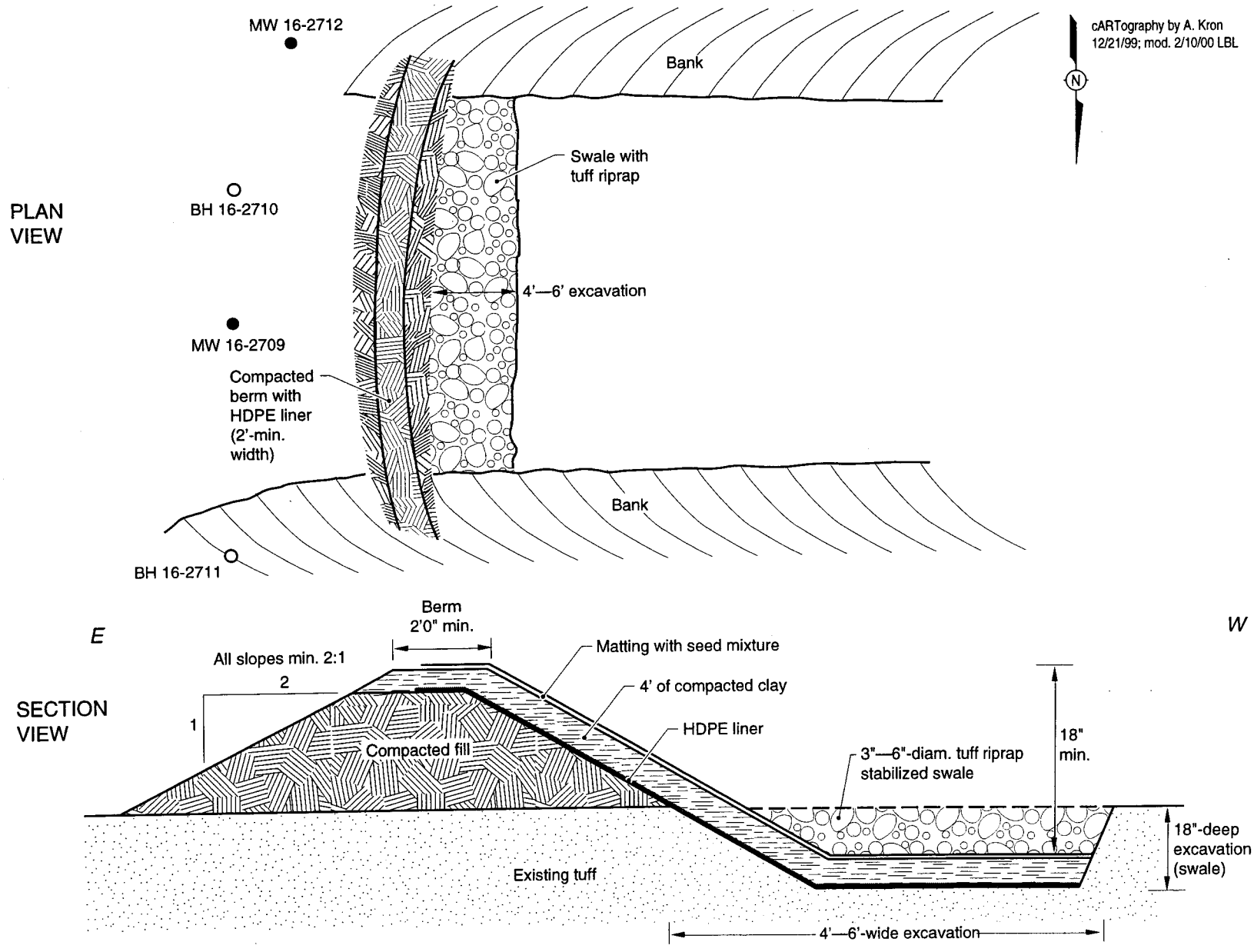


Figure 6. Design of the zero-discharge dam

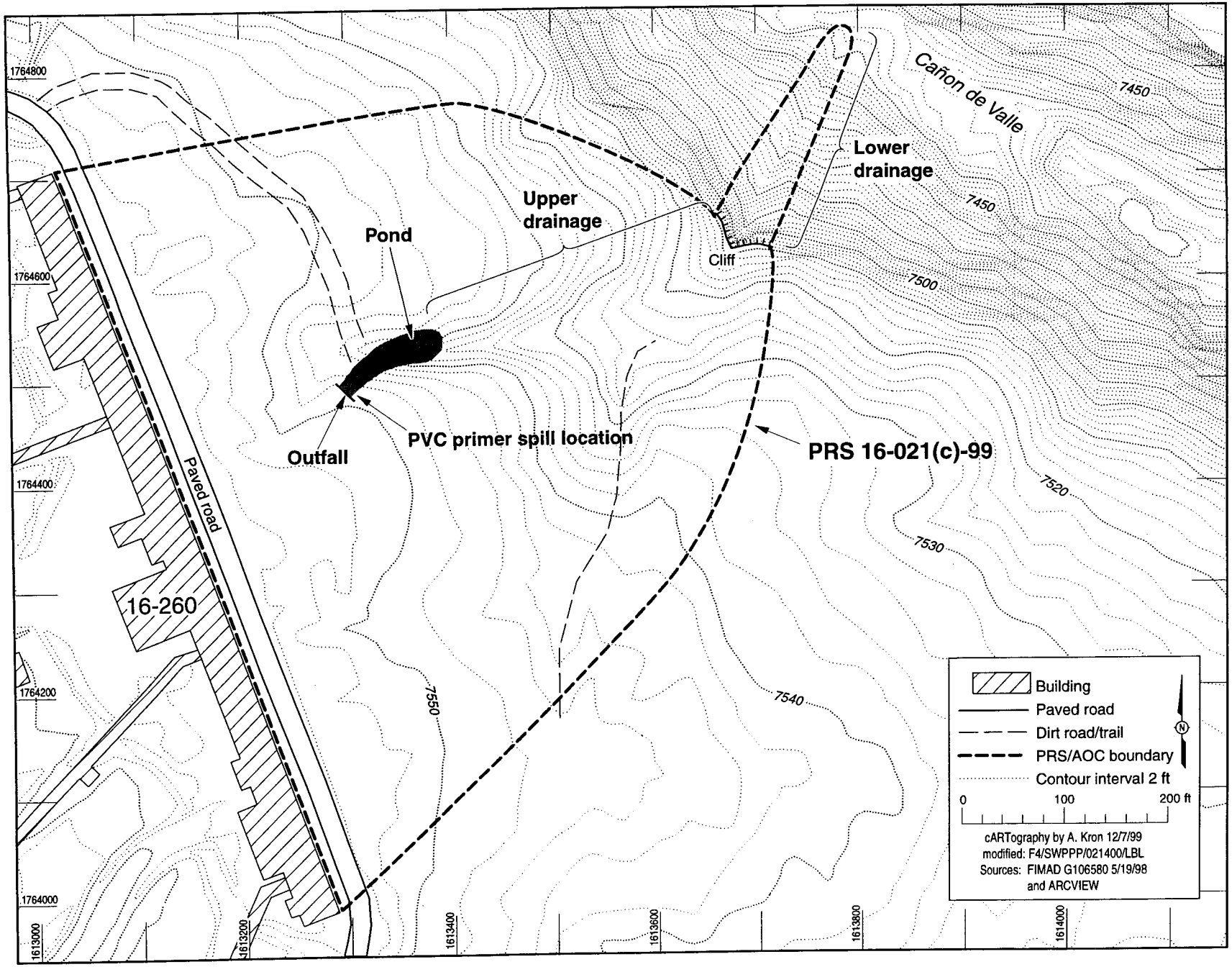


Figure 7. Location of past spill/leak at 16-021(c)-99