Bottom ✓
Ron K —

Los Alamos National Laboratory

ENVIRONMENTAL RESTORATION

Environmental Restoration
University of California
Environmental Restoration, MS M992
Los Alamos, New Mexico 87545
505-667-0808/FAX 505-665-4747

U. S. Department of Energy
Los Alamos Area Office, MS A316
Los Alamos, New Mexico 87544
505-665-7203
FAX 505-665-4504

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Date: April 19, 1996
Refer to: EM/ER:96-205

Mr. David Neleigh
NM Federal Facilities Section
Multimedia Planning and Permitting Division
U.S. Environmental Protection Agency
Region 6, 6PD-N
1445 Ross Ave, Suite 1200
Dallas, TX 75202-2733

SUBJECT: SUBMITTAL OF THE RESOURCE CONSERVATION AND RECOVERY ACT FACILITY INVESTIGATION (RFI) REPORT FOR POTENTIAL RELEASE SITES (PRSs) IN TECHNICAL AREA (TA) 57

Dear Mr. Neleigh:

Enclosed are two copies of the Los Alamos National Laboratory's RFI Report concerning PRSs 57-001(b), 57-001(c), 57-002, 57-004(a), 57-006, 57-007 in TA-57. The report documents the field work performed as detailed in the approved RFI Work Plan for Field Unit 5 and the results of the sampling.

Please ask your office to contact Cheryl Rofer or Mike Gilgosch of our staff at (505) 667-2988 or (505) 667-5794, respectively, if you have any questions.

Sincerely,

Jorg Jansen, Program Manager
Environmental Restoration

Sincerely,

Theodore J. Taylor, Program Manager
Los Alamos Area Office

JJ/TT/am

Enclosure: Two copies of the RFI Report for PRSs at TA-57
Certification

3700

TL

96-1062

HSWA LANL 5/1154/57

Cy (w/enc.):
B. Garcia, NMED-HRMB
D. Griswold, ERD, AL, MS A906
C. Rofer, EES-1, MS D462
M. Gilgosch, LAAO, MS A316
J. Harry, EM/ER, MS M992
B. Hoditschek, NMED-HRMB
R. Kern, NMED-HRMB
N. Naraine, EM-453, DOE-HQ
M. Shaner, P&PI, MS J591 (5 copies)
T. Taylor, LAAO, MS A316
N. Weber, Bureau Chief, NMED-AIP, MS J993
J. White, ESH-19, MS K498
S. Yanicak, NMED-AIP, MS J993
RPF, MS M707

Cy (w/o enc.):
T. Baca, EM, MS J591
D. Bradbury, EM/ER, MS M992
T. Glatzmaier, DDEES/ER, MS M992
D. McInroy, EM/ER, MS M992
G. Rael, ERD, AL, MS A906
W. Spurgeon, EM-453, DOE-HQ
J. Vozella, LAAO, MS A316
EM/ER File, MS M992

CERTIFICATION

I certify under penalty of law that these documents and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violation.

Document Title: RFI Report for Potential Release Sites at TA-57

Name: _____ Date: 4-19-96

Jorg Jansen, Program Manager
Environmental Restoration Project
Los Alamos National Laboratory

or

Tom Baca, Program Director
Environmental Management
Los Alamos National Laboratory

Name: _____ Date: 4/19/96

Joseph Vozella,
Acting Assistant Area Manager of
Environment Projects
Environment, Safety, and Health Branch
DOE-Los Alamos Area Office

or

Theodore J. Taylor
Program Manager
Environment Restoration Program
DOE-Los Alamos Area Office

Barbara
Ron K—

RFI Report for Potential Release Sites at TA-57

57-001(b)
57-001(c)
57-002
57-004(a)
57-006
57-007

(located in former Operable Unit 1154)

Field Unit 5

Environmental Restoration Project

April 1996

A Department of Energy
Environmental Cleanup Program

Los Alamos
NATIONAL LABORATORY

LA-UR-96-1062

EXECUTIVE SUMMARY

This report describes the results of surface and shallow subsurface soil sampling at potential release sites (PRSs) 57-001(b), 57-001(c), 57-002, 57-004(a), 57-006, and 57-007 at Technical Area (TA) 57 (former Operable Unit [OU] 1154), known as the Fenton Hill facility. From the early 1970s until the early 1990s, the Laboratory carried out geothermal recovery experiments at this facility; these PRSs, which include circulation ponds, an outfall, a sludge disposal pit, and discharge areas for an on-site analytical chemistry trailer, received fluids and other materials associated with the geothermal experiments. The objective of this Phase I investigation was to confirm the presence or infer the absence of Resource Conservation and Recovery Act (RCRA) hazardous constituents at these PRSs.

During the summer of 1994, surface and shallow subsurface soil samples were collected from nine locations. All the samples were analyzed for metals. In addition, those samples collected from PRSs at which drilling materials and geothermal circulation fluids had been used were analyzed for semivolatile organic compounds; and those samples collected from the discharge areas for the analytical chemistry trailer were analyzed for volatile organic compounds.

Because no RCRA hazardous constituents were found at levels above screening action levels (SALS) in samples collected from PRSs 57-001(b) (pond portion only), 57-001(c), 57-004(a), 57-006, or 57-007, we are recommending NFA for the pond portion of PRS 57-001(b) and the other four PRSs.

For the outfall portion of PRS 57-001(b) (Burns Swale), arsenic and manganese were found in surface soils in concentrations exceeding background Upper Tolerance Limits (UTLs). For this reason, Burns Swale is scheduled for a Phase II (accelerated, focused) field investigation to determine the extent of the arsenic and manganese contamination. The Phase II data will, in addition, be used to perform a human health risk assessment for the Burns Swale area. A sampling and analysis plan for this Phase II investigation is included in this report.

Finally, for PRS 57-002, a voluntary corrective action (VCA) is recommended, because of the presence of arsenic in soils at concentrations greater than its UTL and of barium in concentrations exceeding its SAL. The VCA plan will be presented as a separate document.

Drilling fluids, produced waters, and other wastes associated with exploration, development, or production of geothermal energy are not hazardous wastes as defined in RCRA, and are exempt from RCRA hazardous waste consideration. For this reason, the PRSs reported on in this document are not listed in the Laboratory Hazardous and Solid Waste Amendments (HSWA) permit. However, as set forth in the RFI Work Plan for OU 1154, the Laboratory agreed to follow the requirements of HSWA (Module VIII of the RCRA permit) to ensure that all environmental problems are investigated in a consistent manner.

Table ES-1 lists proposed actions for each PRS.

TABLE ES-1

PROPOSED ACTIONS FOR PRSs 57-001(b), 57-001(c), 57-002, 57-004(a), 57-006, and 57-007

PRS	HSWA Permit	Proposed Action	NFA Criterion	Rationale	Section No.
57-001(b)					5.1
Burns Swale	No	Phase II sampling		Arsenic and manganese concentrations exceed UTLs	
Pond GTP-3W	No	NFA	4	No plausible route for human exposure to COPCs	
57-001(c)	No	NFA	4	All COPCs eliminated	5.2
57-002	No	VCA		Arsenic concentration exceeds UTL; barium concentration exceeds SAL	5.3
57-004(a)	No	NFA	4	All COPCs eliminated	5.4
57-006	No	NFA	4	All COPCs eliminated	5.5
57-007	No	NFA	4	All COPCs eliminated	5.6

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ACRONYMS AND ABBREVIATIONS

ALARA	As Low As Reasonably Achievable
AP	Administrative Procedures
AR	Administrative Requirements
CME	Central Mining Equipment
COPC	Chemical of Potential Concern
DL	Detection Limit
EP	Extraction Procedure
EPA	Environmental Protection Agency
EQL	Estimated Quantitation Limit
ER	Environmental Restoration
FIMAD	Facility for Information Management, Analysis, and Display
GIS	Geographic Information System
HP	Hewlett Packard
HSWA	Hazardous and Solid Waste Amendments
IWP	Installation Work Plan
J	Estimated
LANL	Los Alamos National Laboratory
MCE	Multiple Chemical Evaluation
NFA	No Further Action
NMED	New Mexico Environment Department
NPDES	National Pollution Discharge Elimination System
OU	Operable Unit
OVA	Organic Vapor Analyzer
PID	Photolonization Detector
ppm	Parts per Million
PRS	Potential Release Site
QA	Quality Assurance
QC	Quality Control
r	Correlation Coefficient
RCRA	Resource Conservation and Recovery Act
RDA	Recommended Daily Allowance
RFI	RCRA Facility Investigation
SAL	Screening Action Level
SMO	Sample Management Office
SNL	Sandia National Laboratories
SOP	Standard Operating Procedure
SVOC	Semivolatile Organic Compound
SW	Solid Waste
TA	Technical Area
TCLP	Toxicity Characteristic Leaching Procedure
UJ	Undetected Estimated
UTL	Upper Tolerance Limit
VCA	Voluntary Corrective Action
VOC	Volatile Organic Compound
XRF	X-Ray Fluorescence

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1.0 INTRODUCTION

In 1970, the Laboratory proposed an experiment to study the feasibility of extracting heat from hot dry rocks deep within the earth. The experiment called for injecting water via a borehole; the water would be naturally heated by the hot rocks found at these great depths, then pumped back to the surface for recovery of the energy from the heated water.

From 1972 until 1992, facilities were constructed and operations carried out at Technical Area (TA) 57, the Fenton Hill site, to support this research. The portion of TA-57 that contains these facilities was formerly designated Operable Unit (OU) 1154 (see Figure 1-1 for the location of TA-57). Today, operations are limited to equipment maintenance and infrequent geothermal recovery studies. The site is active, but no geothermal experiments are currently taking place.

The operations at Fenton Hill produced various liquid and solid wastes. The water that was circulated and recovered from the hot rocks contained dissolved metals and other naturally occurring chemicals; muds used during drilling of the boreholes contained metals; the solvents and lubricants used in drilling contained organic compounds; and the laboratory in which recovered water and sludges were analyzed for chemical constituents used small amounts of several reagents in the analytical procedures.

Drilling fluids, produced waters, and other wastes associated with exploration, development, or production of geothermal energy are not hazardous wastes as defined in the Resource Conservation and Recovery Act (RCRA) and are exempt from RCRA hazardous waste consideration. For this reason, the potential release sites (PRSs) reported on in this document are not listed in the Laboratory Hazardous and Solid Waste Amendments (HSWA) permit. However, as set forth in the RFI Work Plan for OU 1154, the Laboratory agreed to follow the requirements of HSWA (Module VIII of the RCRA permit) to ensure that all environmental problems are investigated in a consistent manner.

The OU 1154 RCRA facility investigation (RFI) Work Plan (LANL 1994, 1159) described operations at the facility and identified ten (PRSs) within TA-57. Of the ten, two were recommended for no further action (NFA) and two for deferred action. In this report, we present the results of the RFI Phase I sampling at the remaining six PRSs, 57-001(b), 57-001(c), 57-002, 57-004(a), 57-006, and 57-007.

1.1 General Site History

The concept of recovering heat from water circulated through hot dry rocks via deep wells was developed in 1970. An exploratory well (GT-1) was drilled in the Barley Canyon area in 1972, but this site was abandoned shortly thereafter because of poor winter access and rough terrain. In 1974, the Fenton Hill site was selected for a second well, GT-2, which was completed in 1975. Three additional wells (EE-1, EE-2, and EE-3) were drilled between 1975 and 1983. Massive hydraulic fracturing operations were begun at each well as drilling was completed. Tracer injection and water loss studies were conducted from 1984 until 1992.

As described in the RFI work plan, operations at TA-57 took place in two alternating modes: drilling and circulating.

The drilling mode encompassed all of the operations involved in drilling boreholes or wells. During drilling, fluids (water and drilling mud) were pumped down the drill stem; the mud, which consisted of many materials, such as barium sulfate, bentonite clay or gel, lignite (a low-

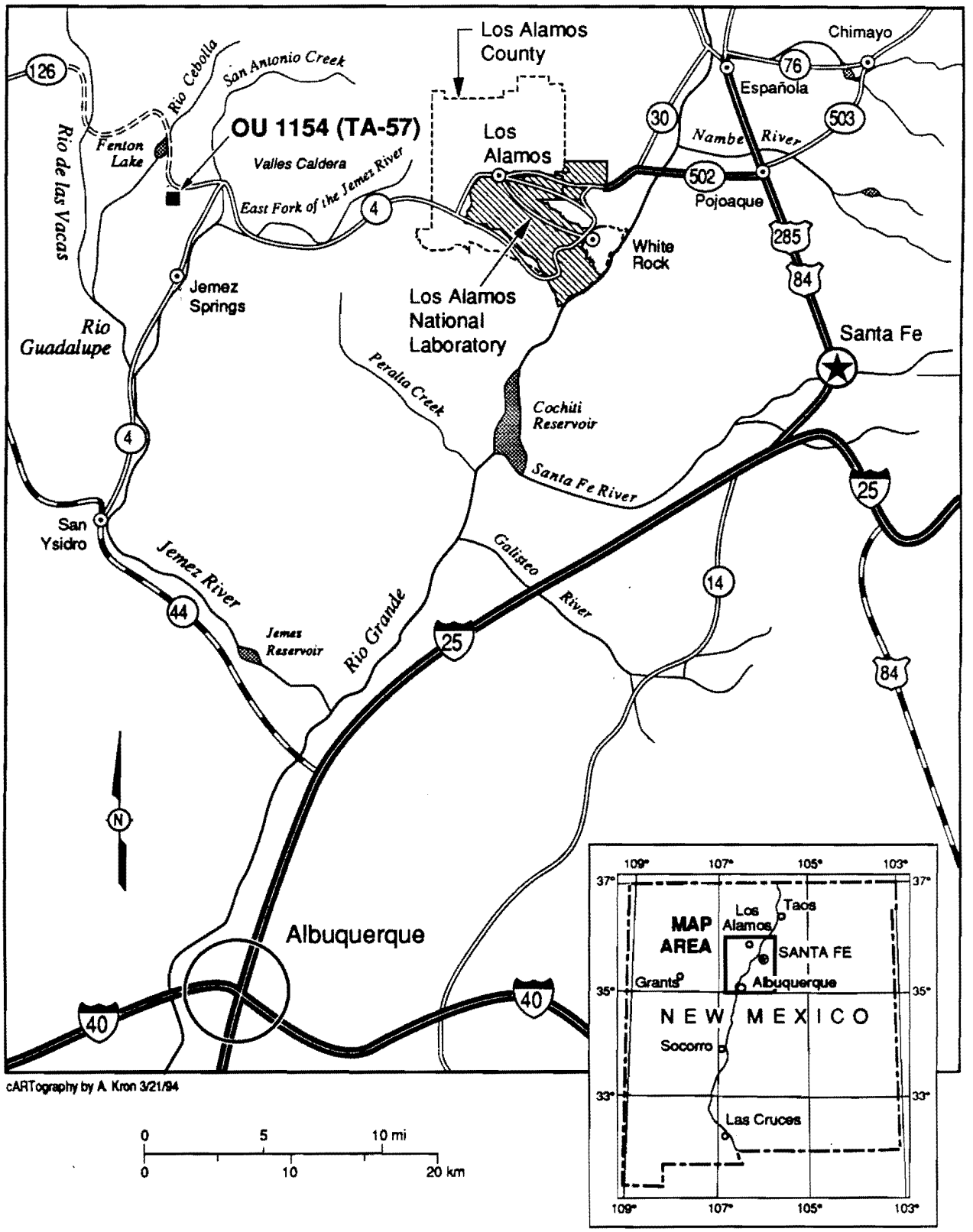


Figure 1-1. Location of TA-57 (Fenton Hill Site) in New Mexico.

grade coal), cottonseed hulls, walnut shells, dispersants and surfactants (drilling lubricants), and sawdust) provided structural integrity to the borehole, filling voids created around the auger and inhibiting cave-ins. In addition, the water and drilling mud solution acted as a lubricating fluid and a medium for conducting cuttings back to the surface. The drilling slurry (mud, water, and cuttings) thus created was discharged to settling ponds, where solid waste settled to the bottom; the supernatant liquid was filtered, then re-injected into the well (LANL 1994,1159).

The circulating mode consisted, first, of injecting water containing tracer compounds into the injection well; the water passed through fractures in the hot rock formations, where it dissolved naturally occurring minerals. It then passed to the recovery well to be pumped back to the surface. The final stages were to pump the heated water through heat exchangers for energy recovery and then to a settling pond. As the water cooled in the pond, some of the dissolved compounds precipitated out and, along with other particulate matter, settled to the bottom of the pond.

During both modes of operation, as the settling ponds filled and solids accumulated, the ponds were "mucked out" and the solids were transported to the sludge pit.

The six PRSs that are covered in this report can be grouped into three categories: settling ponds, sludge pit, and disposal areas for chemical wastes from the analytical laboratories. For the first two categories, three sources of potential contamination were identified: cuttings brought to the surface in drilling operations, chemicals leached into injected waters from the hot rocks, and chemicals introduced in the drilling additives.

1.2 RFI Overview

The OU 1154 RFI Work Plan (LANL 1994,1159) focuses on meeting site characterization requirements in a cost-effective manner. This approach incorporates a health-risk-based decision-making process, consistent with the Installation Work Plan (IWP) for Environmental Restoration (LANL 1995, 1164) and proposed Subpart S to 40 CFR 264, for recommending PRSs or PRS aggregates for NFA, expedited cleanup, voluntary corrective action, or further study. It also incorporates a phased site-characterization methodology that follows EPA and IWP guidelines. The technical approach is described in Chapter 4 of the RFI Work Plan (LANL 1994,1159).

The primary purpose of the RFI at TA-57 was to determine the current distribution of chemicals of potential concern (COPCs) on the surface at PRS 57-001(b) and in shallow subsurface soils at the other PRSs, and to compare these findings with risk-based screening action levels (SALs) for soils. The objectives of the sampling and analysis plan, then, were to

(1) determine the concentrations of chemicals in soils collected from the PRSs;

(2) identify COPCs through comparison of the analytical data with background levels and/or SALs (see Section 3.2 and 3.4 of this document); and

(3) determine whether NFA can be recommended, whether Phase II investigations are required, or whether an accelerated clean-up, voluntary corrective action (VCA), or corrective measures study should be undertaken (see Section 3.4 of this document).

1.2.1 PRSs 57-001(b), 57-001(c), and 57-004(a): Settling Ponds

These three settling ponds contained a homogeneous mix of cuttings, drilling mud, additives, and dissolved materials, returned to the surface in the heated waters. As the circulated waters cooled, some dissolved compounds precipitated out; these, along with particulate matter and other solid materials brought up from the borehole, settled as solids to the pond bottom. The black layer they formed, referred to as "service-type" material, was assumed during sampling to constitute the bottom-most layer of the ponds. (This was confirmed by the fact that analysis showed contamination in this black layer but not in the tuff bedrock layer just below.) Supernatant liquid from the ponds was sampled and analyzed during operations and, if it met NPDES water quality standards, was discharged to Burns Swale, south of the main compound (see Figure 1-2). Metals were analyzed for in the water as indicator constituents.

1.2.1.1 PRS 57-001(b): Settling Pond GTP-3W and Burns Swale PRS 57-001(b)

This PRS comprises two settling ponds, designated GTP-3E (east) and GTP-3W (west), used during the drilling and operation of Well GT-2. Because GTP-3W was the larger and more used of the two, it was selected for sampling (its contents are assumed to be representative of both ponds). Pond GTP-3W was created by constructing a 10-ft-high berm across the head of Burns Swale and excavating into the tuff. A spillway was installed on the western end of the berm that was used to periodically discharge water into the swale. Following decommissioning and cleaning, the pond was backfilled with boulders and clean soil, level with the surrounding terrain; the depth from the current surface to the bottom of the original pond is estimated to be 16 ft.

1.2.1.2 PRS 57-001(c): Settling Pond GTP-2

This PRS, used during experiments related to geothermal energy recovery, contained circulation fluids. After geothermal testing ceased, the pond was decommissioned, cleaned, and filled with clean soil to the level of the original ground surface. The current depth to the bottom of this filled-in pond is approximately 9.5 feet..

1.2.1.3 PRS 57-004(a): Settling Pond GTP-1E

This pond was originally excavated for use as the disposal pit for the drilling of well EE-1. As it became full, the area was enlarged toward the west to serve as a settling pond for discharged drilling materials and for recycling of fluids from the circulation loop. The successive enlargements eventually joined Pond GTP-1E with the area now occupied by Pond GTP-1W (PRS 57-004(b), the existing 1-million-gal. pond). The entire area was decommissioned, cleaned of sludge, and backfilled with clean soil to original ground level (the current depth to the bottom of this pond is not known), after which Pond GTP-1W was excavated and lined with plastic. The Phase I RFI investigation involved only the eastern pond, GTP-1E; the sediments under the existing western pond, from which there is no sign of contaminant release, will be investigated after the decommissioning of the Fenton Hill site.

1.2.2 PRS 57-002: Sludge Pit

The sludge pit, used between 1974 and 1990, was a disposal pit that received all solids removed from the bottom of the settling ponds and mud removed from the drilling mud pits. The pit is located about 2 miles west of the main compound of TA-57 (see Figure 1-3). The pit was divided into two sections: the western section is reported to be 15 - 20 ft deep and the eastern section

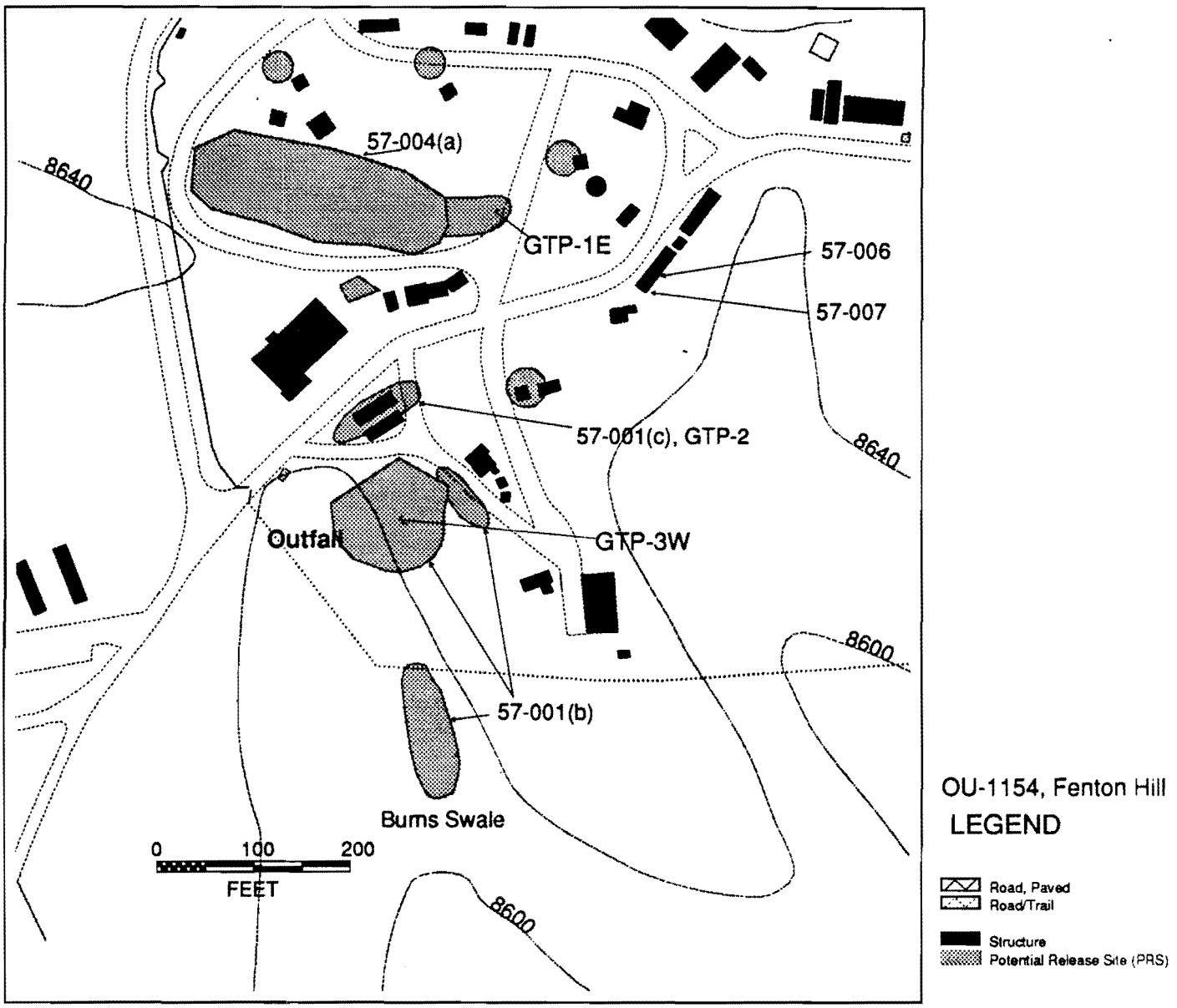


Figure 1-2. Locations of PRSs 57-001(b), 57-001(c), 57-004(a), 57-006, and 57-007

Source: FIMAD, 11/21/95, G103966
Modified by: by C. Rivera Lyons 1/20/96

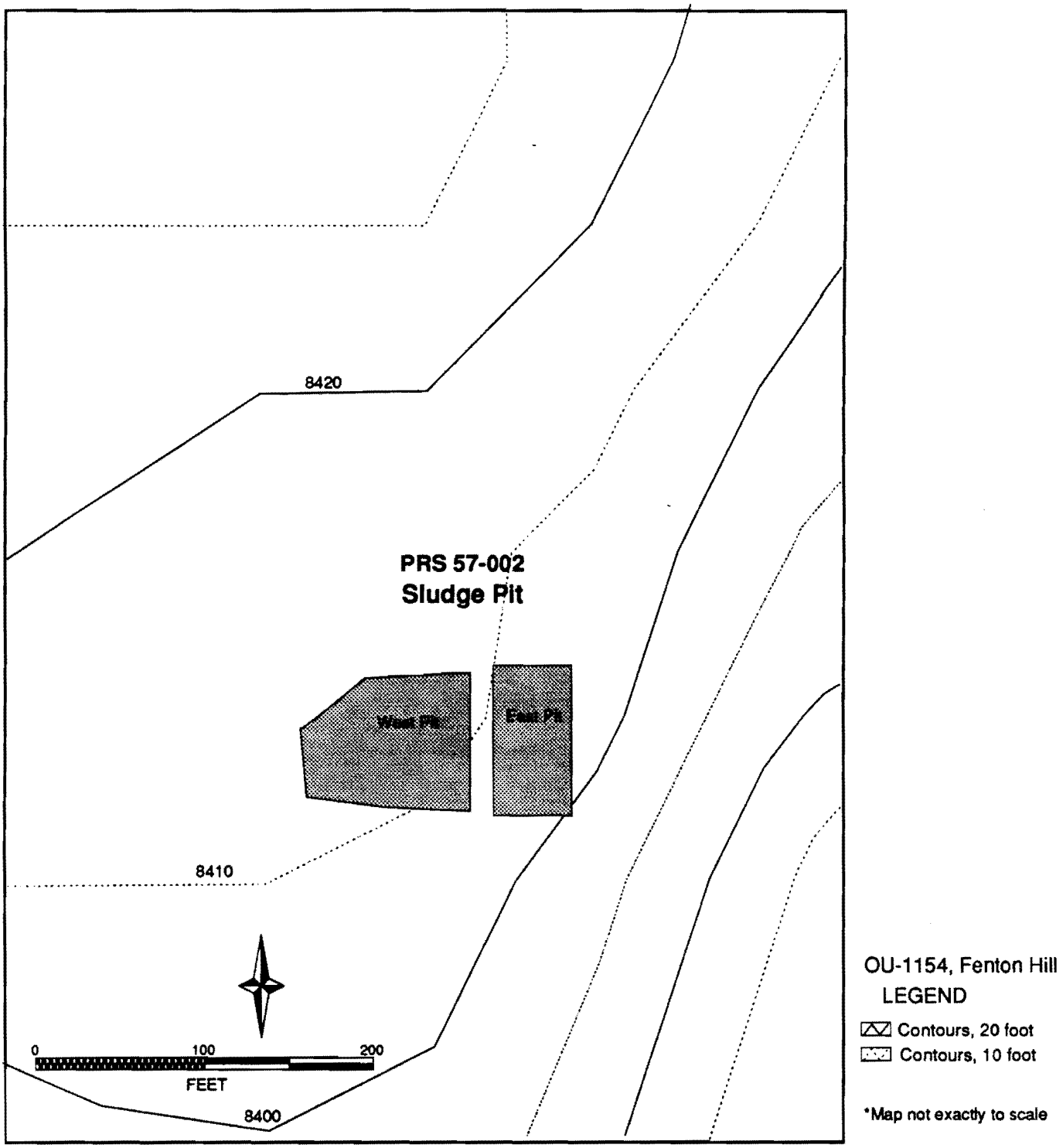


Figure 1-3 - Location of PRS 57-002

Source: FIMAD, 12/14/94, G102838
Modified by: by C. Rivera Lyons 1/20/96

6 - 8 ft deep. The solids in this pit include cuttings, drilling muds, and the precipitate from recovered circulation water. Because the pit was unlined, some of the water in the sludge may have percolated into underlying rock. But the nature of the sludge—finely divided material such as bentonite and barite—precluded major infiltration into bedrock. Indicator constituents analyzed for were metals and SVOCs.

1.2.3 PRSs 57-006 and 57-007: Disposal Areas for Chemical Wastes

1.2.3.1 PRS 57-006: Chemical Waste Drum

A trailer at TA-57 was used as an analytical chemistry laboratory (see Figure 1-2) from about 1976 to 1989, to provide real-time analyses of the materials and water used during the geothermal operations. Chemicals that were considered to be too dangerous to be disposed of via the drain that ran from the sink in the trailer were poured into a special drain connected to a plastic-lined 55-gal. drum buried in the ground beneath the trailer. When the drum was full, its contents were transported to the main Laboratory for disposal. The drum and its residual contents were removed as a voluntary corrective action on September 15, 1994. Samples taken of the soil beneath the former site of the drum were analyzed for metals, VOCs, and total uranium.

1.2.3.2 PRS 57-007: Chemical Waste Leach Field

Waste water from the trailer's analytical chemistry laboratory was poured into a sink that drained to a subsurface leach field located about 20 ft southeast of the trailer. The RFI Work Plan for OU 1154 (LANL 1994, 1159) reports that some chemicals were mixed with water and poured into the sink drain. Indicator constituents analyzed for were metals and VOCs.

1.3 Field Activities

Field work at these PRSs began in mid June 1994, with selection of locations for surface and subsurface sampling. Information from numerous sources was used in selecting these locations: site maps, topographic surveys, surface runoff data, the FIMAD [Facility for Information Management, Analysis, and Display], GIS [Geographic Information Systems] database, interviews with TA-57 site personnel, and site visits. In carrying out the field work, all applicable LANL ER SOPs (LANL, 0875) were followed unless otherwise noted in Chapter 5.

1.3.1 Field Screening and Surveying

1.3.1.1 Land Surveys

Surveying control points were established, using Ashtech M-XII differential geographic positioning receivers; two points were established at the TA-57 main compound, and two were established 2 miles west of the main compound (near PRS 57-002, the sludge pit). The control points were used as a reference for geographical surveying of the sampling locations (by total-station electronic theodolite, in accordance with LANL-ER-SOP-3.01.R1). Coordinates for the sampling locations were then calculated from these data (using WILDsoft, a surveying computer software program—Leica, Inc., 1990, 1285), were electronically recorded, and were entered into the FIMAD database The location of each sampling point was verified against maps generated by FIMAD.

1.3.1.2 Radiological and Chemical Screening

In order to comply with worker safety requirements and Department of Transportation and Laboratory sample transport requirements, radiological and chemical screening were undertaken simultaneously with sample collection. Just before collection of each sample, the sampling location was screened for radioactivity with an ESP-1 beta/gamma meter equipped with an HP 260 pancake probe (following SOPs ESH-1-07-85.R0 and ESH-1-07-04.R0) and for organic vapors with a photoionization detector (Environmental Restoration Decommissioning Project 1995, 1258).

1.3.2 Surface Sampling

Surface samples were collected on August 16, 1994, from the Burns Swale portion of PRS 57-001(b), in accordance with LANL-ER-SOP-6.26.R0. On September 15, 1994 a sample was taken from soil beneath the former site of the chemical waste drum (PRS 57-006); and on December 1, 1994, a sample was taken from the gravel at the bottom of PRS 57-007, the chemical waste leach field.

1.3.3 Subsurface Sampling

Subsurface soil samples were collected on August 15-16, 1994, from the settling ponds (PRSs 57-001[b], 57-001[c], and 57-004[a]), and from the sludge pit (PRS 57-002). These were taken using a Central Mining Equipment (CME) 45 hollow-stem-auger drill rig and 5-ft stainless-steel core barrel samplers, following LANL-ER-SOP-6.26.R0. Metals concentrations in the core material (in particular, barium) were determined on site using the X-ray fluorescence (XRF) technique. An elevated XRF barium concentration in the core material generally dictated the depth at which the sample was taken for chemical analysis.

On March 14, 1995 a section of stored core (4.5 to 5-ft depth) taken from the sludge pit (PRS 57-002), at sampling location 57-3000, was submitted for metals analysis by the TCLP extraction method.

2.0 ENVIRONMENTAL SETTING

The environmental setting of the Laboratory is described in Section 2.4 of the IWP (LANL 1995, 1164). For a detailed discussion of the environmental setting of TA-57, including climate, geology, hydrology, and a conceptual hydrogeologic model for the area and its surroundings, see the RFI Work Plan for OU 1154 (LANL 1994, 1159).

2.1 Climate

Los Alamos County has a semiarid, temperate, mountain climate. Summers are generally sunny with moderate, warm days and cool nights. Although temperatures recorded at Fenton Hill are observed to be somewhat colder than the summer and winter temperatures recorded at Los Alamos, according to Petitt (1976, 24-0012), the temperature patterns at Fenton Hill are generally the same as at Los Alamos. With the high altitude, light winds, clear skies, and dry atmosphere, summer temperatures in the TA-57 area range from 50°F at night to 90°F during the day, and winter temperatures typically range from 0°F at night to above 32°F during the day. Average annual precipitation at TA-57 is estimated to be about 17 in. Of this, approximately 40% is produced by brief, intense thunderstorms during the summer months (July through September), which can generate stream flow in area canyons. Spring snowmelt can also generate stream flow in these canyons.

2.2 Geology

2.2.1 Geologic Setting

A detailed discussion of the geology of the Los Alamos area can be found in Section 2.5.1 of the IWP (LANL 1995, 1164). Technical Area 57, situated on the Jemez Plateau on the south side of the Jemez Mountains, is about 60 km (37 mi) west of Los Alamos. A geologic column of the region near the site is shown in Figure 2-1. Cenozoic volcanic rocks form the upper surface of the Jemez Plateau, overlying the Permian, Pennsylvanian, and Precambrian rocks (Kaufman & Sicilliano 1979, 24-0013). Bandelier Tuff, a specific age group of cenozoic rocks, is about 106 m (350 ft) thick under the Fenton Hill site. The Tshirege member of the cenozoic rocks forms the uppermost layer of the Bandelier Tuff at Fenton Hill.

2.2.2 Soils

A detailed discussion of the soils in the Los Alamos area can be found in Section 2.5.1.3 of the IWP (LANL 1995, 1164). Although no study of the soils in the high mountain area of Fenton Hill has been published, undisturbed soils are probably typical of the soils described for the plateau tops and edges in the Los Alamos area. However, very little remains of the original surface soil at TA-57 or at the U.S. Forest Service gravel pit, which was used as a sludge dumping site during the geothermal operations.

2.3 Hydrology

The hydrology of the Jemez Plateau and of the Fenton Hill area are summarized in the following two sections.

FENTON HILL STRATIGRAPHY					
Age	Era	Period	Depth	Formation	Temp.
	CENOZOIC	Quaternary		Bandelier Tuff	46°F 8°C
2.5my			50ft 15m		53°F 12°C
		Tertiary		Paliza Canyon Abiquiu Tuff(?)	
68my		unconformity	460ft 140m		86°F 30°C
	PALEOZOIC	Permian		Abo red beds	
280my			1,250ft 381m		125°F 52°C
		Pennsylvanian-Mississippian		Madera Limestone Sandia Formation(?)	
345my?		unconformity	2,405ft 733m		190°F 88°C
570my+	PROTEROZOIC			Fenton Hill granodiorite (intrusive)	
1,300 to 1,700 my		Precambrian	15,000ft 4,572m	Metamorphic and igneous complex (undifferentiated)	608°F 320°C

Source: Nuckols et al. 1981, 24-0025
Modified by: cARTography by A. Kron 2/1/94

Figure 2-1. Geologic column of Fenton Hill stratigraphy.

2.3.1 Surface water

The major surface water drainage near Fenton Hill is the Jemez River and its tributaries (Figure 2-2). The Fenton Hill site slopes gently south, so the major part of the runoff is into Lake Fork Creek, which is tributary to the Rio Cebolla below Fenton Lake. The area immediately northwest of TA-57 drains into an unnamed tributary, which joins the Rio Cebolla at Fenton Lake, and the area immediately northeast of TA-57 drains toward San Antonio Creek but is diverted by a low divide into Lake Fork Creek. At the confluence of the East Fork of the Jemez River and San Antonio Creek, the combined streams become the Jemez River. The Rio Guadalupe drains the area west of Fenton Hill and includes the tributaries Rio de Las Vacas and Rio Cebolla.

2.3.2 Groundwater

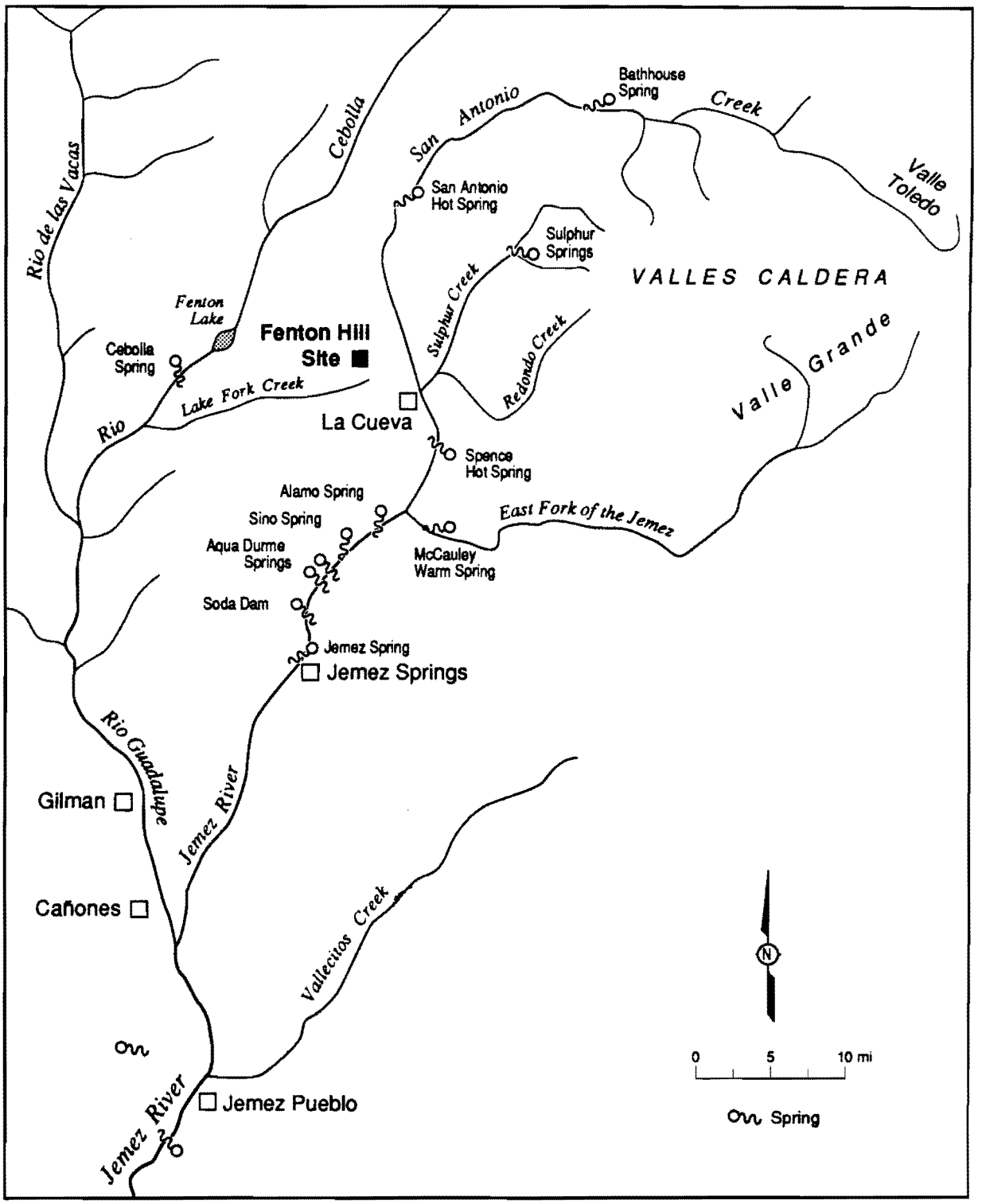
Groundwater is found in the sediments of the Valles caldera and as perched water in volcanic rocks and sediments adjacent to the caldera. The aquifer perched on the Abo Formation produces cold, clean water and is the source tapped by most of the domestic wells that attain bedrock. This perched aquifer is also the water supply for Fenton Hill, via well FH-1, which is about 136 m (450 ft) deep. Beneath the Abo Formation aquifer and other less significant perched aquifers lies the regional aquifer, at a depth of about 533 m (1750 ft), at the base of the Madera formation; many of the hot springs in the region appear at outcrops of this formation.

In Burns Swale, a dry tributary of Lake Fork Canyon, alluvium deposits are 2-6 ft deep in the upper reaches and more than 40 ft deep at the confluence with Lake Fork Canyon. Because alluvium is quite permeable, water can move downgradient in these deposits; alluvial aquifers in the adjacent major river valleys—of the Jemez River, the Rio Guadalupe, and the Rio Cebolla—are the most permeable units in the area.

2.4 Biological Surveys

The Fenton Hill site has been surveyed for biological resources, in compliance with the following: the Federal Endangered Species Act of 1973; the New Mexico Wildlife Conservation Act; the New Mexico Endangered Species Act; Executive Order 11990, "Protection of Wetlands"; Executive Order 11988, "Floodplain Management"; 10 CFR 1022; Compliance With Floodplain/Wetlands Environmental Review Requirements (DOE 1979, 0633); and DOE Order 5400.1, General Environmental Protection Program (DOE 1988, 0075). For detailed information on the results of the biological field surveys for TA-57, see the biological assessment report (Keller, in preparation, 24-0074).

The survey identified at least four species classified as endangered and/or threatened on the federal and state lists: the spotted bat, the pine martin, the Jemez Mountain salamander, and the wood lily. Table 2-1 shows the status of each.



Source: Purtyman et al. 1974, 24-0061
Modified by: cARTography by A. Kron 3/15/94

Figure 2-2. Major surface water drainages near Fenton Hill

TABLE 2-1

TA-57: ENDANGERED AND/OR THREATENED SPECIES

Species		Status	
Common Name	Latin Name	Federal	State
Spotted bat	*Euderma maculatum*	threatened	endangered
Pine martin	*(Martes americana)*	candidate	endangered
Jemez Mountain salamander	*Plethodon neomexicanus*	candidate	endangered
Wood Lily	*Lilium philadelphicum var. andium*		endangered

Mapping of ecological habitats, as part of the survey, showed that suitable habitat for all four species of concern exists in the vicinity of TA-57.

2.5 Cultural Surveys

The Fenton Hill site has also been surveyed for cultural resources, as required by the National Historic Preservation Act (amended). No archaeological sites were found in the areas surveyed; three previous surveys of the Fenton Hill environs also reported no archaeological sites (Scheick 1979, 24-0019; Larson 1987, 24-0020; Larson 1987, 24-0021).

3.0 APPROACH TO DATA ASSESSMENT AND ANALYSES

Assessment and analysis of the data from the PRSs that are the subject of this report follow the field investigation, chemical analyses, and data reporting, and involve a series of quantitative steps. These begin with data verification and routine data validation and, if necessary, continue with more focused data validation. Data verification ensures that the data are complete, properly organized, and in compliance with contractual requirements. Routine data validation involves comparing each data item with specific targets and adding a qualifier flag to the data if a potential deficiency is noted. Focused data validation consists of analyzing QA/QC data for their potential impact on succeeding data assessment steps, which are: comparing site data with background concentration data; verifying the identities of detected organic chemicals; comparing site data with screening action levels (SALs) for human health effects, and performing human health or ecological risk assessments when necessary. The following subsections provide overviews of the methods used to complete these quantitative steps.

3.1 Sample Analyses

All samples requiring chemical and radiological analysis and chain-of-custody documentation were submitted to the sample management office (SMO) for processing and packaging. The SMO shipped the samples to contract laboratories, where all were analyzed for inorganics (metals) and total uranium. In addition, surface samples taken from PRSs associated with the analytical chemistry trailer (PRSs 57-006 and 57-007) were analyzed for volatile organic compounds (VOCs), and samples taken from those areas potentially contaminated by circulating fluids and drilling muds (PRSs 57-001[b], 57-001[c], 57-002, and 57-004[a]) were analyzed for semivolatile organic compounds (SVOCs).

3.1.1 Analytical Methods

All samples were extracted and analyzed using EPA SW-846 methods or equivalent and/or radiological methods, as described in *Quality Control Data Use* (Environmental Restoration Project Decision Support Council, document in preparation). Samples for metals analyses were digested with nitric acid in accordance with EPA-SW-846 Method 3010 (EPA 1986, 1222).

The only deviation from normal ER field operations was that samples were not submitted to the CST-12 Mobile Rad Van for gross radiation screening. Instead, gross alpha and gross beta activities of aliquots of all soil samples were determined by gas proportional counting on a Berthold Counter at the LANL ESH-19 TA-59 Counting Facility, in accordance with LANL ER-SOP 14.01.R0. In this way, a measure of the levels of radioactivity of the samples was obtained before they were shipped to the analytical laboratories.

3.1.2 Data Verification and Validation

Data verification and validation procedures are used to determine whether data packages have been generated according to specifications, are of known quality, and contain the information necessary to ensure the sufficiency of the data for decision making.

Data verification is a check of data deliverables against a set of stated requirements to verify that what has been ordered has been delivered, thus ensuring that the laboratories can be paid. All analytical data generated in support of the ER Project are verified.

Data validation is the process of determining whether individual results can be reliably used to support the decision-making process. Validators determine whether data should be qualified or used with caution because of the potential impact of noted flaws or the failure to achieve precision or bias constraints.

Routine data validation is the comparison of quality indicators (such as surrogate recovery, measurements of method blanks, holding times, differences between replicate measurements) with clearly defined limits to determine whether limitations may need to be placed on the use of the data. Routine validation is most suitable for routine analyses and for those nonroutine analyses for which clearly defined limits have been established.

Focused data validation addresses those characteristics of the data (e.g., precision and bias) that directly affect the decision(s) to be based on the data. The same data set may undergo different focused validations for different decisions.

Personnel from LANL Group CST-3 validated the analytical data for samples from PRSs 57-001(b), 57-001(c), 57-002, 57-004(a), 57-006, and 57-007 in accordance with LANL administrative procedures AP28, AP29, and AP30 (Gautier 1993, 1289). The analytical results and laboratory supporting data are reviewed at one of three levels, as determined by the CST-3 Quality Assurance Officer. The past performance of the laboratory is taken into account in this decision. The most extensive review, Level Three, is a review of all data in the laboratory's data package; Level Two is a review of all final reported data forms, but the raw data is reviewed to a lesser extent if at all; and Level One is a review of most of the final data and of raw data to a lesser extent than Level Two (or not at all). All analytical results for the collected soil samples are reviewed, regardless of the data review level. The analytical data for TA-57 were reviewed at Level One.

Approximately 1475 analyses were conducted for this investigation. Of these, 141 analytical results were qualified as estimated (J) or undetected estimated (UJ). Selenium analyses for 11 samples were rejected (R). (See Chapter 4 for details on the data that were qualified.)

3.2 Background Comparisons

Once the data validation process is complete and the site data are finalized, the next step is to compare site metal concentrations with available background data. The comparison provides the basis for deciding whether a metal that has a natural or anthropogenic background distribution should be retained as a COPC or should be eliminated from further consideration. (The results of focused data validation should exclude from this comparison any contaminant that is identified as an artifact of analytical laboratory or field contamination, analytical interference, or improper analyte identification or quantitation.) Background data are available from two sources: (1) chemical analyses of soil samples collected throughout Los Alamos County, for certain inorganic (metal) and naturally occurring radioactive chemicals (Longmire et al. 1995, 1142 and 1266); and (2) background concentrations of radioactive chemicals associated with global fallout from atmospheric nuclear testing (e.g., plutonium, cesium, strontium, and tritium) reported in LANL Environmental Surveillance reports (Purtymun et al. 1987, 0211; ESG 1988, 0408; ESG 1989, 0308; Environmental Protection Group 1990, 0497; Environmental Protection Group 1992, 0740).

Each measured concentration of a chemical from the site in question is compared with an upper tolerance limit (UTL) estimated from background data. (Details of statistical methods used to generate UTLs from the background data sets and suggested statistical methods for comparing

site and background concentration distributions are presented in the guidance document, *Statistical Comparisons to Background, Part I*, ER Project Assessments Council 1995, 1218.)

If the reported concentration of a chemical exceeds its UTL or fails other statistical background comparison tests (i.e., the site data are statistically greater than background data), that chemical is carried forward to the screening assessment process. If the reported concentration of a chemical does not exceed the UTL, that chemical is removed from further consideration.

The ER Project has developed UTLs for the most commonly found chemicals and the most commonly analyzed media. For chemicals and/or media not included in the Longmire data (or in FIMAD), UTLs will be developed by the Decision Support Council as needed.

3.3 Evaluation of Organic Constituents

Because background data are not available for organic chemicals, the preliminary evaluation of organic chemicals considers detected chemicals and chemicals that were analyzed for but not detected in any sample. This evaluation determines whether, on the basis of detection status, organic chemicals should be retained as COPCs or eliminated from further consideration. Detection status is ascertained by the analytical laboratory on a sample-by-sample, analyte-by-analyte basis. For analytes that are not detected, estimated quantitation limits (EQLs) have been established as reporting limits. (It should be noted that the EQLs reported for individual samples depend on a number of factors and may vary from sample to sample and from analysis to analysis; therefore, the sample-specific EQL must be used in this evaluation.)

As a general rule, if a chemical is reported as detected, then that chemical is carried forward through the screening assessment process. If a chemical is not reported as detected in any sample analyses, that chemical is removed from further consideration. Exceptions may be made if site-specific process knowledge indicates the need. For example, a detected chemical may be removed from further consideration if it can be shown that its presence is not due to Laboratory operations, and a chemical not detected in any sample may be carried through the assessment process if, on the basis of historical operations, it can be expected to be present at the site.

3.4 Human Health Assessment

3.4.1 Screening Assessment

The screening assessment is used to determine whether, as a result of historical Laboratory operations, chemicals have been released to the environment at levels that may be hazardous to human health or the environment. In the steps described below, which were followed for all TA-57 samples, COPCs retained after comparison with background UTLs are compared with their SALs.

3.4.1.1 Comparison with SALs

SALs are medium-specific concentrations that are calculated using chemical-specific toxicity information and conservative, default exposure assumptions. (A complete discussion of the methods used to generate SALs is provided in *Risk-Based Corrective Action Process*, LANL/SNL 1996,1277.) If the reported concentration is equal to or greater than the SAL, the chemical is retained as a COPC pending further analysis. If the reported concentration is below the SAL, the chemical is generally removed from further consideration (if more than one COPC is present at

the site, this decision is deferred pending the results of the multiple chemical evaluation—see below). The decision to identify a chemical as a COPC when a SAL is not available is made on a case-by-case basis, taking into account the availability of process knowledge and toxicological information.

If the comparison shows that any chemicals are to be retained as COPCs, further action may be proposed. If no COPCs are retained, NFA may be proposed on the basis of no risk to human health.

3.4.1.2 Multiple Chemical Evaluation

It is possible that a chemical should be retained as a COPC because of its potential for adverse health effects when combined with other chemicals present at the site. This possibility is evaluated through the Multiple Chemical Evaluation (MCE): the reported concentration for each chemical is divided by its respective SAL, and the resulting normalized values are incorporated into a simple additive model. If the sum of the normalized values is less than 1, the chemicals are removed from further consideration. If the sum of the normalized values is greater than or equal to 1, any chemical having an individual normalized value greater than or equal to 0.1 is retained as a COPC pending further evaluation (LANL/SNL 1996,1277).

Only those chemicals that exceed background concentration thresholds (certain inorganics and radionuclides) or are detected (organics) in at least one sample are included in the MCE. These chemicals are divided into three classes: noncarcinogens, chemical carcinogens, and radionuclides. Additive effects are assumed within each class, but each class is evaluated separately. For further information on MCEs, see LANL/SNL 1996, 1277.

3.4.2 Risk Assessment

Whether or not a human health risk assessment is performed for an individual PRS is decided on the basis of whether any COPCs were identified through the screening assessment. This information is provided, by PRS, in Chapter 5. Risk assessments are carried out in accordance with the guidance in *Risk-Based Corrective Action Process* (LANL/SNL 1996, 1277) and consist of the following four steps:

- identification of chemicals of potential concern,
- exposure assessment,
- toxicity assessment, and
- risk characterization.

3.5 Ecological Assessment

The TA-57 environs and the potential for ecological receptors to come into contact with contaminants have been evaluated. LANL Environmental Restoration Project personnel and EPA Region 6 officials have agreed that further ecological risk assessment at this site will be deferred until the PRSs can be assessed through the new Ecological Exposure Unit (Ecozone) approach (currently being developed by LANL in conjunction with the EPA and the NMED).

4.0 RESULTS OF QUALITY ASSURANCE/QUALITY CONTROL ACTIVITIES

Each group of samples submitted to the LANL Sample Management Office (SMO) for shipment to an analytical laboratory was assigned a unique request number (sometimes referred to as a "sample delivery group" by analytical laboratories). The number assigned was based on the suite of analyses requested (organic, inorganic, and/or radiological). Upon receipt of the completed analyses from the laboratory, a number was assigned to each analytical report for the group represented by the request number. Each report included the results of quality control samples and quality control tests. The following discussion of the quality control results is organized by PRS number and then by request number. In many cases, samples from different PRSs were submitted to the SMO on the same day and thus were included in the same request number package. QC sample results, thus, may apply to more than one PRS.

4.1 Inorganic Analyses

4.1.1 PRS 57-001(b)

Data from PRS 57-001(b) are usable in support of screening decisions. Six samples were collected at this PRS. As discussed below, there were some problems with respect to percent recoveries that were not within acceptance criteria for the blind QC samples. Nevertheless, the values found in the soil samples were low enough to have little or no effect on the screening assessment discussed in Chapter 5.

Samples from this PRS were analyzed under **Request Number 18574**. For the blind QC sample submitted with the soil samples, percent recovery values for aluminum (70%), chromium (58%), mercury (71%), and vanadium (56%) were in the range of >10% but <75%. In accordance with the validation procedures, the analytical laboratory data for the soil samples are qualified as estimated (J). Nevertheless, the values found in the soil samples—even if adjusted upward to allow for the low recoveries in some of the QC samples—were low enough that they do not affect the outcome of the screening assessments discussed in Chapter 5. The percent recovery values for silver (192%) and arsenic (175%) were in the range of >125% but <200%. These data are usable, but because they could result in false positive values, the reported results for the two analytes were qualified: those that were above or equal to the detection limit (DL) as estimated (J) and those that were below the DL as undetected estimated (UJ).

4.1.2 PRS 57-001(c)

Data from PRS 50-001(c) are usable in support of screening decisions. One soil sample was collected at this PRS, which was included in the **Request Number 18574** package. As noted in Section 4.1.1, there were some problems with respect to percent recoveries that were not within acceptance criteria for the blind QC sample associated with this package. But because all the values for the soil samples were either below detection limits or below background UTLs, this problem had little or no effect on the screening assessment.

Arsenic was found in the soil samples above the background UTL. It is possible that these values were biased high, but even so they had no effect on the final outcome of the screening assessment, discussed in Chapter 5. The percent recovery value for selenium, which was >200%, was qualified as unusable (R). Even if this led to an overestimation of selenium values, all affected values would still be below detection limits and should not affect the screening assessment, discussed in Chapter 5.

4.1.3 PRS 57-002

Data from PRS 50-002 are usable in support of screening decisions. Three samples were collected at this PRS; two were analyzed for total metals as part of the **Request Number 18574** package, and the third was analyzed for TCLP metals as part of the **Request Number 21559** package.

As discussed in Section 4.1.1, there were some problems with respect to percent recoveries for **Request Number 18574** that were not within acceptance criteria for the blind QC samples. In the case of chromium, these problems could signal that the maximum level reported for the samples collected at PRS 57-002 (18.7 mg/kg) was biased low (the blind QC sample had low recoveries for four analytes, including chromium at 56%). The true value of chromium in the soil samples, then, could be above the background UTL of 19.3 mg/kg. But even if the maximum concentration were doubled to adjust for the low recovery, the resulting concentration would still be far enough below the SAL to have little or no effect on the final outcome of the screening assessment. Therefore, these data are usable for a screening assessment on which decisions can be based.

In the case of the sample included in **Request Number 21559**, the results for the blind QC sample met acceptance criteria. The metal TCLP results are acceptable and unqualified.

4.1.4 PRS 57-004(a)

Data from PRS 50-004(a) are usable in support of screening decisions. Two samples were collected at this PRS, which were analyzed as part of the **Request Number 18574** package. As noted in Section 4.1.1, there were some problems with respect to percent recoveries that were not within acceptance criteria for the blind QC sample associated with this package. But because all the values for the soil samples were either below detection limits or below background UTLs, this problem had little or no effect on the screening assessment.

4.1.5 PRS 57-006

Data from PRS 57-006 are usable in support of screening decisions. Two samples were collected at this PRS, which were analyzed as part of the **Request Number 19182** package.

Two blind QC samples were submitted in association with this package; for one of these, the results for the metal analytes were in control, but the second sample was not analyzed because of insufficient sample size. Percent recoveries for the QC sample that was analyzed were acceptable. In contrast, the matrix spike sample had percent recoveries for four analytes that were outside of the acceptance criteria: arsenic at 62%, iron at 560%, manganese at 140%, and lead at 330%. It is difficult to determine whether the bias seen in the matrix spike sample might be true of the reported soil sample results as well. If so, the actual arsenic levels in the soil at PRS 57-006 may be slightly higher than reported, and the actual lead levels may be lower than reported. However, the magnitudes of these potential biases should still not be large enough to affect the final outcome of the screening assessment discussed in Chapter 5. Cyanide, although not identified in the RFI work plan as a COPC, was inadvertently analyzed for in samples AAB8397 and AAB8398; but because the holding times for cyanide were exceeded, the results were qualified as unusable (R). In any case, given the nature of the operations at PRS 57-006, cyanide was not an analyte expected to be found. The lack of usable cyanide data, therefore, did not affect the screening assessment (see Chapter 5).

4.1.6 PRS 57-007

Request Number 20573: All of the samples from the one sampling location represented by this request number group met acceptance criteria; the data are deemed acceptable and unqualified.

4.2 Organic Analyses

Most of the samples of "service material" submitted for SVOC analysis contained so much organic matter (such as lignite coal, "tall oil," walnut and cottonseed hulls, and organic-based surfactants) that dilutions were required to prevent damage to the analytical instruments and to attempt quantitation of the target compounds. The dilutions caused the target SVOC compounds to be masked, spike recovery to be low, and detection limits to be very large, which made quantitation of the target compounds impossible. In addition, dilutions were used to attempt to quantify tentatively identified compounds (TICs), with similar effects. The one sample of "service material" sediments that allowed routine SVOC analysis, sample number AAB5559, from location 57-2100, was found to have no detectable target SVOC compounds. Even though the SALs for five of the target SVOC compounds in this sample were below the detection limit of 330 mg/kg, one of the five, benzo(a)pyrene, is a known constituent of coal. The other four target SVOC compounds, which have detection limits greater than their SALs, are not known to have been used at Fenton Hill.

Semivolatile organic constituents were used at Fenton Hill only as authorized for the geothermal resource recovery experiments. Therefore, they are not RCRA-regulated constitutents, and the inability to quantify them from soil samples collected at the site is not a reason to consider them COPCs.

4.2.1 PRS 57-001(b)

Data from PRS 57-001(b) are usable in support of screening decisions. Six samples were collected at this PRS and were submitted to the SMO, as part of the **Request Number 18570** group, for SVOC analysis.

To attempt to quantify SVOCs in these samples, dilution was required because of the high concentrations of organic matter present. But as a result, no SVOCs were detected in any of the samples, and the surrogates added to samples AAB5558, AAB5560, and AAB5565 were undetectable as well. For this reason, the samples were not qualified.

For QC sample 94.19398, the laboratory reported a concentration of <50% of the spiked value for the following compounds: Anthracene; Benzo(a)pyrene; 1,2-Dichlorobenzene; 1,4-Dichlorobenzene; 4-Methylphenol; Pyrene; Naphthalene; and 1,2,4-Trichlorobenzene. Because the concentrations of these compounds in the soil samples were all below reporting limits, they were qualified as UJ. For 2-Methylphenol and 4-Nitrophenol, the detected concentrations were <10% in the QC sample and below detection limits in the soil sample; even so, the results were qualified as R. Nevertheless, because these two compounds are not known to have been used at this PRS, they are unlikely to be present in the soils at concentrations that could affect the outcome of the screening assessment.

4.2.2 PRS 57-001(c)

Data from PRS 57-001(c) are usable in support of screening decisions. One soil sample was collected at this PRS and was submitted under **Request Number 18570.** As discussed in Section 4.2.1, there were some problems with the blind QC sample analyzed with the soil samples in this group (percent recoveries <50%). But because all the values for the soil samples were below

detection limits, the QC blind sample recovery problem should have little effect on the screening assessment discussed in Chapter 5.

4.2.3 PRS 57-002

Data from PRS 57-002 are usable in support of screening decisions. Two samples were collected at this PRS and were analyzed for SVOCs under **Request Number 18570**. Because of the high concentrations of organic matter in these samples, as discussed in Section 4.2.1, there were some problems with respect to percent recoveries that were not within acceptance criteria for the blind QC sample associated with this group. But because all the values for the soil samples were below detection limits, this problem should have little effect on the screening assessment discussed in Chapter 5.

4.2.4 PRS 57-004(a)

Data from PRS 57-004(a) are usable in support of screening decisions. Two samples were collected at this PRS and were submitted for analysis under **Request Number 18570**. Because of the high concentrations of organic matter in these samples, as discussed in Section 4.2.1, there were some problems with respect to percent recoveries that were not within acceptance criteria for the blind QC sample associated with this group. But because all the values for the soil samples were below detection limits, this problem should have little effect on the screening assessment.

4.2.5 PRS 57-006

Data from PRS 57-006 are usable in support of screening decisions. Two samples were collected at this PRS and were analyzed as part of the **Request Number 19224** group. No blind QC sample was analyzed with this group, but specified surrogate recoveries, holding times, and method blank values were all met. Acetone was found in field replicate AAB8398 at 70 mg/kg but in the original sample (AAB8397) at <20 mg/kg. Both of these values were far enough below the SAL for acetone to have no effect on the final outcome of the screening assessment discussed in Chapter 5.

4.2.6 PRS 57-007

Data from PRS 57-007 are usable in support of screening decisions. One sample was collected at this PRS and was analyzed for VOCs under **Request Number 20571**. Specified surrogate recoveries, holding times, and method blank requirements were met.

4.3 Total Uranium Analyses

4.3.1 PRS 57-001(b)

Data from PRS 57-001(b) are fully usable for support of screening decisions. Six soil samples were collected at this PRS and were submitted for total uranium analysis as part of the **Request Number 18574** group. No QC problems were noted for these samples.

4.3.2 PRS 57-001(c)

Data from PRS 57-001(c) are fully usable for support of screening decisions. One soil sample was collected at this PRS and was submitted for total uranium analysis as part of the **Request Number 18574** group. No QC problems were noted for this sample.

4.3.3 PRS 57-002

Data from PRS 57-002 are fully usable for support of screening decisions. Two soil samples were collected at this PRS and were submitted for total uranium analysis as part of the **Request Number 18574** group. No QC problems were noted for these samples.

4.3.4 PRS 57-004(a)

Data from PRS 57-004(a) are fully usable for support of screening decisions. Two soil samples were collected at this PRS and were submitted for total uranium analysis as part of the **Request Number 18574** group. No QC problems were noted for these samples.

4.3.5 PRS 57-006

Data from PRS 57-006 are usable in support of screening decisions. Two samples were collected at this PRS and were submitted for total uranium analysis as part of the **Request Number 19182** group. Because the percent recovery value for total uranium in the blind QC sample was above the acceptance criterion, the total uranium results for samples AAB8397 and AAB8398 were qualified as estimated (J). This should not affect the final outcome of the screening assessment, discussed in Chapter 5.

4.3.6 PRS 57-007

Data from PRS 57-007 are usable in support of screening decisions. One sample was collected at this PRS and was analyzed for total uranium as part of the **Request Number 19182** group. Because this group consisted of a single soil sample, a blind QC sample was not analyzed with it.

5.0 SPECIFIC RESULTS, CONCLUSIONS, AND RECOMMENDATIONS

Information on the sampling done at Fenton Hill is summarized in Table 5-1 (including the depths from which samples were taken and the constituents analyzed for). The sampling locations for the main compound at Fenton Hill are shown in Figure 1-1.

TABLE 5-1

SUMMARY OF SAMPLING AT TA-57

FIMAD Site ID	Depth (ft)	PRS	Date Sampled	Metals	TCLP Metals	SVOCs	VOCs	Total U
57-2200	11-12	57-001(b)	15 Aug 94	X		X		X
57-2300	4-5	57-001(b)	16 Aug 94	X		X		X
57-2300	0-1	57-001(b)	16Aug 94	X		X		X
57-2350	3-4	57-001(b)	16 Aug 94	X		X		X
57-2350	0-1	57-001(b)	16 Aug 94	X		X		X
57-2300R	0-1	57-001(b)	16 Aug 94	X		X		X
57-2100	4.5-5	57-001(c)	15 Aug 94	X		X		X
57-3000	4.5-5	57-002	16 Aug 94	X		X		X
57-3100	9-10	57-002	16 Aug 94	X		X		X
57-2000	5.25-6	57-004(a)	15 Aug 94	X		X		X
57-2000	6-7	57-004(a)	15 Aug 94	X		X		X
57-4000	0-1*	57-007	1 Dec 94	X			X	X
57-4010	0-0.5**	57-006	15 Sep 94	X			X	X
57-4010R	0-0.5**	57-006	15 Sep 94	X			X	X
57-3000	4-5	57-002	14 Mar 95		X			

x = Analytical report received from CST-9.

* Sample collected from 0- to 6-in. depth directly below drum excavation.

** Sediment sample from leach field, collected at 0- to 1-ft depth at end of drain pipe in excavation trench.

5.1 PRS 57-001(b): Settling Ponds and Outfall

This PRS comprises two settling ponds, GTP-3E (east) and GTP-3W (west), as well as an outfall area (Burns Swale). Pond GTP-3E was originally used as the mud pit for the drilling of well GT-2. Pond GTP-3W, which was much larger (estimated to have been about 20 ft deep), was used in conjunction with not only well GT-2 but with the other deep drill holes at the site and was therefore considered to have the higher potential for contamination. For this reason, Pond GTP-3W was selected for sampling. Burns Swale, which received the discharges from Pond GTP-3W and the other settling ponds, was also sampled. On the basis of the analytical results, we recommend NFA for Pond GTP-3W and Phase II investigations for Burns Swale.

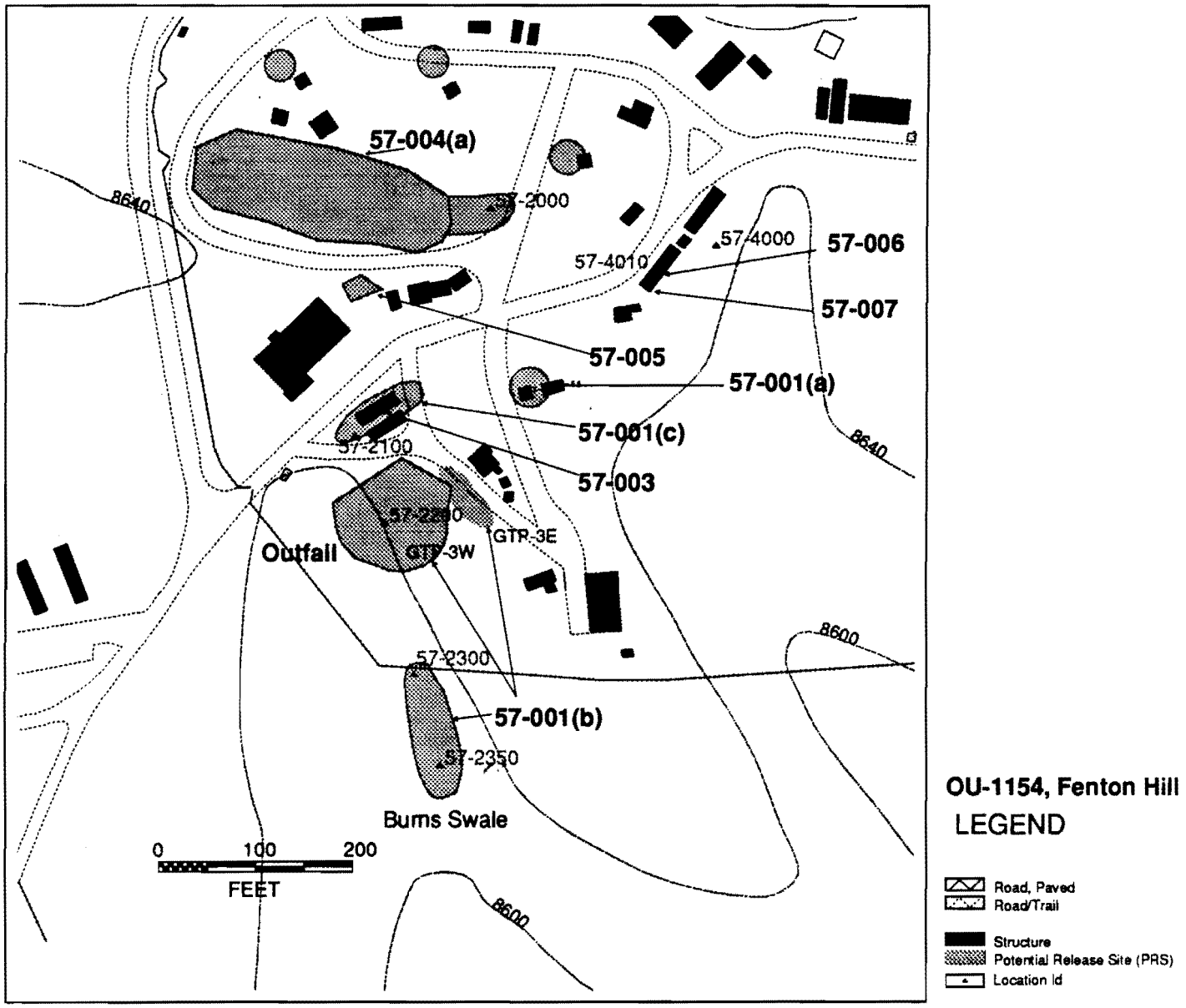


Figure 5-1: Sampling locations at Fenton Hill main compound

Source: FIMAD, 11/21/95, G103966
Modified by: C. Rivera Lyons 1/25/96

5.1.1 History

PRS 57-001(b) is discussed in detail in Section 5.2 of the RFI Work Plan for OU 1154 (LANL 1994, 1159).

Pond GTP-3W was created by constructing an approximately 10-ft-high berm across the head of Burns Swale, a natural drainage channel at the southern edge of the site, and excavating into the tuff. A spillway directed overflow water around the west end of the berm and into the swale. This pond was used as a settling pond for particulates from the water used in the drilling and circulating operations. After the particulates had settled out, the water was either recirculated or discharged into the swale. Materials entering this PRS were drilling muds (which included barite and lubricating materials) and chemical constituents dissolved by the water as it circulated through the hot rocks deep underground. In addition, dissolved solids in the water were precipitated in the settling ponds as the water cooled; these may have added contaminants such as metals to the pond-bottom sludge.

5.1.2 Description

PRS 57-001(b) is described in Section 5.2 of the RFI Work Plan for OU 1154 (LANL 1994, 1159) and in Section 1.2.1.1 of this report.

5.1.3 Previous Investigations

Investigations were conducted for this PRS and for the other settling ponds throughout the geothermal energy recovery project, because water quality, extent of infiltration from ponds, surface releases, and contaminant accumulation in plants were all of concern for experimental as well as environmental reasons. The conclusions of these investigations are summarized below. (See Section 5.2 of the RFI Work Plan for OU 1154—LANL 1994, 1159—for further details.)

5.1.3.1 Water Quality

The chemical characteristics and quality of the pond water varied greatly, depending on the type of operation being carried out; for example, in addition to additives from drilling operations being discharged to the ponds, water used in the geothermal energy recovery experiments and drilling operations was returned to the ponds for reuse, and fresh water was added periodically to replace discharged or evaporated water. Over time, through these processes, the concentrations of chemicals in the ponds increased—especially total dissolved solids and residual concentrations of elements such as arsenic, lithium, boron, and uranium. The quality of the water in ponds GTP-1E (PRS 57-004[a]) and GTP-3W (PRS 57-001[b]) was described in the RFI Work Plan as "slightly above discharge standards," as "deteriorating, due to sulfates and TDS," as "highly mineralized," and as having "elevated lithium and boron." The average chemical composition of the pond waters for 1977 and 1978 are shown in Table 5-3 of the RFI Work Plan for OU 1154 (LANL 1994, 1159).

5.1.3.2 Infiltration From Ponds

Findings from the drilling of several test holes showed that water from the settling ponds was infiltrating the underlying tuff, at a rate of about 4 million liters per year. According to water balance calculations, approximately 31% of the water brought onto the site was lost by this route. (At the same time, as discussed later in this report, sampling of the tuff beneath the ponds did not show any contamination.)

5.1.3.3 Surface Releases

Water from the settling ponds was periodically released from Pond GTP-3W into Burns Swale. To ensure compliance with EPA standards for irrigation, the water in the pond was sampled before each planned surface release; if it did not meet the standards, the water was not released until the relevant constituent concentrations had been reduced. The quality of the water ultimately released to Burns Swale, then, met EPA's proposed standards for continuous irrigation and livestock consumption.

5.1.3.4 Accumulation in Plants

Between the mid 1970s and mid 1980s, samples of vegetation were collected from the bottom and banks of Burns Swale. Although the plants showed no visible signs of stress, chemical analysis revealed concentrations of boron and lithium in the foliage, at levels reported in the literature to cause plant damage. The foliage was also analyzed for arsenic, cadmium, and fluoride, but none of these was found at levels considered toxic to the plants. Because all of these elements were known to be present in the pond water, their presence in the plants was attributed to the discharges from the ponds.

5.1.4 Field Investigation

The sampling done at PRS 57-001(b) is summarized in Table 5-2.

TABLE 5-2

PRS 57-001(b): SUMMARY OF SAMPLING

Location ID	Sample ID	Depth (ft)	Sample Matrix	Sample Request Number		
				SVOCs	INORG	TOTAL U
57-2200	AAB5560	11 - 12	soil	18570	18574	18574
57-2300	AAB5561	4 - 5	soil	18570	18574	18574
57-2300	AAB5562	0 - 1	soil	18570	18574	18574
57-2300R	AAB8396	0 - 1	soil	18570	18574	18574
57-2350	AAB5563	3 - 4	soil	18570	18574	18574
57-2350	AAB5564	0 - 1	soil	18570	18574	18574

5.1.4.1 Pond GTP-3W

Pond GTP-3W, the larger and most used of the two ponds in this PRS, was the focus of the Phase I investigation; it was assumed that the contents of this pond, as revealed by sampling, would be representative of the contents of Pond GTP-3E as well. The sampling location for this pond was designated 57-2200.

At the time of its decommissioning, Pond GTP-3W was mucked out and backfilled—reportedly not only with clean soil but with large boulders taken from a local road construction project. Because the boulders were probably of the same rock type as the Bandelier Tuff underlying the pond, the sampling approach proposed in the RFI Work Plan was to drill an additional 10 ft whenever tuff

was encountered, to ensure that bedrock had been reached, not a boulder. This procedure was found to be unnecessary, however. At 11 ft, a layer of the black "service material" (sludge-like mixture of drilling mud and additives, not entirely removed by the mucking out) was encountered. The black coloration of this material may be due to the thousands of pounds of lignite (a low-grade coal) that was a component of the drilling materials. Visual observations of the "service material" and x-ray fluorescence (XRF) screening, for barium, of sediments from this layer indicated that the 11- to 12-ft depth would contain the highest concentrations of chemicals. Below this layer, at 16.25 ft, tuff bedrock was encountered. Drilling continued to a final depth of 17.25 ft.

Beginning at a depth of 3 ft, the core was sampled at 1-ft intervals; these samples were field-screened for metals by XRF and for VOCs with either an organic vapor analyzer (OVA) or a photoionization detector (PID). Per the RFI Work Plan, these field screenings, as well as visual observations, would be used to determine the horizons having the highest constituent concentrations—an approach adopted because the original depths of the ponds where the most contaminated sediments should be found were not precisely known. The samples to be submitted for laboratory analysis, one for metals and one for SVOCs, were to come from those horizons. If no horizon of high constituent concentration was indicated by the field screening for either metals or organic compounds, the sample was to be taken from the bottom of the hole. Because the Hnu meter did not measure any VOCs at any core horizon, both the metal and the SVOC samples were collected from the 11- to 12-ft depth (the "service" material) on the basis of visual observations and the relatively elevated XRF barium readings at that depth (see Table 5-3).

TABLE 5-3

SAMPLING LOCATION 57-2200: BARIUM CONCENTRATIONS IN SOILS, DETECTED BY FIELD XRF

Depth (ft)	Barium Concentration (mg/kg)
2 - 3	2285
3 - 4	1221
4 - 5	818
6 - 7	166
7 - 8	358
8 - 9	1543
9 - 10	1612
11 - 12	5318
12 - 13	5058
13 - 14	1009
14 - 15	258
15 - 16	1172
16 - 17	440
17 - 18	175

5.1.4.2 Burns Swale

Shallow surface (0-1 ft) and subsurface sediment samples were taken at two locations in Burns Swale: (1) 57-2300, just south of the perimeter fence, at the inlet of the swale; and (2) 57-2350, approximately 100 ft downstream of 57-2300. Although the RFI Work Plan had called for sampling 100 ft and 150 ft south of the site's boundary fence, the rugged terrain and extremely muddy conditions caused by recent heavy rains made the latter location inaccessible by the drill rig. It was therefore decided to collect one sample just south of the fence and the second one at

the location 100 ft south of the fence. Both of the selected sampling locations were judged to be in sediment traps within the swale.

The Work Plan also called for collection of subsurface samples from the sediments overlying the bedrock surface, unless XRF screening revealed elevated metal (barium) concentrations in intervening horizons. Bedrock was estimated to lie at a depth of 3 - 8 ft at both locations.

Sampling location 57-2300: Evidence of historical surface water discharges were noted at this location. One surface sample and a replicate were collected from the 0- to 1-ft depth and were submitted for total metals, total uranium, and SVOCs. Tuff was encountered at 7 ft, and boring continued to a final depth of 9.75 feet. The subsurface sample was collected at the 4- to 5-ft depth rather than at the tuff interface, on the basis of the slightly elevated barium concentration found at this depth as measured by XRF (Table 5-4). This sample was analyzed for total metals, total uranium, and SVOCs. No "service material" was noted on the ground surface or in the collected core.

TABLE 5-4

SAMPLING LOCATION 57-2300: BARIUM CONCENTRATIONS IN SOILS, DETECTED BY FIELD XRF

Depth (ft)	Barium Concentration (mg/kg)
0 - 1	233
1 - 2	258
3 - 4	293
4 - 5	494
5 - 6	237
6 - 7	159
7 - 8	127

Sampling location 57-2350: This site, situated at the bottom of the eroded stream channel, also shows evidence of historical surface water movement. One surface sediment sample was collected from the 0- to 1-ft depth and submitted for total metals, total uranium, and SVOC analyses. Tuff was encountered at 3.5 feet, and boring continued to a final depth of 4.5 ft. Because XRF screening of samples from shallower depths did not show elevated barium concentrations (Table 5-5), the subsurface sample was collected at the tuff interface; it was analyzed for metals, total uranium, and SVOCs.

TABLE 5-5

SAMPLING LOCATION 57-2350: BARIUM CONCENTRATIONS IN SOILS, DETECTED BY FIELD XRF

Depth (ft)	Barium Concentration (mg/kg)
3 - 4	129
4 - 5	104

5.1.5 Background Comparisons

All inorganic analytes, except silver, detected in soil samples from PRS 57-001(b) were compared with their natural background Upper Tolerance Limits (UTLs) (no UTL is available for silver). Those whose concentrations exceeded background UTLs are shown in Table 5-6. As shown in Table A-1 (Appendix A), which lists the complete analytical results for those soil samples, all of these analytes except arsenic, barium, calcium, cadmium, copper, lead, magnesium, manganese, sodium, total uranium, and zinc were eliminated as COPCs because they were detected at concentrations below their respective background UTLs. In the case of silver, for which no UTL has been established, detected concentrations were below the SAL for silver in soil (400 mg/kg). Silver was therefore eliminated as a COPC. The detection limits for antimony, which ranged from <4.9 to 5.3 mg/kg for these samples, were greater than the UTL for antimony in soil (1 mg/kg); but because all reported antimony concentrations were less than the SAL (32 mg/kg), this analyte was also eliminated as a COPC.

The locations from which samples were collected that contained analytes in concentrations exceeding background UTLs are shown in Figure 5-2.

TABLE 5-6

PRS 57-001(b): INORGANIC ANALYTES FOUND IN SOILS AT CONCENTRATIONS GREATER THAN BACKGROUND UTLs

Chemical	Location ID	Sample No.	Depth (ft)	Concentration (mg/kg)	UTL (mg/kg)
Arsenic	57-2200	AAB5560	11-12	103(J)	7.82
	57-2300	AAB5562	0-0.5	30(J)	
	57-2300R	AAB8396	0-0.5	22(J)	
Barium	57-2200	AAB5560	11-12	11200	315
	57-2300	AAB5562	0-0.5	525	
	57-2300R	AAB8396	0-0.5	523	
Calcium	57-2200	AAB5560	11-12	22900	6120
Cadmium	57-2300	AAB5561	4.4-5	4.3	2.7
	57-2350	AAB5564	0-0.5	3.1	
Chromium	57-2200	AAB5560	11-12	23.8(J)	19.3
Copper	57-2200	AAB5560	11-12	216	30.7
Magnesium	57-2200	AAB5560	11-12	25100	4610
Manganese	57-2350	AAB5564	0-0.5	862	714
Sodium	57-2200	AAB5560	11-12	2800	915
Lead	57-2200	AAB5560	11-12	167	23.3
Total Uranium	57-2300	AAB5561	4-5	1.899	1.87
Zinc	57-2200	AAB5560	11-12	221	50.8

The twelve metals shown in Table 5-6 are retained as COPCs and will be evaluated further in the screening assessment.

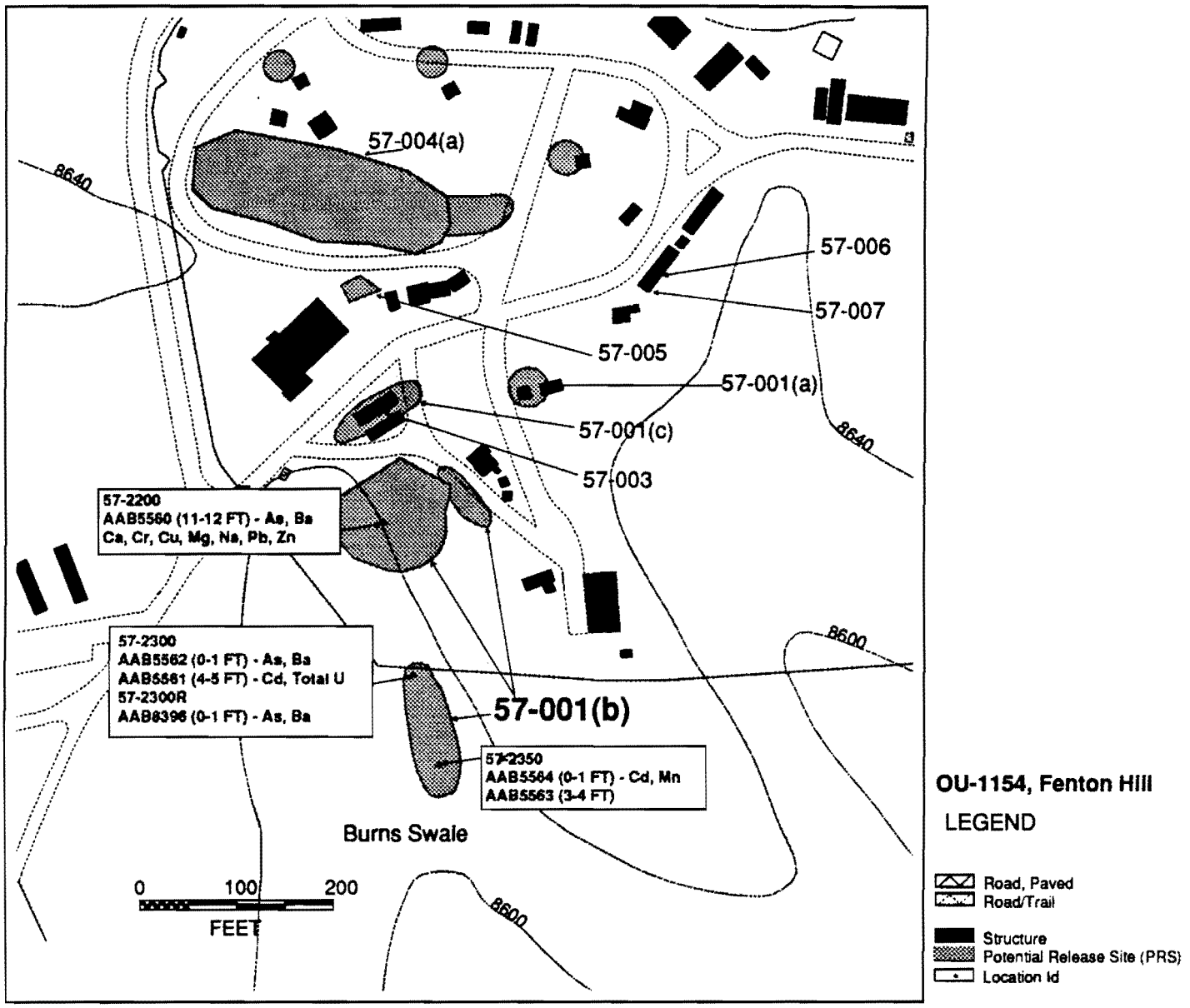


Figure 5-2. PRS 57-001(b): Locations from which samples were collected that contained analytes in concentrations exceeding background UTLs

Source: FIMAD, 11/21/95, G103966
Modified by: C. Rivera Lyons 1/28/96

5.1.6 Evaluation of Organic Constituents

No organic chemicals were detected in soil samples from PRS 57-001(b). See Chapter 4, Section 4.2.1.

5.1.7 Human Health Assessment

5.1.7.1 Screening Assessment for PRS 57-001(b)

The twelve inorganic analytes retained as COPCs after comparison with their background UTLs were next compared with their SALs.

5.1.7.1.1 Pond GTP-3W

The concentrations of the COPCs found in Pond GTP-3W, as compared with their SALs, are shown in Table 5-7.

TABLE 5-7

POND GTP-3W:
CONCENTRATIONS OF COPCs vs SALs

Chemical	Location ID	Sample No.	Depth (ft)	Type	Concentration (mg/kg)	SAL (mg/kg)
Arsenic	57-2200	AAB5560	11-12	core	103(J)	N/A
Barium	57-2200	AAB5560	11-12	core	11200	5300
Calcium	57-2200	AAB5560	11-12	core	22900	No SAL
Chromium	57-2200	AAB5560	11-12	core	23.8(J)	210
Copper	57-2200	AAB5560	11-12	core	216	2800
Lead	57-2200	AAB5560	11-12	core	167	400
Magnesium	57-2200	AAB5564	11-12	core	25100	No SAL
Manganese	57-2200	AAB5560	11-12	core	389	No SAL
Sodium	57-2200	AAB5560	11-12	core	2800	No SAL
Zinc	57-2200	AAB5560	11-12	core	221	23000

Greater than or equal to SAL. Only barium was detected at concentrations above its SAL.

No SAL. Arsenic, calcium, magnesium, manganese, and sodium fall into the No SAL category. For calcium, magnesium, and sodium, no SALs have been established because they are essential nutrients. As shown in Appendix C, their concentrations at PRS 57-001(b) are well below the recommended daily allowances (RDAs—National Research Council 1989, 1251). On that basis, calcium, magnesium, and sodium are eliminated as COPCs. For arsenic and manganese, the calculated SALs are below the background UTLs of the Los Alamos background dataset; the background UTL, then, in essence becomes the SAL. For manganese, the concentration detected in the sample from the pond was below the background UTL, and on that basis manganese is eliminated as a COPC. Arsenic is retained as a COPC because its concentration is elevated with respect to its background UTL.

Below SAL. Chromium, copper, lead, and zinc were all detected in concentrations below their respective SALs.

Multiple Chemical Evaluation. To evaluate multiple chemical effects for this data set, chemicals detected at concentrations below their respective SALs were grouped according to their toxicological effects (carcinogenic or noncarcinogenic). Because there was only one carcinogen (chromium), multiple chemical effects were evaluated only for the three noncarcinogens. The concentration of each was normalized to its SAL, and the results were summed, as described in Subsection 3.4.1. Table 5-8 shows the results of the multiple chemical evaluation for the three noncarcinogens.

TABLE 5-8

POND GTP-3W: MULTIPLE CHEMICAL EVALUATION

Chemical	Concentration (mg/kg)	SAL (mg/kg)	Normalized Value
Copper	216	2 800	0.08
Lead	167	400	0.42
Zinc	221	23 000	0.01
Sum of Normalized Values			**0.51**

The results of the multiple chemical evaluation based on noncarcinogenic effects is less than one (0.51), indicating that potential adverse human health effects from exposure to these chemicals are unlikely. Therefore, all three chemicals are eliminated as COPCs.

The COPCs remaining for Pond GTP-3W are arsenic and barium.

5.1.7.1.2 Burns Swale

Because Burns Swale did not receive any fill material (the site was not decommissioned), samples were collected from surface soils and from either the tuff interface or from the subsurface depth judged to have the highest concentration of potential contaminants. The maximum detected concentrations of the COPCs found in Burns Swale, as compared with their SALs, are shown in Table 5-9.

TABLE 5-9

BURNS SWALE:
CONCENTRATIONS OF COPCs vs SALs

Chemical	Location ID	Sample No.	Depth (ft)	Type	Concentration (mg/kg)	SAL (mg/kg)
Arsenic	57-2300	AAB5562	0-1.0	surface	30(J)	N/A
	57-2300R	AAB8396	0-1.0	surface	22(J)	
Barium	57-2300	AAB5562	0-1.0	surface	525	5 300
	57-2300R	AAB8396	0-1.0	surface	523	
Cadmium	57-2300	AAB5561	4-5	core	4.3	38
	57-2350	AAB5564	0-0.5	surface	3.1	
Manganese	57-2350	AAB5564	0-1.0	surface	862	N/A
Uranium	57-2300	AAB5561	11-12	core	1.899	230 *

N/A = Not applicable. SAL is below background concentrations.

*230 mg/kg is the SAL for uranium soluble salts.

Greater than or equal to SAL. No chemicals fall into the greater than or equal to SAL category.

No SAL. Arsenic and manganese fall into the No SAL category because the calculated SALs are below the background UTLs of the Los Alamos background dataset. The background UTL, then, in essence becomes the SAL. Arsenic and manganese are retained as COPCs because their detected concentrations in Burns Swale are elevated with respect to their background UTLs.

Below SAL. The detected concentrations of barium, cadmium, and uranium were all below the respective SALs for these analytes. Antimony detection limits for these samples were all greater than the UTL but were less than the SAL for antimony in soil (32 mg/kg). For this reason, antimony is categorized as below SAL.

Multiple Chemical Evaluation. To evaluate multiple chemical effects for this data set, chemicals detected below their respective SALs were grouped according to their toxicological effects (carcinogenic or noncarcinogenic). All of the chemicals in this group are noncarcinogens. The concentration of each was normalized to its SAL, and the results were summed as described in Section 3.4.1. Table 5-10 shows the results of the multiple chemical evaluation.

TABLE 5-10

BURNS SWALE: MULTIPLE CHEMICAL EVALUATION

Chemical	Concentration (mg/kg)	SAL (mg/kg)	Normalized Value
Barium	525	5300	0.10
Cadmium	4.3	38	0.11
Uranium	1.899	230*	0.01
Sum of Normalized Values			**0.22**

*230 mg/kg is the SAL for uranium soluble salts.

The results of the multiple chemical evaluation based on noncarcinogenic effects is less than one (0.22), indicating that potential adverse human health effects from exposure to these chemicals are unlikely. Therefore, all three chemicals are eliminated as COPCs.

The COPCs remaining for Burns Swale, then, are arsenic and manganese.

5.1.7.2 Risk Assessment for PRS 57-001(b)

Because the elevated concentrations of arsenic and barium detected in the pond sample were all found at 11-12 ft below the ground surface, there is no plausible route under the recreational use scenario by which humans could be exposed to these contaminants. On that basis, no risk assessment is required for Pond GTP-3W.

The elevated levels of arsenic and manganese (exceeding UTLs) in Burns Swale, on the other hand, could pose an unacceptable risk to humans, and a formal risk assessment may be necessary. We therefore propose an accelerated, focused RFI (Phase II) sampling program for Burns Swale to assess the extent of contamination and thereby better estimate risk to humans.

5.1.8 Ecological Assessment

Given the largely undeveloped environs of this PRS, the potential for receptors to come in contact with contaminants is high. Threatened and endangered species and/or sensitive habitat (see Chapter 2, above) will be considered in the Phase II investigation, following the guidance of Keller (1995, 24-0074). This PRS will be assessed through the new Ecological Exposure Unit (Ecozone) approach, which considers contaminants with concentrations greater than UTLs, when that approach has been approved through the ER Project office.

5.1.9 Extent of Suspected Contamination

The purpose of the Phase I investigations was reconnaissance; the extent of suspected contamination in this PRS can be determined only if additional data are collected.

The suspected contamination of Burns Swale, which is a result of discharges from Pond GTP-3W, consists only of arsenic (location 57-2300) and manganese (location 57-2350) and apparently is limited to the surface. For arsenic, the concentration at sampling location 57-2300 (nearest the discharge point) was above the UTL in the surface sample but not in the subsurface sample. (Arsenic was below UTLs in both the surface and subsurface samples from location 57-2350, 100 ft farther downstream.) For manganese, the concentration in the surface sample at location 57-2350 slightly exceeded the UTL and in the subsurface sample was below the UTL. The extent of suspected surface soil contamination in Burns Swale, thus, can be estimated by determining arsenic and manganese concentrations in the surface soils, in the area from the discharge point to 300 ft downstream.

5.1.10 Conclusions and Recommendations

In the case of Pond GTP-3W, the potential for human contact with contaminants, which are buried 11-12 ft below the ground surface, is negligible. For this reason, we recommend NFA for the pond portion of PRS 57-001(b) on the basis of NFA criterion 4. This portion of the PRS will not be added to the HSWA Module of the Laboratory RCRA operating permit and is proposed for removal from the ER Project list. For the Burns Swale portion, we recommend Phase II sampling, to determine the extent of the arsenic and manganese contamination in surface soils

and to calculate human health risk under the recreational land-use scenario. The sampling and analysis plan for these Phase II investigations is presented below.

5.1.11 Sampling and Analysis Plan for Burns Swale Portion of PRS 57-001(b)

5.1.11.1 Problem Definition

Two inorganic analytes, arsenic and manganese, were detected in Burns Swale at concentrations exceeding the background UTL. The results of a preliminary risk screening did not support an NFA decision. The indication of elevated arsenic and manganese, however, came from only three surface soil samples (including one replicate), and these came from the middle of the drainage—the area expected to have the highest concentrations. This Phase II sampling plan is designed to determine the distributions of arsenic and manganese in Burns Swale surface soils. A human health risk assessment will be performed on the basis of the sampling results. The human health risk assessment will define whether Burns Swale can be recommended for NFA or will require corrective measures.

5.1.11.2 Site Description

Burns Swale, a small drainage off the Fenton Hill site, courses through a wooded area (see Figure 1-2 in Chapter 1 and Sections 5.1 and 5.1.1 in this chapter). The source of the arsenic and manganese found in the surface soils of the swale was the permitted liquid discharges from Pond GTP-3W —a source that no longer exists because the pond has been decommissioned.

As stated in the RFI Work Plan, the depth to the nearest groundwater (perched on the Abo Formation) at this location is approximately 450 ft. PRS 57-001(b) is not believed to pose a threat to this or any other groundwater: neither the tuff underlying the sludge layer in the pond system nor the tuff underlying the soil in Burns Swale has metal concentrations that exceed UTLs, indicating that vertical movement of contaminants into the tuff and towards groundwater is minimal.

5.1.11.2 Historical Data

Elevated arsenic and manganese levels were found in surface soil samples during Phase I sampling in Burns Swale, at locations 57-2300 and 57-2350, respectively (see Table 5-9 and Figure 5-2). This contamination probably resulted from the discharge of fluids from Pond GTP-3W.

5.1.11.3 Regulatory Drivers

Because the Fenton Hill site PRSs are not part of the HSWA permit, there are no EPA regulatory drivers for this investigation. The fact that RCRA hazardous constituents were found above UTLs on non-Laboratory property, however, means that the extent of the elevated arsenic and manganese concentrations on surface soils needs to be defined.

5.1.12 Design of Sampling and Analysis Plan

5.1.12.1 Overview of Information to be Collected

Surface soil samples will be collected in Burns Swale and analyzed for metals. The data thus obtained will be the basis for a human health risk assessment under a recreational land-use scenario for hikers and campers. The primary COPCs are arsenic and manganese; secondary COPCs are barium and lead, both of which were detected at concentrations greater than 10% of

their respective SALs (even though lead was detected in the pond and not in Burns Swale, it was deemed prudent to calculate the risk associated with the potential presence of this noncarcinogen. The pond is known to have been the source of contaminants in the swale. In this way, we can verify the absence of risk under the hiker/camper scenario). The distributions of these four analytes will be determined, and the upper 95 percent confidence limits of their mean concentrations will be estimated.

5.1.12.3 Assumptions Underlying the Design

Arsenic concentration is highly correlated with barium concentration in soil samples previously collected at the Fenton Hill site (r^2 = 0.83). For this reason, surface soil samples (0- to 6-in. depth), to be collected at the approximate locations shown in Figure 5-3, will be analyzed for barium concentrations using the XRF method (LANL 1995, 0951). Those concentrations will be used as a surrogate for arsenic, both in selecting the samples to be submitted for laboratory analysis and in determining the distribution of arsenic concentrations in soil. The precise locations from which the selected samples were taken will be entered into the FIMAD database.

5.1.12.4 Requirements for Data Quality Implied by Intended Data Use

The analytical techniques used must be capable of measuring arsenic concentrations in soil to below the SAL of 7.82 mg/kg (down to 1.0 mg/kg). The XRF instrument should be capable of detecting barium concentrations in soil as low as 25 mg/kg.

5.1.12.5 Measurements to Verify Assumptions and Requirements

The results of laboratory analyses for barium and arsenic will be used to estimate and qualitatively evaluate the correlation between the two. (A poor correlation will not be considered cause for concern if arsenic levels are close to the Lab-wide arsenic UTL.) It is assumed that areas where lead and manganese might be elevated are also closely correlated with elevated barium. The lead/barium and manganese/barium correlations will also be estimated and evaluated qualitatively. Because lead and barium are secondary COPCs and expected to contribute little to the total estimated risk, a poor correlation will not be considered cause for concern.

One field replicate sample will be collected from each of the three (or fewer) strata (see 5.1.13.1) in Burns Swale for laboratory analysis. To evaluate the level of precision of the results, we wil (1) calculate the relative percent difference between each replicate and its "original" (the difference divided by the average); (2) calculate an average for each field replicate pair in the FIMAD data base that was analyzed for arsenic by the same analytical technique as that used for the Burns Swale samples; (3) if a field replicate pair's average is within the range of the arsenic concentrations found in the Burns Swale samples, calculate a relative percent difference for that FIMAD pair; and (4) compare the FIMAD relative percent differences with those of the Burns Swale samples, using graphical techniques such as boxplots. If the distributions appear similar, we will consider the Burns Swale results as having an acceptable level of precision. If they do not, focused validation of the analytical data may be required to determine whether the Burns Swale results are acceptable. The same procedure will be used to evaluate the level of precision of the analytical results for barium, lead, and manganese.

The distribution of above-background concentrations of arsenic is expected to be limited to the first 300 ft of Burns Swale. To determine the boundaries of this distribution, a site-specific background data set will be established. Twenty background samples will be collected from undisturbed areas near Burns Swale where soils are similar to those found in the swale and will

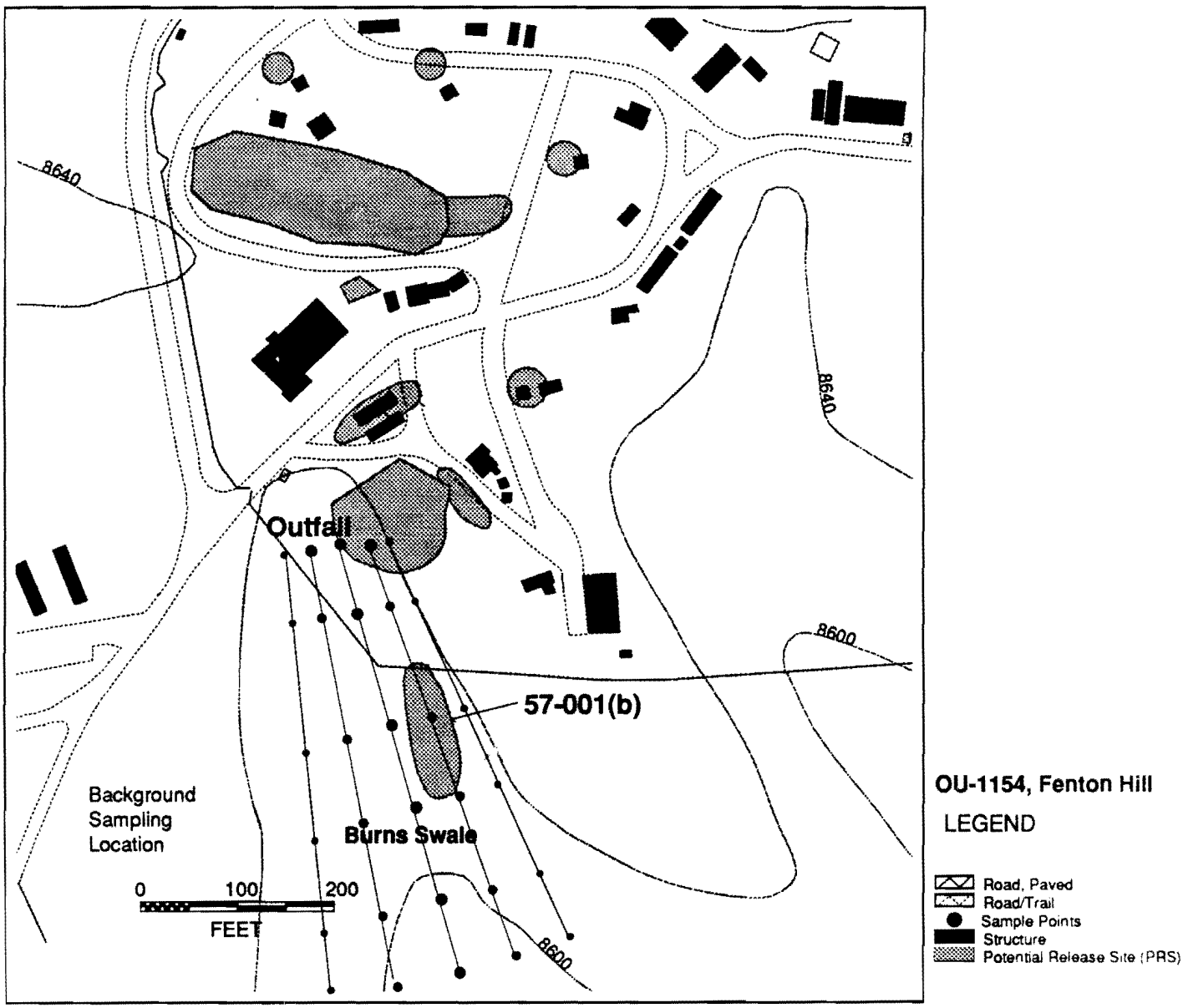


Figure 5-3. Sampling map for Phase II Sampling Plan at PRS 57-001(b) Burns Swale Portion

Source: FIMAD, 11/21/95, G103966
Modified by: C. Rivera Lyons 3/5/96

be screened for barium by XRF. The UTL (the 95 percent upper confidence limit on the 95th percentile of the background samples) for barium will be estimated. The boundaries will then be drawn to delimit the area within which the above-UTL concentrations were found.

In the event that barium concentrations on the periphery of the sampling area still exceed the UTL (i.e., the area selected for sampling was too small), the sampling area will be extended using a grid system similar to the one described below. Samples will be collected and screened by XRF until the boundaries become clear.

5.1.13 Implementation of Sampling and Analysis Plan

5.1.13.1 Field Methods

For the XRF survey, a transect line will be established from the discharge point down the center of Burns Swale, for a length of about 300 ft. On either side of this center line, two additional transect lines will be established: one along the bank of the swale (3 ft beyond the top of the bank) and one halfway between the bank and the center line, for a total for five lines. (Should the "bank" not be clearly defined, the lines will be located 3 ft and 15 ft from the channel center.) Samples will be collected at six locations along each of these lines: at approximately 30, 60, 105, 150, 225, and 300 ft from the discharge point. Field observations, a tape measure, and pin flags will be used to establish these 30 sampling locations in Burns Swale.

Because a stratified sampling scheme yields a total variance less than or equal to the variance of a simple sampling scheme, the XRF barium results will be used to stratify the sampling area in Burns Swale into not more than three strata (representing areas of relatively "elevated," relatively "low," and "background" soil concentrations of barium/arsenic). In this way, the number of off-site laboratory analyses will be minimized, as will the degree of uncertainty in the estimated mean concentrations of arsenic, barium, lead, and manganese. A subset of the XRF-screened samples —at least two samples from randomly selected locations in each of the three strata—will be submitted to an off-site laboratory; they will be analyzed for arsenic, barium, lead, and manganese by the SW-846 method (Method 3050 nitric acid extraction and appropriate analytical techniques). The number of samples submitted for wet chemistry analysis will be such that the upper 95 percent confidence level of the mean arsenic concentration is not more than 5 times the mean arsenic concentration. (For 15 samples previously collected at Fenton Hill, the range was 0.23 to 108 mg/kg, and the 95 percent confidence level of the mean was twice the mean.)

In addition, twenty locations will be selected, in deposits of a similar nature but far enough from Burns Swale to have been unaffected by the pond contaminants, for background sampling. These locations will be surveyed in accordance with LANL-ER-SOP-3.01.R1. The soil samples will be collected in accordance with LANL-ER-SOP-6.09 and will be screened by XRF for barium.

5.1.13.2 Measurement Methods

In the Building OH-15 laboratory at TA-59, each soil sample will be thoroughly dried under a heat lamp, ground with a ceramic mortar, and poured into the cups of a Spectrace 9000 XRF instrument. The barium concentrations in the samples will be measured in accordance with LANL-ER-SOP-10.08.R0. At the same time, internal standards will be calibrated and performance standards measured. All the measurements, including the internal standards and performance standard measurements, are included on printouts from the XRF instrument.

5.1.13.3 Field Decisions

As discussed in Section 5.1.12.3, the XRF barium measurements will be the basis for selection of soil samples to be analyzed for arsenic.

5.1.13.4 Sample Handling

The soil samples will be packed in a locked cooler for delivery directly to the SMO, which will send the samples to a contract laboratory. All analyses will be done by Method 3050 nitric acid extraction and the appropriate ICP or AA analytical technique.

5.1.13.5 Data Tracking

For in-house data, FIMAD will prepare a structured blank table into which ESH-19 will enter the barium XRF readings in mg/kg concentration units. Analytical data from contract laboratories will come directly to the SMO, which will be responsible for transmitting the data to FIMAD. Hard copies of these data will be supplied to a data validator, who will be responsible for focused Level One validation.

5.1.13.6 Schedule

The sampling activities, including sampling kit preparation, documentation, and surveying, should take no longer than 3 days. Preparing the samples and doing the XRF measurements should take 1.5 days. The samples will then be submitted immediately to the SMO for laboratory analysis for arsenic, barium, lead, and manganese. The off-site laboratory guarantees a 45-day turnaround. The validation of the data may take from 2 to 4 months. Sampling may take place at risk before the sampling plan has been reviewed and approved by EPA/NMED.

5.1.14 Data Assessment

5.1.14.1 Verification and Routine Data Validation

The SMO and the data validator will use their standard procedures to verify and validate the analytical results from the laboratories. The SMO will electronically transfer the data to FIMAD, and the validator will place the appropriate validation qualifiers on the FIMAD data set, which will then be available to the user by either Databrowser or Microsoft Access data accessing systems.

5.1.14.2 Data Quality Assessment

The data quality assessment will be "qualitive" in nature. A chemist will review the results of the routine validation to determine whether a focused validation is warranted for any of the data. To determine precision, field duplicate results will be compared qualitatively with other field duplicate pairs collected throughout the ER Project at LANL. A technical team comprising a chemist, a statistician, a human health risk assessor, and field personnel will assess the usability of the data for determining the extent of arsenic contamination and for risk assessment. If an estimated bias might affect the determination or the outcome of the risk assessment, the bias will be discussed and the need for further sampling will be considered.

5.1.15 Administration

5.1.15.1 Project Task Organization

The organization for the Phase II investigations will comprise the following positions.

Field Project Leader	Overall responsibility for project.
Field Team Manager	Manages all field operations for this task.
Field Team Leader	Leads team in field operations; responsible for waste management.
Site Safety Officer	Ensures that all operations are performed safely.
Samplers	Physically collect samples.
Documentation Specialist	Prepares field sampling kits and performs documentation in field.
Surveyor	Responsible for the surveying to be done in the field.
Surveyor's Helper	Assists surveyor.
XRF Operator	Operates Spectrace 9000.

5.1.15.2 Training

All personnel participating in this task will have met all the ER Project training requirements as defined in LANL-ER-AP-05.2.R1 (LANL 1995, 0951).

5.1.15.3 Records

The field records and hard copies of analytical data will be in the custody of the field team manager, who will be responsible for transmitting the information to the Records Processing Facility.

5.1.15.4 Oversight

No special oversight is being planned for this 1- to 2-day sampling operation. Because soil samples were collected in the same area, by the same field crew, and using the same methods during the Phase I investigation, a readiness review is not planned. The Health and Safety Plan will be modified slightly (new dates and names of personnel will be incorporated).

5.1.15.5 Inspection/Acceptance Policies

Not relevant.

5.1.15.6 Reports to Management

Additional reports to management are not required for this brief sampling operation.

5.2 PRS 57-001(c)—Settling Pond GTP-2

Pond GTP-2, used during experiments related to geothermal energy recovery, contained circulation fluids. After geothermal testing ceased, the pond was decommissioned, cleaned, and filled with clean soil to the level of the original ground surface. As shown in Table A-1 (Appendix A), which lists the complete analytical results for those soil samples, all of these analytes except arsenic, barium, calcium, copper, lead, magnesium, sodium, and zinc were eliminated as COPCs because they were detected at concentrations below their respective background UTLs. On the basis of NFA criterion 4, we are recommending NFA for this PRS.

5.2.1 History

PRS 57-001(c) is discussed in detail in Section 5.2 of the RFI Work for OU 1154 (LANL 1994, 1159).

5.2.2 Description

Pond GTP-2 is described in Section 5.2 of the RFI Work Plan for OU 1154 (LANL 1994, 1159) and in Section 1.2.1.2 of this report.

5.2.3 Previous Investigations

Investigations carried out before the RFI, of this and the other settling ponds at TA-57, are discussed in detail in Section 5.2 of the RFI Work Plan for OU 1154 (LANL 1994, 1159) and are summarized in Section 5.1.3 of this report.

5.2.4 Field Investigation

Subsurface samples were collected from this pond with a CME-45 drill rig, using a hollow-stem auger and stainless-steel core barrel sampler. Beginning at a depth of 3 ft, sediment samples were taken at 1-ft intervals; these were field-screened for metals by XRF and for VOCs by either OVA or PID. Additional sediment samples were collected for screening from horizons for which olfactory, visual, and/or other evidence indicated the presence of high constituent concentrations. One soil sample was taken from the core (from the horizon judged on the basis of field observations and screening to have the highest constituent concentrations) and was submitted for metals and SVOC analyses. The sampling done at PRS 57-001(c) is summarized in Table 5-11.

TABLE 5-11

PRS 57-001(c): SUMMARY OF SAMPLING

Location ID	Sample ID	Depth (ft)	Sample Matrix	Sample Request Number		
				SVOCs	INORG	TOTAL U
57-2100	AAB5559	4.5 - 5	soil	18570	18574	18574

The depth of the pond was estimated to be 12 ft; the drilling planned was to penetrate 10 ft below that depth. At 9.5 ft, the auger encountered a very hard, nonwelded tuff. The maximum drilling depth reached was 15 feet. The core revealed a slimy, black clay-like material, which contained pieces of wood, at 4.5 ft. This material had a strong organic odor, and Fenton Hill site personnel confirmed that it was similar to the "service material" (mainly drilling muds). Because XRF screening of the core detected no horizon having greatly elevated barium concentrations (see Table 5-12), and no detectable amounts of VOCs were found by Hnu, a sample was collected from the "service material" layer, from the 4.5- to 5-ft depth. It was submitted for total metals, total uranium, and SVOC analyses.

TABLE 5-12

SAMPLING LOCATION 57-2100: BARIUM CONCENTRATIONS IN SOILS, DETECTED BY FIELD XRF

Depth (ft)	Barium Concentrations (mg/kg)
2 - 3	307
3 - 4	173
4 - 5	163
8 - 9	46
9 - 10	50
10 - 11	116
11 - 12	79
12 - 13	119
13 - 14	52
14 - 15	30

5.2.5 Background Comparisons

All inorganic analytes, except silver, detected in soil samples from PRS 57-001(c) were compared with their natural background UTLs (no UTL is available for silver). Because none of these analytes were detected at concentrations greater than their respective UTLs, all were eliminated as COPCs (see Appendix A for the complete analytical results for these samples). Silver, for which no UTL has been established, was also eliminated, because the detected concentrations were below the SAL for silver in soil (400 mg/kg). In the case of antimony, the detection limit in this sample was <5.1 mg/kg, which is greater than the UTL for antimony in soil (1 mg/kg); but because this detection limit is substantially lower than the SAL for antimony (32 mg/kg), this analyte is also eliminated as a COPC.

5.2.6 Evaluation of Organic Constituents

No organic chemicals were detected in the samples from PRS 57-001(c).

5.2.7 Human Health Assessment

5.2.7.1 Screening Assessment for PRS 57-001(c)

Because no chemicals were found in concentrations exceeding their background UTLs, there was no need for a screening assessment.

5.2.7.2 Risk Assessment for PRS 57-001(c)

Because no chemicals were found in concentrations exceeding their background UTLs, there was no need for a risk assessment.

5.2.8 Ecological Assessment

There are no ecotoxicological concerns at this PRS because there are no COPCs.

5.2.9 Extent of Contamination

No contamination was detected at this PRS.

5.2.10 Conclusions and Recommendations

We recommend NFA for PRS 57-001 (c) on the basis of NFA criterion 4. This PRS will not be added to the HSWA Module of the Laboratory RCRA operating permit and is proposed for removal from the ER Project list of PRSs.

5.3 PRS 57-002—Sludge Pit

This PRS is a pit that was used between 1974 and 1990 for disposal of sludge cleaned out of settling ponds GTP-1, GTP-2, and GTP-3, as well as for disposal of mud from the drilling mud pits. The sludge pit is located at the former site of a gravel pit that was used by the State of New Mexico in conjunction with the building of State Road 126; the site is on U.S. Forest Service property about 2 miles west of the main compound of TA-57.

On the basis of the Phase I field investigations, we recommend voluntary corrective action (VCA) for PRS 57-002. Arsenic was found in soil samples at concentrations exceeding background UTLs, and barium was found at concentrations exceeding the SAL. The extent of arsenic and barium contamination at this PRS is unknown.

5.3.1 History

PRS 57-002 is discussed in detail in Section 5.3 of the RFI Work Plan for OU 1154 (LANL 1994, 1159).

The sludge pit was a disposal site for wet solids removed from the bottom of the settling ponds and for mud from the drilling mud pits. Materials entering this PRS that may have contributed to the list of COPCs were drilling muds (which included barite and lubricating materials), precipitated constituents from the circulation waters, and other dissolved solids collected during the passage of water through the hot underground rocks.

5.3.2 Description

The sludge pit is described in Section 5.3 of the RFI Work Plan for OU 1154 (LANL 1994, 1159) and in Section 1.2.2 of this report.

5.3.3 Previous Investigations

Previous investigations at this PRS are discussed in detail in Sections 5.2 and 5.3 of the RFI Work Plan for OU 1154 (LANL 1994, 1159). An EPA SW-846 EP toxicity test Method 3010 (EPA 1986, 1222) was performed on each truckload of sludge before it was discharged to the pit, to ensure that minimal amounts of metals could be leached from the sludge under natural conditions.

5.3.4 Field Investigation

The pit was sampled via two coreholes, one in the east portion and one in the west portion. Because the composition of the sludge from the various settling ponds would have been basically the same, and because the low-viscosity sludge would have flowed laterally across the surface of the pit, the pit's contents should be relatively homogeneous. The two coreholes, therefore, should

be fully adequate to provide samples representative of the contents. Both coreholes were projected to penetrate the entire depth of the sludge and to extend into the underlying tuff.

The western portion of the sludge pit was estimated to be 15 - 20 ft deep and the eastern portion to be 6 - 8 ft deep. The RFI Work Plan called for each corehole to be drilled 10 ft into the underlying bedrock and for samples to be taken at 1-ft intervals, beginning at the ground surface, for field XRF and OVA or PID analysis; it also called for sampling at horizons providing visual or other evidence of high constituent concentrations.

Samples for laboratory analysis were to be selected from those horizons judged on the basis of field screening and other information to have the highest constituent concentrations. Two samples were to be selected from each core: one for metals and one for SVOCs. The sampling done at PRS 57-002 is summarized in Table 5-13.

TABLE 5-13

PRS 57-002: SUMMARY OF SAMPLING

Location ID	Sample No.	Depth (ft)	Sample Matrix	Sample Request Number			
				SVOCS	INORG	TOTAL U	TCLP
57-3000	AAB5565	4.5 - 5	soil	18570	18574	18574	N/A
57-3100	AAB5566	9 - 10	soil	18570	18574	18574	N/A
57-3000	AAA5350	4.5-5	soil	N/A	N/A	N/A	21559

N/A - Not Applicable

Sampling location 57-3000 was the site of the corehole drilled in the eastern portion of the sludge pit, which was expected to have a deposit depth of 6 - 8 ft. Tuff was encountered at 7 ft, which was the maximum boring depth. The core revealed a black, saturated clay-like material at 4.5 ft, which was similar to the "service material" (sludge of drilling muds and additives) found in other cores collected at TA-57, and which has been shown at these other locations to be the layer of highest constituent concentrations. For this reason, the sample was taken from the 4.5- to 5-ft depth interval; it was submitted for total metals, total uranium, and SVOC analyses. A second aliquot of this material was submitted for TCLP (SW-846 Method 1311 [EPA 1986, 1222]) metals analysis. Materials collected from the sludge pit were not screened by XRF; no detectable amounts of VOCs were found by Hnu screening, although the "service" material did have an "unpleasant" musty odor similar to that of petroleum.

Sampling location 57-3100 was the site of the corehole drilled in the western portion of the sludge pit, which was expected to have a deposit depth of 15 - 20 ft. Tuff was encountered at 12.75 ft; the maximum drilling depth was 15 ft. The black "service material" was encountered at 9 -10 ft, and as before, the sample was taken from this depth interval; it was submitted for total metals, total uranium, and SVOC analyses. No detectable amounts of VOCs were found by Hnu screening, although the material from the 9- to10-ft horizon did have an "unpleasant" musty odor similar to that of petroleum.

5.3.5 Background Comparisons

All inorganic analytes, except silver, detected in soil samples from PRS 57-002 were compared with their natural background UTLs (no UTL is available for silver). Those whose concentrations exceeded background UTLs are shown in Table 5-14. As shown in Table A-1 (Appendix A), which lists the complete analytical results for those soil samples, all of these analytes except

arsenic, barium, calcium, copper, lead, magnesium, sodium, and zinc were eliminated as COPCs because they were detected at concentrations below their respective background UTLs. In the case of silver, for which no UTL has been established, detected concentrations were much lower than the SAL for silver in soil (400 mg/kg). Silver is therefore eliminated as a COPC. For antimony, the detection limits ranged from <5.7 to <10.2 mg/kg for these samples; although greater than the UTL for antimony in soil (1 mg/kg), all the reported antimony concentrations were below the SAL (32 mg/kg), and therefore this analyte was also eliminated as a COPC.

The locations from which samples were collected that contained analytes in concentrations exceeding background UTLs are shown in Fig. 5-4.

TABLE 5-14

PRS 57-002: INORGANIC ANALYTES FOUND AT CONCENTRATIONS GREATER THAN BACKGROUND UTLs

Chemical	Location ID	Sample No.	Depth (ft)	Concentration (mg/kg)	UTL (mg/kg)
Arsenic	57-3000	AAB5565	4.5-5	108(J)	7.82
Barium	57-3000	AAB5565	4.5-5	24100	315
	57-3100	AAB5566	9-10	686	
Calcium	57-3000	AAB5565	4.5-5	39700	6120
	57-3100	AAB5566	9-10	28800	
Copper	57-3000	AAB5565	4.5-5	225	30.7
	57-3100	AAB5566	9-10	37.3	
Magnesium	57-3000	AAB5565	4.5-5	13300	4610
Sodium	57-3000	AAB5565	4.5-5	4180	915
	57-3100	AAB5566	9-10	1660	
Lead	57-3000	AAB5565	4.5-5	249	23.3
	57-3100	AAB5566	9-10	248	
Zinc	57-3000	AAB5565	4.5-5	220	50.8
	57-3100	AAB5566	9-10	95.8	

The eight chemicals shown in Table 5-14 are retained as COPCs and will be evaluated further in the screening assessment. The TCLP extraction done on the sample taken from the 4.5- to 5-ft depth at location 57-3000 did not show metal concentrations that exceeded the EPA regulatory limits established for metals. Thus, the service material is not considered a RCRA hazardous waste.

5.3.6 Evaluation of Organic Constituents

No SVOCs were detected at PRS 57-002, because dilutions made in the laboratory (in an attempt to identify TICs and to minimize the matrix effects caused by the highly organic content of this material) raised the detection limits to a point that the SVOCs were masked. However, analyses of a sample from location 57-2100 that was similar in nature (predominantly "service material) but was not diluted showed no detectable SVOCs (see Chapter 4).

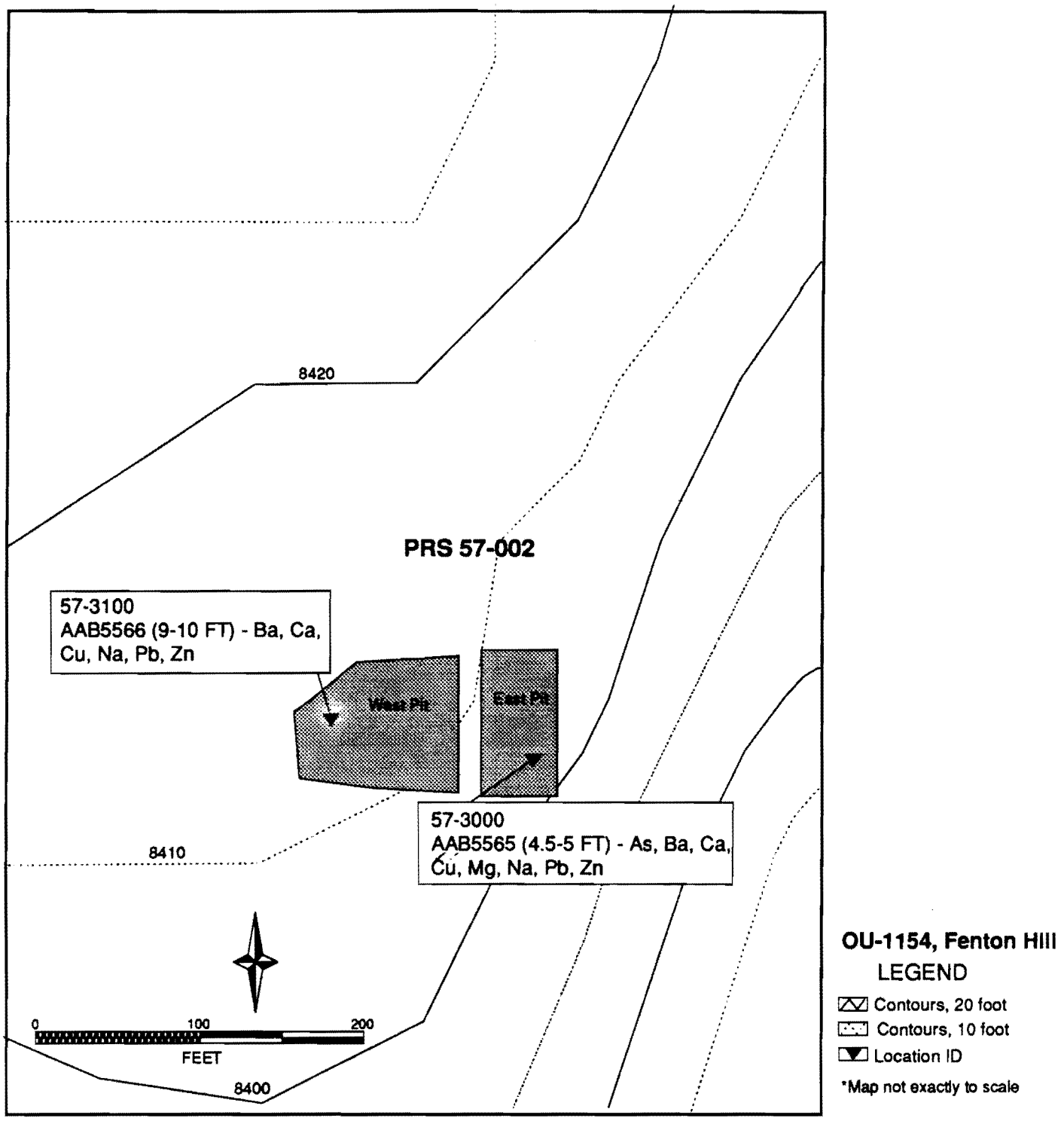


Figure 5-4. PRS 57-002: Locations from which samples were collected that contained analytes in concentrations exceeding background UTLs

Source: FIMAD, 12/14/94, G102838
Modified by: C. Rivera Lyons 2/24/96

5.3.7 Human Health Assessment

5.3.7.1 Screening Assessment for PRS 57-002

The detected concentrations of the eight inorganic analytes retained as COPCs after comparison with their background UTLs were next compared with their SALs. The comparison is shown in Table 5-15.

TABLE 5-15

PRS 57-002: CONCENTRATIONS OF COPCs vs SALs

Chemical	Location ID	Sample No.	Depth (ft)	Concentration (mg/kg)	SAL (mg/kg)
Arsenic	57-3000	AAB5565	4.5 - 5	108(J)	N/A
Barium	57-3000	AAB5565	4.5 - 5	24100	5300
	57-3100	AAB5566	9 - 10	686	
Calcium	57-3000	AAB5565	4.5 - 5	39700	No SAL
	57-3100	AAB5566	9 - 10	28800	
Copper	57-3000	AAB5565	4.5 - 5	225	2800
	57-3100	AAB5566	9 - 10	37.3	
Lead	57-3000	AAB5565	4.5 - 5	249	400
	57-3100	AAB5566	9- 10	248	
Magnesium	57-3000	AAB5565	4.5 - 5	13300	No SAL
Sodium	57-3000	AAB5565	4.5 - 5	4180	No SAL
	57-3100	AAB5566	9 - 10	1660	
Zinc	57-3000	AAB5565	4.5 - 5	220	23000
	57-3100	AAB5566	9 - 10	95.8	

N/A = Not applicable. SAL is below background concentration.
No SAL = No SAL is available.

Greater than or equal to SAL. Only barium was detected at concentrations exceeding its SAL.

No SAL. Arsenic, calcium, magnesium, and sodium fall into the No SAL category. In the case of arsenic, the calculated SAL is less than the background UTL in the Los Alamos background dataset (7.82 mg/kg); the background UTL, then, in essence becomes the SAL. Because the maximum detected concentration of arsenic at PRS 57-002 is 108 mg/kg, which is elevated with respect to this background UTL, arsenic will remain a COPC .

Calcium, magnesium, and sodium have no SALs because they are essential nutrients. Their concentrations at PRS 57-002 are well below the RDAs for humans (see Appendix C); for this reason, calcium, magnesium, and sodium are eliminated as COPCs.

Below SAL. Copper, lead, and zinc were detected in concentrations below their respective SALs.

Multiple Chemical Evaluation. To evaluate multiple chemical effects for this data set, analytes detected below their respective SALs were grouped according to their toxicological effects (carcinogenic or noncarcinogenic). All three of these chemicals are noncarcinogens. The concentration of each was normalized to its SAL, and the results were summed, as described in

Subsection 3.4.1. Table 5-16 shows the results of the multiple chemical evaluation based on noncarcinogenic effects.

TABLE 5-16

PRS 57-002: MULTIPLE CHEMICAL EVALUATION

Chemical	Sample Value (mg/kg)	SAL (mg/kg)	Normalized Value
Copper	225	2 800	0.08
Lead	249	400	0.62
Zinc	220	23 000	0.01
Sum of Normalized Values			**0.71**

The normalized value of the multiple chemical evaluation based on noncarcinogenic effects is less than one (0.71), indicating that potential adverse human health effects from exposure are unlikely. Therefore, all three of these chemicals are eliminated as COPCs.

Only arsenic and barium remain as COPCs for PRS 57-002.

5.3.7.2 Risk Assessment for PRS 57-002

Because the elevated concentrations of arsenic and barium detected at this PRS may pose an unacceptable risk, a formal risk assessment may be necessary.

5.3.8 Ecological Assessment

Given the largely undeveloped environs of this PRS, the potential for receptors to come in contact with contaminants is high. For this reason, this PRS will be assessed through the new Ecological Exposure Unit (Ecozone) approach, which considers contaminants with concentrations greater than UTLs, when that approach has been approved through the ER Project office. Threatened and endangered species and/or sensitive habitat (see Chapter 2) will be evaluated as part of this assessment.

5.3.9 Extent of Contamination

The purpose of the Phase I investigations was reconnaissance; the extent of contamination in this PRS can be determined only if additional data are collected.

5.3.10 Conclusions and Recommendations

On the basis of the screening assessment, we recommend a voluntary corrective action (VCA) for this PRS; a VCA proposal will be prepared.

5.4 PRS 57-004 (a)—Settling Ponds

PRS 57-004(a) consists of two settling ponds: a decommissioned, backfilled pond designated GTP-1E (east) and the existing 1-million-gal.-capacity pond designated GTP-1W (west). The eastern pond was originally excavated as a disposal pit for materials produced from the drilling of well EE-1. It was enlarged in several stages as operations advanced, and was also used for settling and recycling of fluids from the circulation loop. The successive enlargements eventually

extended Pond GTP-1E into the area that would later be occupied by Pond GTP-1W. When the entire pond area was decommissioned, it was cleaned of sludge and backfilled with clean soil to original ground level. Subsequently, Pond GTP-1W was excavated and lined with plastic. The Phase I RFI investigation involved only the eastern pond area of this PRS, GTP-1E; the western pond, from which there is no sign of contaminant release, will be investigated after the decommissioning of the Fenton Hill site.

Chemical analysis of samples from Pond GTP-1E showed that there were no COPCs (none of the detected chemicals were found in concentrations exceeding their SALs). On that basis, we recommend NFA for this portion of PRS 57-004(a).

5.4.1 History

PRS 57-004 (a) is discussed in detail in Section 5.2 of the RFI Work Plan for OU 1154 (LANL 1994, 1159).

Materials entering this settling pond that may have contributed to the list of chemicals detected during the Phase I investigations were drilling muds (which included barite and lubricating materials) and dissolved constituents originating from the circulation of water through the hot underground rocks. Some of the dissolved constituents would have precipitated out as the circulation waters cooled in the pond, thereby adding contaminants such as metals to the sludge in the pond bottom.

5.4.2 Description

Pond GTP-1E is described in detail in Section 5.2 of the RFI Work Plan for OU 1154 (LANL 1994, 1159) and Section 1.2.1.3 of this report.

5.4.3 Previous Investigations

Previous investigations carried out at PRS 57-004 (a) and at the other settling ponds within TA-57 are discussed in detail in Section 5.2 of the RFI Work Plan for OU 1154 (LANL 1994, 1159) and are summarized in Section 5.1.3 of this report.

5.4.4 Field Investigation

A CME-45 drill rig using a hollow-stem auger and a 5-ft stainless-steel core barrel sampler was used to collect the subsurface samples from pond GTP-1E. As called for in the Work Plan, the core was taken from an area of overlap of this pond with the area now occupied by Pond GTP-1W. Sediment samples were collected from the core at 1-ft intervals, beginning at a depth of 3 ft, and were screened for metals by XRF and for VOCs by OVA or PID. The Work Plan also called for additional samples to be collected for XRF screening from sediment horizons in which visual or other evidence indicated high constituent concentrations. Samples for laboratory analysis were to be selected from the horizon(s) that were judged, on the basis of field screening and other information, to have the highest constituent concentrations. Two samples were to be selected from each core: one for metals and one for SVOCs (both samples could come from the same horizon). If no horizon of high constituent concentration was indicated by the field screening for either metals or SVOCs, the sample was to be taken from the bottom of the core. Information on the sampling done at PRS 57-004(a) is summarized in Table 5-17.

TABLE 5-17

PRS 57-004(a): SUMMARY OF SAMPLING

Location ID	Sample ID	Depth (ft)	Sample Matrix	Sample Request Number		
				SVOCs	INORG	TOTAL U
57-2000	AAB5558	5.25 - 6	soil	18570	18574	18574
57-2000	AAB8781	6 - 7	tuff	18570	18574	18574

At the selected sampling location, 57-2000, the depth of the pond was estimated to be 12 ft; the Work Plan called for drilling 10 ft beyond this depth. At 4.5 ft a grey, sandy, possibly very weathered tuff layer was encountered; at 5.25 ft, a layer of black, bentonite-like material having an organic odor was encountered; and at 6 ft, a very hard, nonwelded tuff was encountered. (Drilling continued to a total depth of only 7.33 ft because of the hardness of this tuff material.) The black 5.25- to 6-ft-depth layer was confirmed by Fenton Hill personnel to be similar to the "service" material (drilling mud and additives) that is assumed to constitute the deepest layer of the pond and to consist of the accumulated solids in which contaminant concentrations are highest. Screening by XRF showed this layer to have relatively high concentrations of barium (Table 5-18). For these reasons, a sample was collected from this horizon to be analyzed for metals, total uranium, and SVOCs. No detectable levels of organic compounds were detected in the core by Hnu, but a second sample was collected from the tuff at the bottom of the core; it was submitted not only for SVOCs analysis but also for metals and total uranium. The purpose of this slight deviation from the Work Plan—to analyze the tuff sample for metals—was to verify that contaminants were not being carried into the tuff below the settling ponds at Fenton Hill (certain water balance calculations had indicated the possibility of significant amounts of water from the ponds infiltrating the tuff).

TABLE 5-18

SAMPLING LOCATION 57-2000: BARIUM CONCENTRATIONS IN SOIL DETECTED BY FIELD XRF

Depth (ft)	Barium Concentration (mg/kg)
2 - 3	368
3 - 4	325
4 - 5	280
5 - 6	212
5.25 - 6	565
6 - 7	91
7 - 7.33	439

5.4.5 Background Comparisons

All inorganic analytes, except cyanide and silver, detected in soil samples from PRS 57-004(a) were compared with their natural background UTLs (no background data are available for cyanide and silver). Those whose concentrations exceeded background UTLs are shown in Table 5-19. As shown in Appendix A, which lists the complete analytical results for those samples,all inorganic analytes except arsenic, barium, cadmium, calcium, chromium, copper, lead, total uranium, and zinc were eliminated as COPCs because they were detected at concentrations below their

respective background UTLs. In the case of silver, for which no UTL has been established, detected concentrations were <1.2 and <0.8 mg/ kg, which are much lower than the SAL for silver in soil (400 mg/kg). Silver is therefore also eliminated as a COPC. Sodium, although detected at concentrations exceeding its UTL, is eliminated as a COPC because the RDA for sodium (see Appendix C) is much greater than the amount that could be ingested daily in the camper/hiker risk scenario. For antimony, the detection limit was greater than the UTL for antimony in soil (1 mg/kg), but because the reported antimony concentrations in both samples were below the SAL (32 mg/kg), this analyte was also eliminated as a COPC.

The location from which the core was taken that contained analytes in concentrations exceeding background UTLs is shown in Fig. 5-5.

TABLE 5-19

PRS 57-004(a): INORGANIC ANALYTES FOUND AT CONCENTRATIONS GREATER THAN BACKGROUND UTLs

Chemical	Location ID	Sample No.	Depth (ft)	Concentration (mg/kg)	UTL (mg/kg)
Arsenic	57-2000	AAB5558	5.25-6	7.9(J)	7.82
Barium	57-2000	AAB5558	5.25-6	852	315
Calcium	57-2000	AAB5558	5.25-6	31500	6120
Cadmium	57-2000	AAB5558	5.25-6	6	2.7
Chromium	57-2000	AAB5558	5.25-6	28.1(J)	19.3
Copper	57-2000	AAB5558	5.25-6	244	30.7
Lead	57-2000	AAB5558	5.25-6	161	23.3
Total Uranium	57-2000	AAB5558	5.25-6	2.3	1.87
Zinc	57-2000	AAB5558	5.25-6	1290	50.8

Ten chemicals—the nine shown in Table 5-19 and cyanide—are retained as COPCs and will be evaluated further in the screening assessment.

5.4.6 Evaluation of Organic Constituents

No organic chemicals were detected in the two samples (AAB8781 and AAB5558) collected at PRS 57-004(a), both of which were analyzed for SVOCs. For the latter sample, SVOCs were not detected because dilutions made in the laboratory in an attempt to identify TICs and minimize the matrix effects due to the high organic content of the sample raised the detection limits to a point at which target SVOCs could not be detected. However, analysis of a sample from location 57-2100 that was similiar in nature (predominantly "service material") but was not diluted yielded no detectable SVOCs (see Chapter 4).

5.4.7 Human Health Assessment

5.4.7.1 Screening Assessment for PRS 57-004(a)

The detected concentrations of the ten inorganic analytes retained as COPCs after comparison with their background UTLs were next compared with their SALs. Table 5-20 shows the comparison.

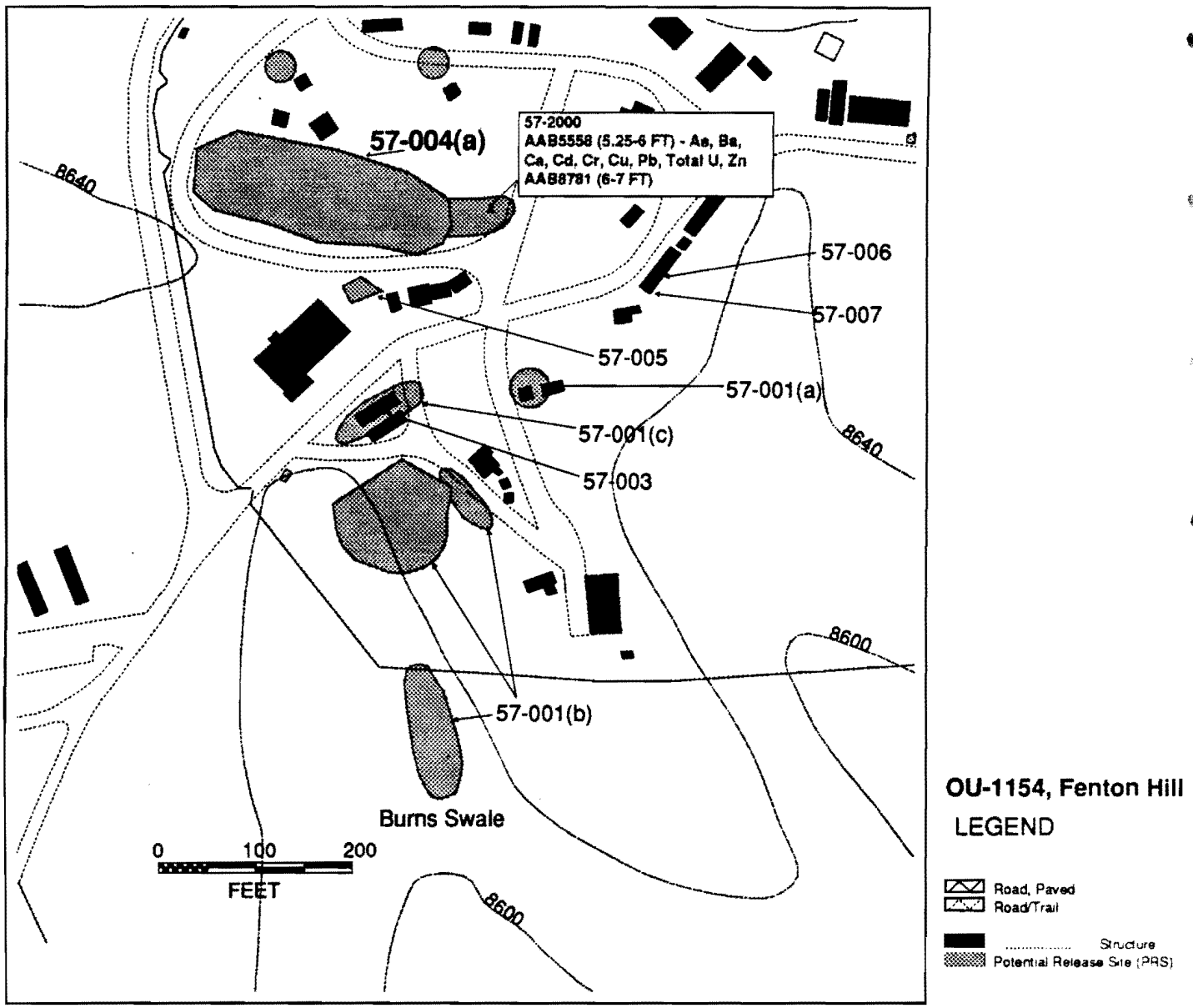


Figure 5-5. PRS 57-004(a): Locations from which samples were collected that contained analytes in concentrations exceeding background UTLs

Source: FIMAD, 11/21/95, G103966
Modified by: C. Rivera Lyons 2/10/96

TABLE 5-20

PRS 57-004(a): CONCENTRATIONS OF COPCs vs SALs

Chemical	Location ID	Sample No.	Depth (ft)	Concentration (mg/kg)	SAL (mg/kg)
Arsenic	57-2000	AAB5558	5.25 - 6	7.9(J)	N/A
Barium	57-2000	AAB5558	5.25 - 6	852	5300
Cadmium	57-2000	AAB5558	5.25 - 6	6	38
Calcium	57-2000	AAB5558	5.25 - 6	31500	No SAL
Chromium	57-2000	AAB5558	5.25 - 6	28.1(J)	210
Copper	57-2000	AAB5558	5.25 - 6	244	2800
Cyanide	57-2000	AAB5558	5.25 - 6	0.97	1300
Lead	57-2000	AAB5558	5.25 - 6	161	400
Uranium	57-2000	AAB5558	5.25 - 6	2.3	230 *
Zinc	57-2000	AAB5558	5.25 - 6	1290	23000

N/A = Not applicable. SAL is below the background UTL.
No SAL = No SAL is available.
*230 mg/kg is the SAL for uranium soluble salts.

Greater than or equal to SAL. No chemicals were detected in concentrations exceeding their SALs.

No SAL. Arsenic and calcium fall into the No SAL category. In the case of arsenic, the calculated SAL is below the background UTL of the Los Alamos background dataset (7.82 mg/kg); the laboratory uncertainty associated with Sample AAB5558, in which arsenic was detected at 7.9 mg/kg, is +/- 1.58. This concentration is slightly above the UTL for arsenic in soil. Because the sample in which this slightly elevated concentration was detected came from a depth of 5 ft below the ground surface, there is no plausible pathway by which humans could be exposed to this chemical. For this reason, arsenic is eliminated as a COPC. Calcium falls into the No SAL category because it is an essential nutrient. As shown in Appendix C, concentrations of this nutrient at this PRS are well below the RDA . On that basis, calcium is eliminated as a COPC.

Below SAL. Barium, cadmium, chromium, copper, cyanide, lead, uranium, and zinc were all detected at concentrations below their respective SALs.

Multiple Chemical Evaluation. To evaluate multiple chemical effects for this data set, chemicals detected at concentrations below their respective SALs were grouped according to their toxicological effects (carcinogenic or noncarcinogenic). Because there was only one carcinogen (chromium), a multiple chemical evaluation was done only for the seven noncarcinogens. The concentration of each was normalized to its SAL, and the results were summed as described in Subsection 3.4.1. Table 5-21 shows the results of the multiple chemical evaluation for the seven noncarcinogens.

TABLE 5-21

PRS 57-004(a): MULTIPLE CHEMICAL EVALUATION

Chemical	Concentration (mg/kg)	SAL (mg/kg)	Normalized Value
Barium	852	5300	0.16
Cadmium	6	38	0.16
Copper	244	2800	0.09
Cyanide	0.97	1300	0.001
Lead	161	400	0.4
Uranium	2.3	230*	0.01
Zinc	1290	23000	0.06
Sum of Normalized Values			**0.88**

*230 mg/kg is the SAL for uranium soluble salts.

The results of the multiple chemical evaluation based on noncarcinogenic effects is less than one (0.88), indicating that potential adverse human health effects from exposure to these constituents are unlikely. Therefore, all seven chemicals are eliminated as COPCs. No COPCs remain for this PRS.

5.4.7.2 Risk Assessment for PRS 57-004 (a)

No risk assessment was performed for this PRS because no COPCs were retained following the screening assessment.

5.4.8 Ecological Assessment

Because the environs of this PRS are moderately developed, and the residual chemicals are situated several feet underground, there is essentially no potential for receptors to come in contact with any of these constituents. Therefore, there are no ecotoxicological risk concerns at this PRS.

5.4.9 Extent of Contamination

No contamination was detected at this PRS.

5.4.10 Conclusions and Recommendations

We recommend NFA for the Pond GTP-1E portion of PRS 57-004(a) on the basis of NFA criterion 4. This PRS will not be added to the HSWA Module of the Laboratory RCRA operating permit and is proposed for removal from the ER Project list of PRSs.

5.5 PRS 57-006—Chemical Waste Drum

From about 1976 to 1989, real-time chemical analyses were done in a trailer on site at Fenton Hill, to monitor the drilling operations, the circulating geothermal fluids, the liquid discharges, and the quality of the sludge at the bottom of the settling ponds. Chemicals that were considered to be too

"dangerous or toxic" for the main sink drain in the trailer and the leach field to which it discharged were poured into a special drain connected to a plastic-lined 55-gal. drum buried in the ground beneath the trailer. The drum contained potentially hazardous concentrations of lead, mercury, and solvents. As part of the Phase I RFI activities at Fenton Hill, the drum, the liner, and the contents were voluntarily removed and disposed of by the Laboratory. Sampling of the soil beneath the former location of the drum showed no chemicals present in concentrations exceeding SALs. On that basis, we are recommending NFA for this PRS.

5.5.1 History

PRS 57-006 is discussed in Section 5.4 of the RFI Work Plan for OU 1154 (LANL 1994, 1159).

The chemical waste drum was reportedly emptied one or two times during the years that the trailer was in use; the waste was disposed of in accordance with standard Laboratory waste management procedures. Materials entering this PRS that may have contributed to the list of COPCs were small amounts of drilling muds (which included barite and lubricating materials), constituents dissolved from the circulation of water through the hot underground rock, and solvents and other chemicals used in the trailer operations.

5.5.2 Description

The now-removed chemical waste drum is described in Section 5.4 of the RFI Work Plan for OU 1154 (LANL 1994, 1159) and Section 1.2.3.1 of this report.

5.5.3 Previous Investigations

The contents of the chemical waste drum were sampled during the spring and summer of 1993. Analysis of these samples revealed the presence of elevated levels of lead and mercury, and a variety of organic solvents. The contents of the drum were subsequently removed and disposed of by standard Laboratory waste disposal practices. See Section 5.4 of the RFI Work Plan for OU 1154 (LANL 1994, 1159) for a more detailed discussion of these activities.

5.5.4 Field Investigation

On September 15, 1994, investigation of the 55-gal. drum revealed the presence of approximately one-quarter to one-half in. of sludge residue in the bottom of the drum, and of about 4 - 6 in. of liquid in the space between the drum and its plastic liner. Because the liner was not tightly sealed onto the drum, it is possible that this liquid was rainwater that had gained entry between the drum and the liner.

A VCA was carried out the same day, per the RFI Work Plan. The liquid was removed from the space between the drum and the liner and was disposed of in accordance with standard Laboratory procedures. The drum itself was then excavated by hand. It appeared to be in good condition, having no apparent corrosion or other damage that would affect its integrity. Using a bobcat and a "drum grabber" attachment, it was loaded into an 85-gal. overpack drum and disposed of in accordance with standard Laboratory procedures.

One soil sample and one replicate were then collected from the top 6 in. of soil situated directly beneath the former location of the drum (the bottom of the drum had been 3 ft below the ground surface). These soil samples were submitted for total metals, total uranium, and VOC analyses. Information on the sampling done at PRS 57-006 is summarized in Table 5-22.

TABLE 5-22

PRS 57-006: SUMMARY OF SAMPLING

Location ID	Sample No.	Depth (ft)	Sample Matrix	Sample Request Number		
				VOCs	INORG	TOTAL U
57-4010	AAB8397	0 - 0.5	soil	19224	19182	19182
57-4010R	AAB8398	0 - 0.5	soil	19224	19182	19182

5.5.5 Background Comparisons

All inorganic analytes, except silver, measured at PRS 57-006 were compared with their natural background UTLs (no UTL is available for silver). Those whose concentrations exceeded background UTLs are shown in Table 5-23. As shown in Appendix A, which lists the complete analytical results for these soil samples, all inorganic analytes except lead and mercury were eliminated as COPCs because they were detected at concentrations below their respective background UTLs. In the case of silver, the reported concentration (<0.74 mg/kg) is far below the SAL for silver in soil (400 mg/kg). Silver is therefore also eliminated as a COPC. For antimony, the reported concentration of <4.2 mg/kg, although greater than the UTL for antimony in soil (1 mg/kg), is substantially below the SAL for antimony in soil (32 mg/kg). For this reason, antimony is also eliminated as a COPC.

The location from which samples were collected that contained analytes exceeding their background UTLs is shown in Fig. 5-6.

TABLE 5-23

PRS 57-006: INORGANIC ANALYTES FOUND AT CONCENTRATIONS GREATER THAN BACKGROUND UTLs

Chemical	Location ID	Sample No.	Depth (ft)	Concentration (mg/kg)	UTL (mg/kg)
Lead	57-4010	AAB8398	0-0.5	90.4	23.3
	57-4010R	AAB8397	0-0.5	187	
Mercury	57-4010	AAB8397	0-0.5	0.43	0.1
	57-4010R	AAB8398	0-0.5	1.1	

Lead and mercury are retained as COPCs and will be evaluated further in the screening assessment.

5.5.6 Evaluation of Organic Constituents

Samples from PRS 57-006 were analyzed for volatile organic chemicals; none were detected, with the exception of acetone: the replicate soil sample collected from beneath the drum had an acetone concentration of 70 mg/kg. But because no acetone was detected in the regular soil sample, the presence of acetone in the replicate sample is attributed to cross-contamination in the analytical chemistry laboratory. In any case, the concentration of acetone in the replicate sample

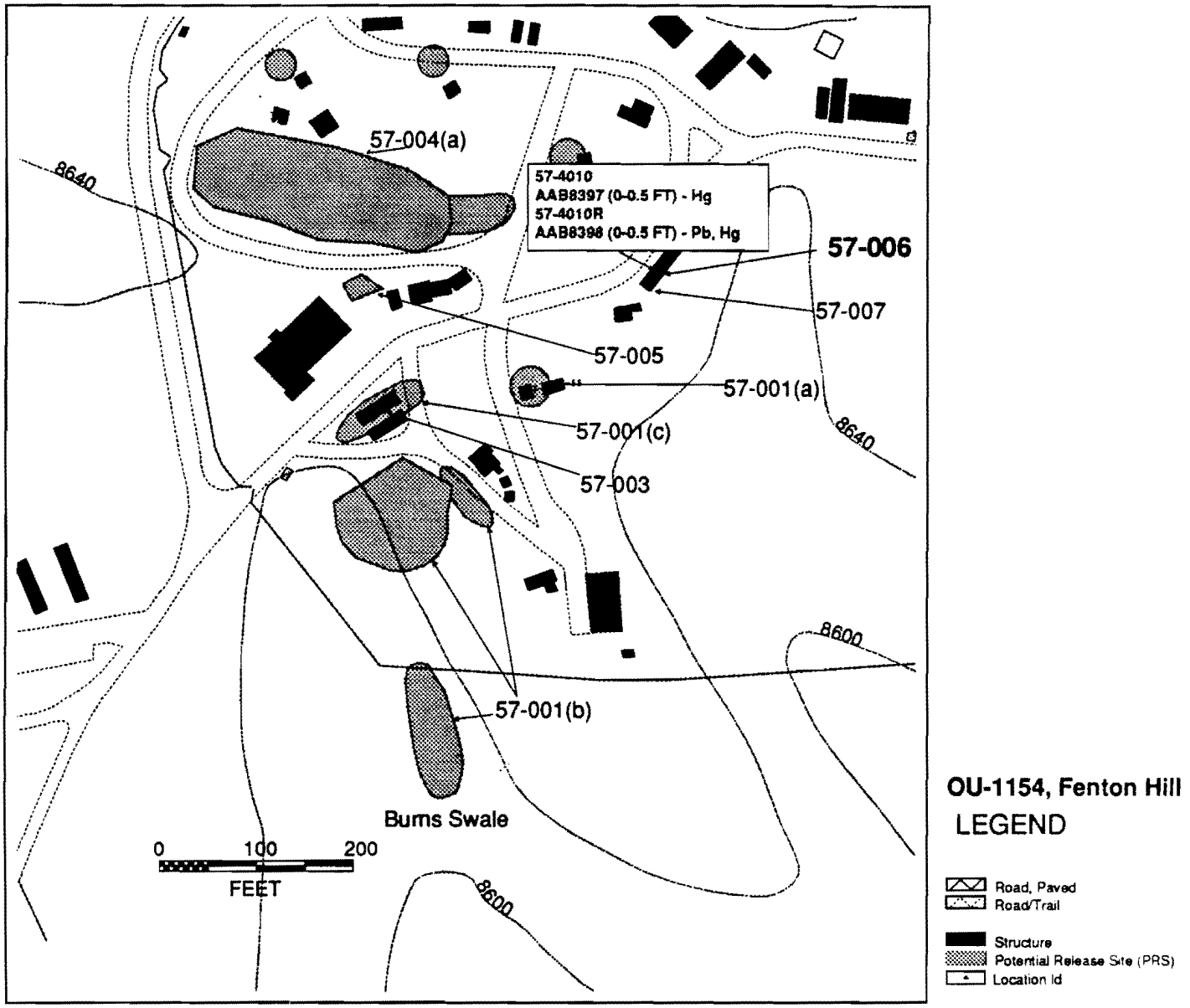


Figure 5-6. PRS 57-006: Locations from which samples were collected that contained analytes in concentrations exceeding background UTLs

Source: FIMAD, 11/21/95, G103966
Modified by: C. Rivera Lyons 2/20/96

is far below the SAL for acetone in soil (2000 mg/kg), and on that basis acetone can be eliminated as a COPC.

5.5.7 Human Health Assessment

5.5.7.1 Screening Assessment for PRS 57-006

The concentrations of the two inorganic analytes retained as COPCs after comparison with their background UTLs were next compared with their SALs. Table 5-24 shows the comparison.

TABLE 5-24

PRS 57-006: CONCENTRATIONS OF COPCs vs SALs

Chemical	Location ID	Sample No.	Depth (ft)	Concentration (mg/kg)	SAL (mg/kg)
Lead	57-4010	AAB8397	0 - 0.5	90.4	400
	57-4010R	AAB8398	0 - 0.5	187	
Mercury	57-4010	AAB8397	0 - 0.5	0.43	23
	57-4010R	AAB8398	0 - 0.5	1.1	

Greater than or equal to SAL. No chemicals were detected in concentrations exceeding their respective SALs.

No SAL. No chemicals fall into the No SAL category.

Below SAL. Two chemicals, lead and mercury, were detected at concentrations below their SALs.

Multiple Chemical Evaluation. To evaluate multiple chemical effects for this data set, chemicals detected at concentrations below their respective SALs were grouped according to their toxicological effects (carcinogenic or noncarcinogenic). Both lead and mercury are noncarcinogens. The concentration of each was normalized to its SAL, and the results were summed as described in Subsection 3.4.1. The results of the evaluation based on noncarcinogenic effects are shown in Table 5-25.

TABLE 5-25

PRS 57-006: MULTIPLE CHEMICAL EVALUATION

Chemical	Concentration (mg/kg)	SAL (mg/kg)	Normalized Value
Lead	187	400	0.47
Mercury	1.1	23	0.05
Sum of Normalized Values			**0.52**

The results of the multiple chemical evaluation based on noncarcinogenic effects is less than one (0.52), indicating that potential adverse human health effects from exposure are unlikely. On that basis, both lead and mercury are eliminated as COPCs. No COPCs are retained for PRS 57-006.

5.5.7.2 Risk Assessment for PRS 57-006

No risk assessment was performed for PRS 57-006 because no COPCs were identified by the screening assessment.

5.5.8 Ecological Assessment

Given the moderately developed environs of this PRS, there is some potential for receptors to come in contact with contaminants. For this reason, this PRS will be assessed through the new Ecological Exposure Unit (Ecozone) approach, which considers contaminants with concentrations greater than UTLs, when that approach has been approved through the ER Project office. Threatened and endangered species and/or sensitive habitat (see Chapter 2) will be evaluated as part of this assessment.

5.5.9 Extent of Contamination

No contamination was detected at this PRS.

5.5.10 Conclusions and Recommendations

We recommend NFA for PRS 57-006 on the basis of NFA criterion 4. This PRS will not be added to the HSWA Module of the Laboratory RCRA operating permit and is proposed for removal from the ER Project list of PRSs.

5.6 PRS 57-007—Chemical Waste Leach Field

This PRS is the leach field located adjacent to the trailer in which the materials and fluids from the geothermal activities were chemically analyzed. Waste water not discharged to the chemical waste drum (PRS 57-006) was disposed of in the trailer's main sink, which drained to this leach field. Phase I sampling of the field was designed to determine the presence or absence of metallic and volatile organic indicator constituents in the leach field sediments.

The recommendation for PRS 57-007 is NFA, based on the analytical results and the screening assessment, which indicated negligible risk.

5.6.1 History

PRS 57-007 is discussed in detail in Section 5.4 of the RFI Work Plan for OU 1154 (LANL 1994, 1159).

According to existing documentation, the leach field was located approximately 20 ft southeast of the trailer and was constructed of cinder blocks filled with gravel. The field is believed to have been about 8 -10 ft below ground surface and was open at the bottom. Materials that could potentially have contributed contaminants to the leach field, via disposal through the drain in the trailer, are very small amounts of drilling muds (which included barite and lubricating materials), other constituents picked up during circulation of water through the hot underground rock, and small amounts of chemicals used for the analyses carried out in the trailer that were inadvertently disposed of via the main drain.

5.6.2 Description

The leach field is described in Section 5.4 of the RFI Work Plan for OU 1154 (LANL 1994, 1159).

5.6.3 Previous Investigations

No previous investigations were performed at PRS 57-007.

5.6.4 Field Investigation

The exact location of the leach field was not known, but it was thought to be about 20 ft southeast of the former location of the trailer (which had been removed in 1989). It proved necessary to use power excavating equipment as well as hand tools to locate the field. During the removal of the trailer, the end of the PVC drainline leading to the leach field had been exposed; believing that the leach field could be located by excavating along this line, a bobcat fitted with a front-end loader plus hand excavation techniques were used to expose the line. The leach field was found to be only about 1 - 2 ft below the ground surface, rather than the 8 - 10 ft expected, and was oriented southwest to northeast. Thus, the area actually sampled was northeast of the original location of the trailer.

The RFI Work Plan called for one sample of sediment to be collected from the leach field, from the location judged to be the most highly contaminated (on the basis of field screening data, visual observations, and other field information). If no evidence of contamination was observed, a sampling location immediately beneath the end of the drainline was to be selected on the basis of professional judgment.

Because no visual or olfactory evidence of potential contamination was found in the leach field itself, the sediment sample was collected at the 0- to 1-ft depth from the area beneath the end of the drainline. This sample, consisting of brown sand mixed with gravel, was submitted for total metals, total uranium, and VOC analyses. Information on the sampling done at PRS 57-007 is summarized in Table 5-26.

TABLE 5-26

PRS 57-007: SUMMARY OF SAMPLING

Location ID	Sample No.	Depth (ft)	Sample Matrix	Sample Request Number		
				VOCs	INORG	TOTAL U
57-4000	AAB5567	0 - 1	sediment	20571	20573	20573

5.6.5 Background Comparisons

All inorganic analytes detected at PRS 57-007, except silver, were compared with their natural background UTLs (no UTL is available for silver). Those analytes whose concentrations exceeded background UTLs are shown in Table 5-27. As shown in Appendix A , which lists the complete analytical results for these soil samples, all inorganic analytes except mercury, total uranium, and zinc were eliminated as COPCs because they were detected at concentrations below their respective background UTLs. In the case of silver, the reported detection limit of <0.69 mg/kg is much smaller than the SAL for silver in soil (400 mg/kg). Silver is therefore eliminated as a COPC. For antimony, the reported detection limit of <3.6 mg/kg, although exceeding the UTL for antimony in soil (1 mg/kg), is much lower than the SAL for antimony in soils. For this reason, antimony is also eliminated as a COPC.

The location from which the sample was collected that contained analytes exceeding their background UTLs is shown in Fig. 5-7.

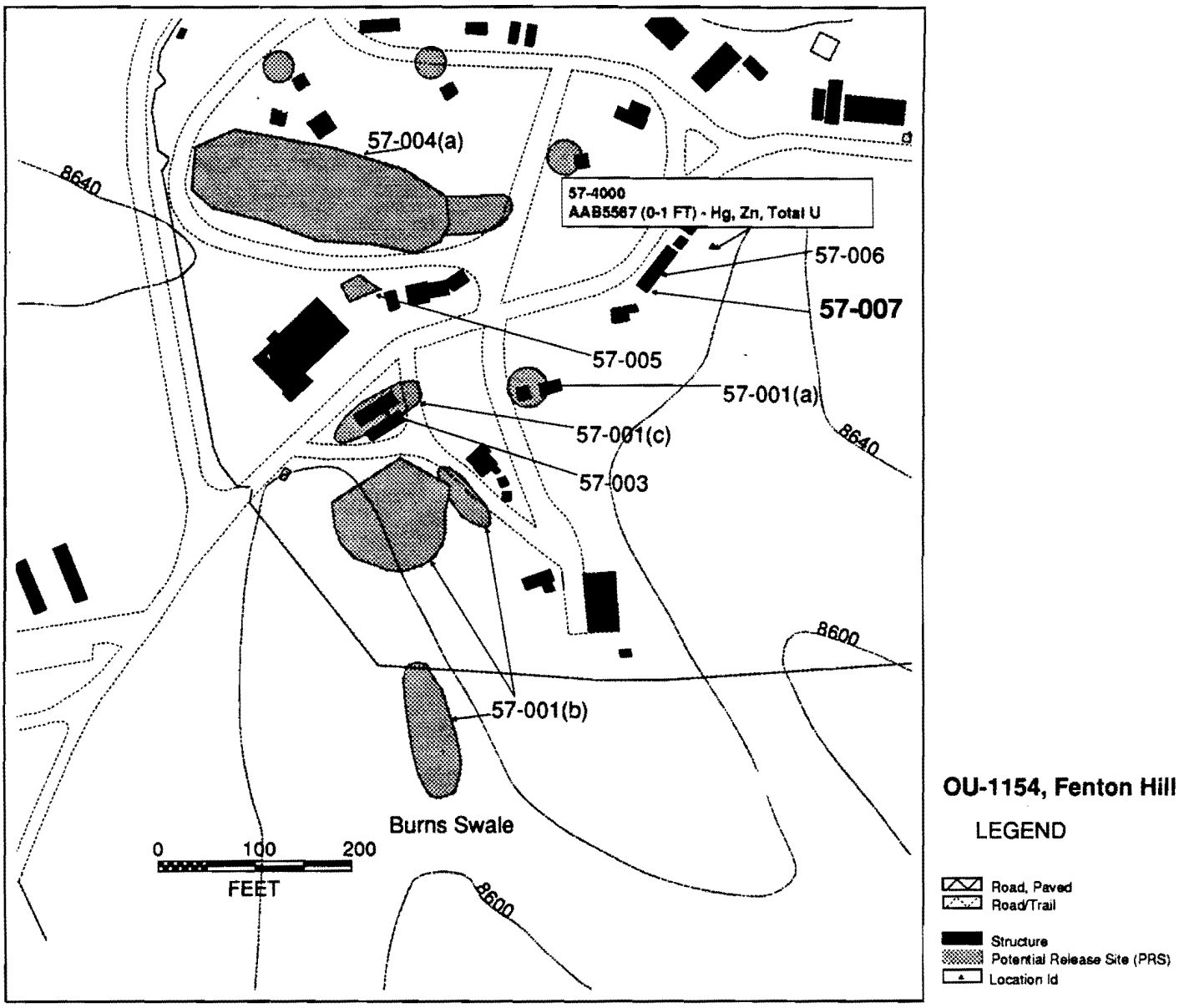


Figure 5-7. PRS 57-007: Locations from which samples were collected that contained analytes in concentrations exceeding background UTLs

Source: FIMAD, 11/21/95, G103966
Modified by: C. Rivera Lyons 2/17/96

TABLE 5-27

PRS 57-007: INORGANIC ANALYTES FOUND AT CONCENTRATIONS GREATER THAN BACKGROUND UTLs

Chemical	Location ID	Sample No.	Depth (ft)	Concentration (mg/kg)	UTL (mg/kg)
Mercury	57-4000	AAB5567	0-1	0.7	0.1
Zinc	57-4000	AAB5567	0-1	51.9	50.8
Total Uranium	57-4000	AAB5567	0-1	3.8	1.87

5.6.6 Evaluation of Organic Constituents

PRS 57-007 was sampled for volatile organic chemicals; none were detected.

5.6.7 Human Health Assessment

5.6.7.1 Screening Assessment for PRS 57-007

The concentrations of the three inorganic analytes retained as COPCs after comparison with their background UTLs were next compared with their SALs. Table 5-28 shows the comparison.

TABLE 5-28

PRS 57-007: CONCENTRATIONS OF COPCs vs SALs

Chemical	Location ID	Sample No.	Depth (ft)	Concentration (mg/kg)	SAL (mg/kg)
Mercury	57-4000	AAB5567	0 - 1.0	0.7	23
Uranium	57-4000	AAB5567	0 - 1.0	3.8	230 *
Zinc	57-4000	AAB5567	0 - 1.0	51.9	23 000

*230 mg/kg is the SAL for uranium soluble salts.

Greater than or equal to SAL. No chemicals were detected at concentrations exceeding their respective SALs.

No SAL. No chemicals fall into the No SAL category.

Below SAL. Mercury, uranium, and zinc were all detected at concentrations below their respective SALs.

Multiple Chemical Evaluation. To evaluate multiple chemical effects for this data set, chemicals detected at concentrations below their respective SALs were grouped according to their toxicological effects (carcinogenic or noncarcinogenic). All of the chemicals listed in Table 5-28 are noncarcinogens. The concentration of each was normalized to its SAL, and the results were

summed as described in Subsection 3.4.1. The multiple chemical evaluation based on noncarcinogenic effects is shown in Table 5-29.

TABLE 5-29

PRS 57-007: MULTIPLE CHEMICAL EVALUATION

Chemical	Concentration (mg/kg)	SAL (mg/kg)	Normalized Value
Mercury	0.7	23	0.03
Uranium	3.8	230*	0.02
Zinc	51.9	23000	0.002
Sum of Normalized Values			**0.05**

*230 mg/kg is the SAL for uranium soluble salts.

The results of the multiple chemical evaluation based on noncarcinogenic effects is less than one (0.05), indicating that potential adverse human health effects from exposure are unlikely. Therefore, all three chemicals are eliminated as COPCs. No chemicals remain as COPCs at this PRS.

5.6.7.2 Risk Assessment for PRS 57-007

No risk assessment was performed for PRS 57-007 because no COPCs were identified by the screening assessment.

5.6.8 Ecological Assessment

Because the environs of this PRS are moderately developed, there is some potential for receptors to come in contact with contaminants. For this reason, this PRS will be assessed through the new Ecological Exposure Unit (Ecozone) approach, which considers contaminants with concentrations greater than UTLs, when that approach has been approved through the ER Project office. Threatened and endangered species and/or sensitive habitat (see Chapter 2) will be evaluated as part of this assessment.

5.6.9 Extent of Contamination

No contaminants were detected at this PRS.

5.6.10 Conclusions and Recommendations

We recommend NFA for PRS 57-007 on the basis of NFA criterion 4. This PRS will not be added to the HSWA Module of the Laboratory RCRA operating permit and is proposed for removal from the ER Project list of PRSs.

REFERENCES

DOE (US Department of Energy), March 7, 1979. "Compliance with Floodplain/ Wetlands Environmental Review Requirements," Final Rule, 10 CFR Part 1022, Vol. 44, No. 46., Washington, DC. (DOE 1979, 0633)

DOE (US Department of Energy), November 9, 1988. "General Environmental Protection Program," DOE Order 5400. 1, Washington, DC. (DOE 1988, 0075)

Environmental Protection Agency, November 1986. "Test Methods for Evaluating Solid Waste," Vols. IA, IB, IC, and II, SW-846, Third Edition, Office of Solid Waste and Emergency Response Washington, DC. (Environmental Protection Agency 1986, 1222)

Environmental Protection Group, December 1990. "Environmental Surveillance at Los Alamos During 1989," Los Alamos National Laboratory Report LA-12000-ENV, ER ID Number 6995, Los Alamos, New Mexico. (Environmental Protection Group 1990, 0497)

Environmental Protection Group, March 1992. "Environmental Surveillance at Los Alamos During 1990," Los Alamos National Laboratory Report LA-12271-MS, ER ID Number 7004, Los Alamos, New Mexico. (Environmental Protection Group 1992, 0740)

Environmental Restoration Decommissioning Project, July 1995. "Health and Safety Activities Manual," Los Alamos National Laboratory, Los Alamos, New Mexico. (Environmental Restoration Decommissioning Project 1995, 1258)

Environmental Restoration Project Assessments Council, March 28, 1995. "Statistical Comparisons to Background, Part 1," Los Alamos National Laboratory Report LA-UR-95-1217, ER ID Number 45753, Los Alamos, New Mexico. (Environmental Restoration Project Assessments Council, 1995, 1218)

Environmental Restoration Project Decision Support Council, "Quality Control Data Use" (in preparation), Los Alamos, New Mexico. (Environmental Restoration Project Decision Support Council, _____).

ESG, May 1988. "Environmental Surveillance at Los Alamos During 1987," Los Alamos National Laboratory Report LA-11306-ENV, ER ID Number 6877, Los Alamos, New Mexico. (ESG 1988, 0408)

ESG, June 1989. "Environmental Surveillance at Los Alamos During 1988," Los Alamos National Laboratory Report LA-11628-ENV, ER ID Number 6894, Los Alamos, New Mexico. (ESG 1989, 0308)

Gautier, M. A. (Comp.), November 1993. "Quality Assurance Program Plan," Los Alamos National Laboratory, Los Alamos, New Mexico. (Gautier 1993, 1289)

Kaufman, E. L., and Siciliano, C. L. B., May 1979. "Environmental Analysis of the Fenton Hill Hot Dry Rock Geothermal Test Site," Los Alamos National Laboratory Report No. LA-7830-HDR, Los Alamos, New Mexico. (Kaufman and Siciliano 1979, 24-0013)

Keller, D., "Biological Resources Survey," Los Alamos National Laboratory Report (in preparation), Los Alamos, New Mexico. (Keller _____, 24-0074)

LANL (Los Alamos National Laboratory), "Administrative and Quality Procedures for Environmental Restoration," Los Alamos National Laboratory Report, Los Alamos, New Mexico. (LANL 1995, 0951)

LANL (Los Alamos National Laboratory), "Los Alamos National Laboratory Environmental Restoration Program Standard Operating Procedures," Los Alamos National Laboratory Report. Los Alamos, New Mexico. (LANL, 0875)

LANL (Los Alamos National Laboratory), February 1995. "Installation Work Plan for Environmental Restoration," Revision 4, Los Alamos National Laboratory Report LA-UR-95-740, ER ID Number 49822, Los Alamos, New Mexico. (LANL 1995, 1164)

LANL (Los Alamos National Laboratory), May 1994. "RFI Work Plan for Operable Unit 1154," Los Alamos National Laboratory Report LA-UR-94-1096, Los Alamos, New Mexico. (LANL 1994, 1159)

LANL/SNL (Los Alamos National Laboratory and Sandia National Laboratories), January 2, 1996. "Risk-Based Corrective Action Process," Los Alamos National Laboratory Report LA-UR-96-111, prepared by the Environmental Restoration Project Decision Support Council, Los Alamos, New Mexico. (LANL/SNL 1996, 1277)

Larson, Beverly M., 1987. "Fill Dirt Area, Fenton Hill Site, TA-57," Cultural Resource Survey Report No. 233, Los Alamos National Laboratory EM-8 Cultural Resource Management Team Report No. 11, Los Alamos, New Mexico. (Larson 1987, 24-0020)

Larson, Beverly M., 1987. "LANL Tailings Pile, Lake Fork Mesa, Forest Service Road 1676," Cultural Resource Survey Report, Survey No. 239, Los Alamos National Laboratory EM-8 Cultural Resource Management Team Report No. 16, Los Alamos, New Mexico. (Larson 1987, 24-0021)

Leica Inc., September 1990. "WILDsoft™Surveying System Software, Version 1.6," Norcross, Georgia. ISBN 0-944813-17-8. (Leica, Inc. 1990, 1285)

Longmire, P., S. Reneau, P. Watt, L. McFadden, J. Gardner, C. Duffy, and R. Ryti, January 1995. "Natural Background Geochemistry, Geomorphology, and Pedogenesis of Selected Soil Profiles and Bandelier Tuff, Los Alamos, New Mexico," (draft) Los Alamos National Laboratory Report LA-12913-MS, Los Alamos, New Mexico. (Longmire et al. 1995, 1142)

Longmire, P. A., D. E. Broxton, and S. L. Reneau, October 1995. "Natural Background Geochemistry and Statistical Analysis of Selected Soil Profiles, Sediments, and Bandelier Tuff, Los Alamos, New Mexico," Los Alamos National Laboratory Report LA-UR-95-3486, Los Alamos, New Mexico. (Longmire et al. 1995, 1266)

National Research Council, 1989. "Recommended Dietary Allowances," 10th Edition, National Academy Press, Washington, DC. (National Research Council 1989, 1251)

Pettitt, R. A., September 1976. "Environmental Monitoring for the Hot Dry Rock Geothermal Energy Development Project," Annual Report for the period July 1975 - June 1976. Los Alamos National Laboratory Report No. LA-6504-SR, Los Alamos, New Mexico. (Pettitt 1976, 24-0012)

Purtymun, W. D., R. J. Peters, T. E. Buhl, M. N. Maes, and F. H. Brown, November 1987. "Background Concentrations of Radionuclides in Soils and River Sediments in Northern New Mexico, 1974-1986," Los Alamos National Laboratory Report LA-11134-MS, Los Alamos, New Mexico. (Purtymun et al. 1987, 0211)

Scheick, Cherie, 1979. "A Cultural Resource Survey of Fenton Hill," conducted for Los Alamos Scientific Laboratory, Prepared for the Laboratory and USDA FS and submitted by John D. Beal, Contract Program Administrator, School of American Research, Santa Fe, New Mexico. (Scheick 1979, 24-0019)

APPENDIX A ANALYTICAL DATA

The analytical data is presented in two tables. Table A-1 presents the inorganic analytical data for all PRSs. Table A-2 presents the organic analytical data for those compounds in each PRS that exceed their SALs. (Raw data results for the entire site were too lengthy for inclusion here; they may be obtained upon request.)

All analytical data are available from the Facility for Information Management, Analysis, and Display (FIMAD). If FIMAD is not accessible, data will be provided upon request. A hard copy of the data is available from the Records Processing Facility (RPF), under _____.

LEGEND
XXX - Exceeds UTL
XXX - Exceeds SAL
N/A -- Not Applicable

									Laboratory Metal Analysis							
FIMAD Site ID	Customer No.	CST-9 Sample No	Sample Type	Begin Depth	End Depth	Depth Units	PRS No.	PRS Description	Ag (mg/kg)	Al (mg/kg)	As (mg/kg)	Ba (mg/kg)	Be (mg/kg)	Cd (mg/kg)	Cn (mg/kg)	Co (mg/kg)
57-2000	AAB5558	94.19387	CO	5.25	6	ft.	57-004(a)	Pond GTP-1E	<1.2	7610(J)	7.9(J)	852	<0.84(U)	6	0.97	<11.9(U)
57-2000	AAB8781	94.19390	CO	6	7	ft.	57-004(a)	Pond GTP-1E	<0.8	3390(J)	<1.2(U)	<31.5(U)	<0.56(U)	<0.37	<0.41	<0.76
57-2100	AAB5559	94.19388	CO	4.5	5	ft.	57-001(c)	Pond GTP-2	<1.3	412(J)	<1.8(U)	<13.7(U)	<0.05	1.3	<0.45	<0.85
57-2200	AAB5560	94.19389	CO	11	12	ft.	57-001(b)	Pond GTP-3W	<1.7	8810(J)	103(J)	11200	<0.84(U)	<0.96(U)	<0.86	<6.2(U)
57-2300	AAB5561	94.19393	CO	4	5	ft.	57-001(b)	Burns Swale	<0.93	13400(J)	<0.61(U)	129	1.6	4.3	<0.47	<8.3(U)
57-2300	AAB5562	94.19394	SU	0	12	in.	57-001(b)	Burns Swale	<0.86	3220(J)	30(J)	525	<0.52(U)	2.4	<0.43	<1.9(U)
57-2300R	AAB8396	94.19397	SU	0	12	in.	57-001(b)	Burns Swale	<0.87	3650(J)	22(J)	523	<0.54(U)	2.2	<0.44	<1.7(U)
57-2350	AAB5563	94.19395	CO	3	4	ft.	57-001(b)	Burns Swale	<0.86	7960(J)	<0.46	50.3(U)	<0.69	2.5	<0.43	<1.9(U)
57-2350	AAB5564	94.19396	SU	0	12	in.	57-001(b)	Burns Swale	<0.93	6930(J)	2.6(J)	157	<0.96(U)	3.1	<0.47	<3.3(U)
57-3000	AAB5565	94.19391	CO	4.5	5	ft.	57-002	Sludge Pit East	<1.8	7590(J)	108(J)	24100	<0.67(U)	<0.82	<0.91	<6.2(U)
57-3100	AAB5566	94.19392	CO	9	10	ft.	57-002	Sludge Pit East	<1	8340(J)	7.5(J)	686	<0.65(U)	<0.46	<0.51	<5.1(U)
57-4000	AAB5567	94.31957	SU	0	12	in.	TBD	Chemical Leach Field	<0.69	3000	<1.2	54.3	<0.64	<0.45(U)	<0.44	<0.78(U)
57-4010	AAB8397	94.23433	SU	0	6	in.	TBD	Chemical Waste Drum	<0.74	4930	<1.4(U)	78.1(U)	<0.64(U)	<0.48(U)	<0.38	<1.6(U)
57-4010R	AAB8398	94.23434	SU	0	6	in.	TBD	Chemical Waste Drum	<0.74	4420	<1.1(U)	93.2	<0.62(U)	<0.34	<0.34	<1.6(U)
BACKGROUND UTLs									N/A	38700	7.82	315	1.95	2.7	N/A	19.2
SALs (Screening Action Levels)									400	N/A	N/A	5600	N/A	80	1600	4600
57-3000**	AAA5350	95.05259	CO	4.5	5	ft.	57-002	Sludge Pit East	<0.055 mg/l	N/A	0.009 mg/l	1.6 mg/l	N/A	<0.004 mg/l	N/A	N/A
Regulatory TCLP Values									5 mg/l	N/A	5 mg/l	100 mg/l	1 mg/l	N/A	N/A	5 mg/l

* 230 mg/kg is the SAL for Uranium soluble salts

**However, look at TCLP test results to determine actual COPC.

TABLE A-1
CONCENTRATIONS OF INORGANIC ANALYTES IN SOIL
FENTON HILL PROJECT, TA-57 (OU 1154)

LEGEND
XXX - Exceeds UTL
XXX - Exceeds SAL
N/A -- Not Applicable

FIMAD Site ID	Customer No.	CST-9 Sample No	Sample Type	Begin Depth	End Depth	Depth Units	PRS No.	PRS Description	Cr (mg/kg)	Cu (mg/kg)	Hg (mg/kg)	K (mg/kg)	Mg (mg/kg)	Mn (mg/kg)	Na (mg/kg)
57-2000	AAB5558	94.19387	CO	5.25	6	ft.	57-004(a)	Pond GTP-1E	28.1(J)	244	<0.04(UJ)	1680	3340	498	<1600(U)
57-2000	AAB8781	94.19390	CO	6	7	ft.	57-004(a)	Pond GTP-1E	<1.2	<1.2	<0.03(UJ)	<657(U)	<91.4(U)	274	<447(U)
57-2100	AAB5559	94.19388	CO	4.5	5	ft.	57-001(c)	Pond GTP-2	<1.3(UJ)	<1.3	<0.03(UJ)	<116(U)	<63.9(U)	47	<41.4(U)
57-2200	AAB5560	94.19389	CO	11	12	ft.	57-001(b)	Pond GTP-3W	23.8(J)	216	<0.06(UJ)	2920	25100	389	2800
57-2300	AAB5561	94.19393	CO	4	5	ft.	57-001(b)	Burns Swale	7.1(J)	7.3	<0.03(U)	1280	2570	378	<522(U)
57-2300	AAB5562	94.19394	SU	0	12	in.	57-001(b)	Burns Swale	3.1(J)	7.2	<0.03(UJ)	<843(U)	<856(U)	267	<237(U)
57-2300R	AAB8396	94.19397	SU	0	12	in.	57-001(b)	Burns Swale	2.6(J)	6.7	<0.03(U)	<783	<865(U)	522	<187(U)
57-2350	AAB5563	94.19395	CO	3	4	ft.	57-001(b)	Burns Swale	<1.6(J)	<3.3(U)	<0.03(UJ)	<593(U)	<641(U)	328	<333(U)
57-2350	AAB5564	94.19396	SU	0	12	in.	57-001(b)	Burns Swale	3.9(J)	<6.1(U)	<0.03(UJ)	1400	1270	862	<220(U)
57-3000	AAB5565	94.19391	CO	4.5	5	ft.	57-002	Sludge Pit East	16.6(J)	225	<0.17(U)	2670	13300	399(UJ)	4180
57-3100	AAB5566	94.19392	CO	9	10	ft.	57-002	Sludge Pit East	18.7(J)	37.3	<0.03(UJ)	2030	2980	384	1660
57-4000	AAB5567	94.31957	SU	0	12	in.	TBD	Chemical Leach Field	<1.3(U)	<2	0.7	<419	<210	336	<88
57-4010	AAB8397	94.23433	SU	0	6	in.	TBD	Chemical Waste Drum	3.1(U)	<4.8(U)	0.43	<791(U)	<501(U)	249	<252(U)
57-4010R	AAB8398	94.23434	SU	0	6	in.	TBD	Chemical Waste Drum	3.7	5.6	1.1	<603(U)	<469(U)	252	<155(U)
BACKGROUND UTLs									19.3	30.7	0.1	3410	4610	714	915
SALs (Screening Action Levels)									400	3000	24	N/A	N/A	11000	N/A
57-3000**	AAA5350	95.05259	CO	4.5	5	ft.	57-002	Sludge Pit East	0.028 mg/l	N/A	0.0002 mg	N/A	N/A	N/A	N/A
Regulatory TCLP Values									N/A	0.2 mg/l	N/A	N/A	N/A	N/A	N/A

* 230 mg/kg is the SAL for Uranium soluble salts

**However, look at TCLP test results to determine actual COPC.

TABLE A-1 (cont.)
CONCENTRATIONS OF INORGANIC ANALYTES IN SOIL
FENTON HILL PROJECT, TA-57 (OU 1154)

LEGEND
XXX - Exceeds UTL
XXX - Exceeds SAL
N/A -- Not Applicable

FIMAD Site ID	Customer No.	CST-9 ample No	Sample Type	Begin Depth	End Depth	Depth Units	PRS No.	PRS Description	Ni (mg/kg)	Pb (mg/kg)	Sb (mg/kg)	Se (mg/kg)	Tl (mg/kg)	V (mg/kg)	Zn (mg/kg)	Total U (mg/kg)
57-2000	AAB5558	94.19387	CO	5.25	6	ft.	57-004(a)	Pond GTP-1E	13.9	161	<6.8	<0.65(R)	<0.65	<10.9(UJ)	1290	2.3
57-2000	AAB8781	94.19390	CO	6	7	ft.	57-004(a)	Pond GTP-1E	<1.3	8.4	<4.5	<0.43(R)	<0.43	<0.65(UJ)	41.2	0.708
57-2100	AAB5559	94.19388	CO	4.5	5	ft.	57-001(c)	Pond GTP-2	<1.4	14.9	<5.1	<0.48(R)	<0.48	<0.73(UJ)	<3.4(U)	0.602
57-2200	AAB5560	94.19389	CO	11	12	ft.	57-001(b)	Pond GTP-3W	<10.3(U)	167	<9.6	<0.91(R)	<1(U)	<14.7(UJ)	221	1.435
57-2300	AAB5561	94.19393	CO	4	5	ft.	57-001(b)	Burns Swale	<7.6(U)	17.3	<5.3	<0.59	<0.5	20.5(J)	33.1	1.899
57-2300	AAB5562	94.19394	SU	0	12	in.	57-001(b)	Burns Swale	<2.7	18.3	<4.9	<0.56	<0.46	<4.9(UJ)	35.1	0.463
57-2300R	AAB8396	94.19397	SU	0	12	in.	57-001(b)	Burns Swale	<2.8(U)	18.4	<4.9	<0.47	<0.47	<6.4(UJ)	37.7	0.478
57-2350	AAB5563	94.19395	CO	3	4	ft.	57-001(b)	Burns Swale	<2.7(U)	9.9	<4.9	<0.46	<0.46	<4.9(UJ)	39.6	1.161
57-2350	AAB5564	94.19396	SU	0	12	in.	57-001(b)	Burns Swale	<6.2(U)	11.1	<5.3	<0.5	<0.5	<12.2(UJ)	37	1.019
57-3000	AAB5565	94.19391	CO	4.5	5	ft.	57-002	Sludge Pit East	<11	249	<10.2	<0.97	<4.1(U)	<10.5(UJ)	220	1.66
57-3100	AAB5566	94.19392	CO	9	10	ft.	57-002	Sludge Pit East	<10.1(U)	248	<5.7	<0.66	<0.54	<12.7(UJ)	95.8	1.48
57-4000	AAB5567	94.31957	SU	0	12	in.	TBD	Chemical Leach Field	<2(U)	7.6	<3.6	<0.55	<0.54(U)	<1.7	51.9	3.8
57-4010	AAB8397	94.23433	SU	0	6	in.	TBD	Chemical Waste Drum	<2.7(U)	90.4	<4.2	<0.93(U)	<0.26	<5.1(U)	41.7	0.494(J)
57-4010R	AAB8398	94.23434	SU	0	6	in.	TBD	Chemical Waste Drum	<3.1(U)	187	<4.2	<0.53(U)	<0.26	<4.7(U)	40.9	0.549(J)
BACKGROUND UTLs									15.2	23.3	1	1.7	1	41.9	50.8	1.87
SALs (Screening Action Levels)									1600	400	32	400	6.4	560	24000	230*
57-3000**	AAA5350	95.05259	CO	4.5	5	ft.	57-002	Sludge Pit East	N/A	0.66 mg/l	N/A	<0.002 mg/	N/A	N/A	N/A	N/A
Regulatory TCLP Values									N/A	5 mg/l	N/A	1 mg/l	N/A	N/A	N/A	N/A

* 230 mg/kg is the SAL for Uranium soluble salts
**However, look at TCLP test results to determine actual COPC.

TABLE A-1 (cont.)
CONCENTRATIONS OF INORGANIC ANALYTES IN SOIL
FENTON HILL PROJECT, TA-57 (OU 1154)

		PRS NUMBER FIMAD SITE ID/CUSTOMER NO. CST-9 SAMPLE NO.						
		57-004(a)		57-001(c)	57-001(b)			
VOCs (ppb)	SALs (ppb)	57-2000/AAB5558 94.19387	57-2000/AAB8781 94.19390	57-2100/AAB5559 94.19388	57-2200/AAB5560 94.19389	57-2300/AAB5561 94.19393	57-2300/AAB5562 94.19394	57-2300R/AAB8396 94.19397
Vinyl Chloride	5	N/A	N/A	N/A	N/A	N/A	N/A	N/A
SVOCs (ppb)								
Aniline	19000	<98000	N/A	N/A	<69000	N/A	N/A	N/A
Anthracene	19000	<98000(UJ)	N/A	N/A	<69000(UJ)	N/A	N/A	N/A
Azobenzene	4000	<98000	N/A	N/A	<69000	N/A	N/A	N/A
Benzo[a]anthracene	610	<98000	N/A	N/A	<69000	N/A	N/A	N/A
Benzo[a]pyrene	61	<98000(UJ)	<330(UJ)	<390(UJ)	<69000(UJ)	<400(UJ)	<350(UJ)	<360(UJ)
Benzo[b]fluoranthene	610	<98000	N/A	N/A	<69000	N/A	N/A	N/A
Benzo[k]fluoranthene	6100	<98000	N/A	N/A	<69000	N/A	N/A	N/A
Bis(2-chloroethyl)ether	74	<98000	<330	<390	<69000	<400	<350	<360
Bis(2-chloroisopropyl)ethe	3900	<98000	N/A	N/A	<69000	N/A	N/A	N/A
Bis(2-ethylhexy)phthalate	32000	<98000	N/A	N/A	<69000	N/A	N/A	N/A
Chrysene	24000	<98000	N/A	N/A	<69000	N/A	N/A	N/A
p-Dichlorobenzene	7400	<98000(R)	N/A	N/A	<69000(R)	N/A	N/A	N/A
3,3'-Dichlorobenzidine	990	<98000	N/A	N/A	<69000	N/A	N/A	N/A
2,4-Dichlorophenol	200000	<98000	N/A	N/A	N/A	N/A	N/A	N/A
2,6-Dinitrotoulene	65000	<98000	N/A	N/A	<69000	N/A	N/A	N/A
Hexachlorobenzene	280	<98000	<330	N/A	<69000	<400	<350	<360
Hexachlorobutadiene	5700	<98000	N/A	N/A	<69000	N/A	N/A	N/A
Hexachloroethane	32000	<98000	N/A	N/A	<69000	N/A	N/A	N/A
2-Nitroaniline	3900	<240000	N/A	N/A	<170000	N/A	N/A	N/A
Nitrobenzene	33000	<98000	N/A	N/A	<69000	N/A	N/A	N/A
N-Nitrosodi-n-propylamine	63	<98000	<330	<390	<69000	<400	<350	<360
N-Nitrosodiphenylamine	8.7	<98000	<330	<390	<69000	<400	<350	<360
Pentachlorophenol	25000	<240000	N/A	N/A	<170000	N/A	N/A	N/A
2,4,6-Trichlorophenol	4000	<98000	N/A	N/A	<69000	N/A	N/A	N/A
Indeno[1,2,3-cd]pyrene	610	N/A	N/A	N/A	<69000	N/A	N/A	N/A

N/A - Not Applicable

TABLE A-2
ORGANIC ANALYTES HAVING DETECTION LIMITS THAT EXCEED SALs
TA-57 (OU 1154)

		PRS NUMBER FIMAD SITE ID/CUSTOMER NO. CST-9 SAMPLE NO.						
		57-001(b)		57-002		57-007	57-006	
	SALs	57-2350/AAB5563	57-2350/AAB5564	57-3000/AAB5565	57-3100/AAB5566	57-4000/AAB5567	57-4010/AAB8397	57-4010R/AAB8398
VOCs (ppb)	(ppb)	94.19395	94.19396	94.19391	94.19392	94.31957	94.23433	94.23434
Vinyl Chloride	5	N/A	N/A	N/A	N/A	<10	<10	<10
SVOCs (ppb)								
Aniline	19000	N/A	N/A	<64000	N/A	N/A	N/A	N/A
Anthracene	19000	N/A	N/A	<64000(UJ)	N/A	N/A	N/A	N/A
Azobenzene	4000	N/A	N/A	<64000	<4200	N/A	N/A	N/A
Benzo[a]anthracene	610	N/A	N/A	<64000	<4200	N/A	N/A	N/A
Benzo[a]pyrene	61	<370(UJ)	<410(UJ)	<64000(UJ)	<4200(UJ)	N/A	N/A	N/A
Benzo[b]fluoranthene	610	N/A	N/A	<64000	<4200	N/A	N/A	N/A
Benzo[k]fluoranthene	6100	N/A	N/A	<64000	<4200	N/A	N/A	N/A
Bis(2-chloroethyl)ether	74	<370	<410	<64000	<4200	N/A	N/A	N/A
Bis(2-chloroisopropyl)ethe	3900	N/A	N/A	<64000	<4200	N/A	N/A	N/A
Bis(2-ethylhexy)phthalate	32000	N/A	N/A	<64000	N/A	N/A	N/A	N/A
Chrysene	24000	N/A	N/A	<64000	N/A	N/A	N/A	N/A
p-Dichlorobenzene	7400	N/A	N/A	<64000(R)	N/A	N/A	N/A	N/A
3,3'-Dichlorobenzidine	990	N/A	N/A	<64000	N/A	N/A	N/A	N/A
2,4-Dichlorophenol	200000	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2,6-Dinitrotoulene	65000	N/A	N/A	<64000	N/A	N/A	N/A	N/A
Hexachlorobenzene	280	<370	<410	<64000	<4200	N/A	N/A	N/A
Hexachlorobutadiene	5700	N/A	N/A	<64000	N/A	N/A	N/A	N/A
Hexachloroethane	32000	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2-Nitroaniline	3900	N/A	N/A	<160000	<10000	N/A	N/A	N/A
Nitrobenzene	33000	N/A	N/A	<64000	N/A	N/A	N/A	N/A
N-Nitrosodi-n-propylamine	63	<370	<410	<64000	<4200	N/A	N/A	N/A
N-Nitrosodiphenylamine	8.7	<370	<410	<64000	<4200	N/A	N/A	N/A
Pentachlorophenol	25000	N/A	N/A	<160000	N/A	N/A	N/A	N/A
2,4,6-Trichlorophenol	4000	N/A	N/A	<64000	<4200	N/A	N/A	N/A
Indeno[1,2,3-cd]pyrene	610	N/A	N/A	<64000	<4200	N/A	N/A	N/A

N/A - Not Applicable

TABLE A-2 (cont)
ORGANIC ANALYTES HAVING DETECTION LIMITS THAT EXCEED SALs
TA-57 (OU 1154)

APPENDIX B DATA QUALITY EVALUATION SUMMARY

The table below summarizes quality data for the PRSs covered in this report. Chapter 4 discusses quality assurance and quality control.

DATA QUALITY EVALUATION FOR TA-57 SAMPLES

SUITE	REQUEST NUMBER	COMMENTS
Inorganic	18574	The percent recovery values for Al, Cr, Hg and V in the blind QC sample were >10 and <75% (70%, 58%, 71%, and 56%, respectively). The percent recovery values for Ag and As were > 125 and < 200% (192% and 175%, respectively). The reported results for these analytes were qualified as estimated (UJ or J). The percent recovery value for Se was > 200 %; the results were therefore qualified as unusable (R).
Total U	18574	Total Uranium analyzed by KPA. No problems.
Organic	19224	Surrogate recoveries, holding times, and method blank requirements were met. A blind QC sample was not assigned to this request number group. Acetone was found in a concentration of 70 mg/kg in the field replicate (AAB8398) but at less than 20 mg/kg in the original sample (AAB8397).
Organic	20571	Surrogate recoveries, holding times, and method blank requirements were met.
Organic	18570	The laboratory was unable to detect any of the surrogates spiked into samples AAB5558, AAB5560, and AAB5565. The surrogates were masked as a result of dilutions (made in an attempt to quantify TICs present in the samples and to prevent damage to laboratory instruments from the high concentrations of organic matter). Because it was not possible to recover the surrogate spiking compounds,the samples were not qualified. The laboratory reported a concentration < 50% of the spiked value for the following spiked components of Sample 94.19398: Anthracene; Benzo(a)pyrene; 1,2-Dichlorobenzene; 1,4-Dichlorobenzene; 4-Methylphenol; Pyrene; Naphthalene; and 1,2,4-Trichlorobenzene. The analytical results for these compounds were qualified as UJ. The detected concentration for 2-Methylphenol and 4-Nitrophenol was <10%; the results were therefore qualified as R
Inorganic	20573	The samples were within the EPA-EMSL/LV control limits.
Total U	20573	A blind QC sample was not analyzed with this request number group because the group consisted of only one sample.
Total U	19182	The percent recovery value for the blind QC sample was not within control limits; the total uranium results for samples AAB8397 and AAB8398 were therefore qualified as estimated (J).
Inorganic	19182	Of two blind QC samples submitted with this request number group, one was not analyzed because of insufficient sample size—inaccurate recoveries for As (62%), Fe (560%), Mn (140%), and Pb(330%). For the other QC sample, results for the metal analytes were in control. The holding times for Cn for samples AAB8397 and AAB8398 were exceeded; the results were therefore qualified as rejected (R).
Inorganic	21559	The results for the blind QC sample were in control and were not qualified.

APPENDIX C RISK ASSESSMENT CALCULATIONS

Risk assesment calculations were not done at the Fenton Hill site. Therefore, this appendix provides the calculations used for the screening assessment, on the basis of which the need for risk assessments was precluded.

All recommended daily allowances (RDAs) listed below are from *Recommended Dietary Allowances*, 10th Edition (National Research Council 1989, 1251).

ESSENTIAL NUTRIENTS

The essential nutrients detected at concentrations exceeding background UTLs are calcium, magnesium, and sodium. For each of the following calculations, the standard soil ingestion rate is 200 mg/day for a child and 100 mg/day for an individual 11 to 24 years of age.

The generic equation is:

mg of nutrient per kg of soil ÷ a conversion factor X mg of soil per day ingested

Calcium

The RDAs for calcium are

- 800 mg/day for a child 1 to 10 years of age.
- 1200 mg/day for an individual 11 to 24 years of age.

Calculations for PRS 57-001(b)

22 900 mg calcium per kg of soil ÷ 1 000 000 mg/kg X 200 mg of soil per day = **4.58** mg calcium per day.

22 900 mg calcium per kg of soil ÷ 1 000 000 mg/kg X 100 mg of soil per day = **2.29** mg calcium per day.

Using the standard ingestion rates and the highest concentration of calcium found in the soil at this PRS, the amounts of calcium that would be ingested are 200 to 600 times lower than the RDAs. Calcium is therefore eliminated as a COPC at PRS 57-001(b).

Calculations for PRS 57-002

39 700 mg calcium per kg of soil ÷ 1 000 000 mg/kg X 200 mg of soil per day = **7.94** mg calcium per day.

39 700 mg calcium per kg of soil ÷ 1 000 000 mg/kg X 100 mg of soil per day = **3.97** mg calcium per day.

Using the standard ingestion rates and the highest concentration of calcium in the soil at this PRS, the amounts of calcium that would be ingested are100 to 300 times lower than the RDAs. Calcium is therefore eliminated as a COPC at PRS 57-002.

Calculations for PRS 57-004(a)

31 500 mg calcium per kg of soil ÷ 1 000 000 mg/kg X 200 mg of soil per day = **6.3** mg calcium per day.

31 500 mg calcium per kg of soil ÷ 1 000 000 mg/kg X 100 mg of soil per day = **3.15** mg calcium per day.

Using the standard ingestion rates and the highest concentration of calcium in the soil at this PRS, the amounts of calcium that would be ingested are 190 to 250 times lower than the RDAs. Calcium is therefore eliminated as a COPC at PRS 57-004(a).

Magnesium

The RDAs for magnesium are

- 40 mg/day for an infant 0 to 6 months of age
- 50 mg/day for an infant 6 months to 1 year of age
- Amount varies, depending on weight, for a child 1 to 14 years of age
- 400 mg/day for a male 14 to 18 years of age
- 300 mg/day for a female 14 to 18 years of age
- 350 mg/day for a male 19 years of age and older
- 280 mg/day for a female 19 years of age and older

Calculations for PRS 57-001(b)

25 100 mg magnesium per kg of soil ÷ 1 000 000 mg/kg X 200 mg of soil per day = **5.02** mg magnesium per day.

25 100 mg magnesium per kg of soil ÷ 1 000 000 mg/kg X 100 mg of soil per day = **2.51** mg magnesium per day.

Using the standard ingestion rates and the highest concentration of magnesium found in the soil at PRS 57-001(b), the amounts of magnesium that would be ingested are approximately 8 to 150 times lower than the RDAs. Magnesium is therefore eliminated as a COPC at PRS 57-001(b).

Calculations for PRS 57-002

13 300 mg magnesium per kg of soil ÷ 1 000 000 mg/kg X 200 mg of soil per day = **2.66** mg magnesium per day.

13 300 mg magnesium per kg of soil ÷ 1 000 000 mg/kg X 100 mg of soil per day = **1.33** mg magnesium per day.

Using the standard ingestion rates and the highest concentration of magnesium found in the soil at PRS 57-002, the amounts of magnesium that would be ingested are 15 to 300 times lower than the RDAs. Magnesium is therefore eliminated as a COPC at PRS 57-002.

Sodium

The RDAs for sodium are

- 46 mg/day for infants
- 500 mg/day for adults

Calculations for PRS 57-001(b)

2 800 mg sodium per kg of soil ÷ 1 000 000 mg/kg X 200 mg of soil per day = **0.56** mg sodium per day.

2 800 mg sodium per kg of soil ÷ 1 000 000 mg/kg X 100 mg of soil per day = **0.28** mg sodium per day.

Using the standard soil ingestion rates and the highest concentration of sodium found at PRS 57-001(b), the amounts of sodium that would be ingested are 80 to 2000 times lower than the RDAs. Sodium is therefore eliminated as a COPC for PRS 57-001(b).

Calculations for PRS 57-002

4 180 mg sodium per kg of soil ÷ 1 000 000 mg/kg X 200 mg of soil per day = **0.83** mg sodium per day.

4 180 mg sodium per kg of soil ÷ 1 000 000 mg/kg X 100 mg of soil per day = **0.42** mg sodium per day.

Using the standard soil ingestion rates and the highest concentration of sodium found at PRS 57-002, the amounts of sodium that would be ingested are 55 to 1000 times lower than the RDAs. Sodium is therefore eliminated as a COPC for PRS 57-002.

APPENDIX D LIST OF CONTRIBUTORS

Name and Affiliation	RFI Report Assignment
Cheryl Rofer, EES-1, Los Alamos National Laboratory	Field Project Leader
Bill Kopp, ESH-19, Los Alamos National Laboratory	Report Team Leader
Catherine Rivera Lyons, ESH-19, Los Alamos National Laboratory	Data Analyst
Ron Conrad, ESH-19, Los Alamos National Laboratory	Chemistry
Albert Dye, ESH-19, Los Alamos National Laboratory	Data Validation
Mary Mullen, ESH-20, Los Alamos National Laboratory	Statistican
Linda Causey, Radian Corporation	Risk Assessment
Dave Breshears, EES-15, Los Alamos National Laboratory	Ecological Risk
Vivi Hriscu, CIC-1, Los Alamos National Laboratory	Technical Writing/Editing
Fawn Coriz, ESH-19, Los Alamos National Laboratory	Writing Assistant