RFI Report for Potential Release Sites

35-003(d, e, f, g, l, m, o, q, and r)
35-016(g and h)

(located in former
Operable Unit 1129)

Field Unit 4

Environmental
Restoration
Project

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A Department of Energy
Environmental Cleanup Program

Los Alamos
NATIONAL LABORATORY

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EXECUTIVE SUMMARY

This is the second of several reports that describe the Phase I results of the Resource Conservation and Recovery Act (RCRA) facility investigation (RFI) to evaluate contamination at Technical Area (TA) -35. TA-35 is located in former Operable Unit 1129, which is part of Field Unit 4 in the Environmental Restoration Project at Los Alamos National Laboratory (the Laboratory). Included in this RFI report are the results of investigations for Potential Release Site (PRS) Nos. 35-003(d, e, f, g, l, m, o, q, and r); and 35-016(g and h).

TA-35 (also known as Ten Site) is currently used for nuclear safeguard studies, laser research and development, physical research, fusion work, and other experimental research. It is one of the largest technical areas at the Laboratory with approximately 300 designated structures. It is located on Ten Site Mesa between Mortandad Canyon and Ten Site Canyon.

Operations at TA-35 began in 1951 and include research operations; two experimental reactors (between 1956 and 1964); lasers and laser fusion research, including development, fabrication, and operation of lasers and laser targets; nuclear safeguards research and development of assay instrumentation; and research in ceramics, robotics, polymer synthesis, high-speed impact studies, and strain-rate measurements on a variety of materials. Other operations include the TA-35 wastewater treatment plant.

Effluent routes from TA-35 include ventilation stacks, septic systems, storm sewer lines and discharge channels, industrial waste lines and outfalls, and leaking storage structures including underground and aboveground tanks and surface compounds. The chemicals and other constituents that contributed to the list of potential contaminants include metals, volatile organic compounds, semivolatile organic compounds, polychlorinated biphenyl compounds, and radionuclides. Radionuclides were investigated as part of this RFI, although radiological contamination is not regulated by RCRA.

The purpose of the Phase I RFI was to determine whether chemicals of potential concern (COPCs) are present in the PRSs at TA-35. Field activities followed sampling and analysis plans (SAPs) that were designed to confirm the presence or absence of COPCs. These SAPs were submitted as part of the *RFI Work Plan for Operable Unit 1129* (LANL 1992, 7666) and the addendum to the work plan (Pratt 1994, 43475), except as noted in Chapter 5.0 of this RFI report.

Field activities for the PRSs described in this RFI report began on January 6, 1994, and ended on December 22, 1995.

The data analysis process consisted of using a decision approach that involved a series of qualitative and quantitative steps. First, analytical data are verified and validated, then the data undergo a data quality assessment, and finally the data are compared with appropriate site-specific background values. A human health screening assessment was performed to determine if COPCs are present. An ecological assessment was performed by evaluating the potential for ecological receptors to be exposed to COPCs associated with the site.

No significant concerns are associated with the quality of the data except the radiological analysis performed at the mobile laboratory facility. The radiological analysis data set from the mobile laboratory facility was discarded. Data quality evaluation is presented in Chapter 4.0 of this RFI report.

For the purposes of the screening assessments reported in this RFI report, the PRSs at TA-35 have been organized into the decision units listed in Table ES-1. Where appropriate, PRSs are reported individually.

Further investigation is recommended for the following PRSs: PRS Nos. 35-003(d, e, f, g, l, m, o, q, and r) and 35-016(g and h). The results of the RFI for each PRS are summarized in Table ES-1.

TABLE ES-1

SUMMARY OF PROPOSED ACTIONS

		Proposed Action			
PRS	**HSWA**	**NFA Criteria**	**Further Action**	**Rationale**	**Section No.**
35-003(h)	X	4		Contamination below SALs, no COPCs identified	5.3
35-003(j) 35-003(k) 35-014(d) 35-015(b)	X X X	4		COPCs were determined to pose a negligible threat to human health	5.4
35-004(b)	X	4		Contamination below SALs, no COPCs identified in human health screening assessment	5.6
35-016(e)		4		Contamination below SALs, no COPCs identified in human health screening assessment	5.7
35-008 35-014(e_1)	X X		VCA	Contamination above SALs, surface water issues, remedy obvious	5.19
35-009(a)	X	4		Contamination below SALs, no COPCs identified in human health screening assessment	5.8
35-009(b)	X	4		Contamination below SALs, no COPCs identified in human health screening assessment	5.9
35-009(c)	X	4		COPCs were determined to pose a negligible threat to human health	5.10
35-009(d)	X	4		COPCs were determined to pose a negligible threat to human health	5.11
35-014(a)	X	1		Site has not received solid or hazardous wastes as defined in the HSWA module	5.12
35-014(b)	X	4		Contamination below SALs, no COPCs identified	5.13
35-014(e_2) 35-016(i)	X X	3 and 4		Contamination below SALs, no COPCs identified in human health screening assessment	5.14
35-014(f)			VCA	Contamination obvious, small area, remedy obvious	5.15
35-016(f)		4		Contamination below SALs, no COPCs identified in human health screening assessment	5.16

ACRONYMS AND ABBREVIATIONS

ALARA	as low as reasonably achievable
API	American Petroleum Institute
ASTM	American Society for Testing and Materials
CCRMP	Canadian Certified Reference Material Program
CMP	corrugated metal pipe
CO_2	carbon dioxide
COC	chemical of concern
COPC	chemical of potential concern
cpm	counts per minute
CRQL	contract required quantitation limit
CVAA	cold vapor atomic absorption
D&D	decontamination and decommissioning
DL	detection limit
EDL	estimated detection limit
EDXRF	energy dispersive x-ray fluorescence
EPA	Environmental Protection Agency
EQL	estimated quantitation limit
ER	Environmental Restoration
FIMAD	Facility for Information Management, Analysis, and Display
FU	field unit
GC/ECD	gas chromatography/electron capture detector
GC/FID	gas chromatography/flame ionization detector
GC/MS	gas chromatography/mass spectrometry
GFAA	graphite furnace atomic absorption
GM	Geiger-Müller
GPC	gas proportional counter
HPGe	high-purity germanium
H&S	health and safety
HSWA	Hazardous and Solid Waste Amendments
IC	ion chromatography
ICPES	inductively coupled plasma emission spectroscopy
ICPMS	inductively coupled plasma mass spectrometry
IQR	interquartile range
IWP	Installation Work Plan
J	The analyte was positively identified, and the associated numerical value is the approximate concentration of the analyte in the sample.
J+	Reported value is an estimate and likely biased high.
J–	Reported value is an estimate and likely biased low.
KrF	krypton fluoride
LAMPRE	Los Alamos Molten Plutonium Reactor Experiment
LAPRE	Los Alamos Power Reactor Experiment
LCS	laboratory control sample
LSC	liquid scintillation counting
Myr	million years
MCE	multiple chemical evaluation
NA	not analyzed
N/A	not applicable
N.A.	not available
NaI(Tl)	thallium-doped sodium iodide
ND	not detected
NFA	no further action
NIST	National Institute of Standards and Technology

NM	New Mexico
NMED	New Mexico Environment Department
NPDES	National Pollution Discharge Elimination System
NR	not requested
nr	not reported
NTU	nephelemetric turbidity units
OVA	organic vapor analyzer
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PE	performance evaluation
PPE	personal protective equipment
ppm	parts per million
PRG	preliminary remediation goal
PRS	potential release site
PSDA	particle-size distribution analysis
Qbo	Otowi Member of the Bandelier Tuff
Qbt2	cooling unit 2 of the Tshirege Member of the Bandelier Tuff
Qbt3	cooling unit 3 of the Tshirege Member of the Bandelier Tuff
QAPP	quality assurance project plan
QA/QC	quality assurance/quality control
QC	quality control
R	The sample results are rejected because of serious deficiencies in the ability to analyze the sample and meet quality control criteria; presence or absence cannot be verified.
Rad Van	radiological analysis van
RCRA	Resource Conservation and Recovery Act
RCT	radiological control technician
RFI	RCRA facility investigation
RPD	relative percent difference
RPF	Records-Processing Facility
RSS	ranked set sampling
S	The sample results were obtained using a screening analytical method performed in a mobile laboratory facility.
SAL	screening action level
SAP	sampling and analysis plan
SMO	Sample Management Office
SOP	standard operating procedure
SRM	standard reference material
SSHASP	site-specific health and safety plan
SVOC	semivolatile organic compound
TA	Technical Area
TBD	to be determined
TCLP	toxicity characteristic leaching procedure
TIC	tentatively identified compound
TLV	threshold limit value
TPH	total petroleum hydrocarbons
U	The analyte was analyzed for but not detected. Reported value is the sample quantitation limit or detection limit.
UJ	The analyte was analyzed for and was not detected. The reported value is an estimate of the sample quantitation limit or detection limit.
UTL	upper tolerance limit
VCA	voluntary corrective action
VOC	volatile organic compound
WEPP	Water Erosion Prediction Project
XRF	x-ray fluorescence

1.0 INTRODUCTION

This report describes the Phase I results of the Resource Conservation and Recovery Act (RCRA) facility investigation (RFI) in portions of Technical Area (TA) -35 at Los Alamos National Laboratory (hereafter referred to as "the Laboratory"). The purpose of the investigation was to evaluate contamination at former Operable Unit 1129 in Field Unit 4 of the Laboratory's Environmental Restoration Project. Sampling activities were conducted under the guidelines described in the *RFI Work Plan for Operable Unit 1129* (LANL 1992, 7666) (hereafter referred to as "the work plan") and the June 1994 addendum to the work plan (Pratt 1994, 43475). The work plan was approved by the Environmental Protection Agency (EPA) on November 3, 1993, and the addendum was approved by EPA on May 22, 1995. Included in this RFI report are the results of Phase I investigations for potential release site (PRS) Nos. 35-003(d, e, f, g, l, m, o, q, and r) and 35-016(g and h).

1.1 General Site History

Details of the history of TA-35 are discussed more completely in Section 3.3 of the work plan (LANL 1992, 7666). See Figure 1.1-1 and Figure 1.1-2 for the location of TA-35.

TA-35 (also known as Ten Site) is one of the largest technical areas at the Laboratory with approximately 300 designated structures. It is currently used for laser and laser fusion research, which consist of development, fabrication, and operation of lasers and laser targets; nuclear safeguards research and the development of assay instrumentation; and research in ceramics, robotics, polymer synthesis, high-speed impact studies, and strain-rate measurements on a variety of materials.

Operations at TA-35 began in 1951 with the completion of the original Ten Site Laboratory and office building (TA-35-2). The building has been used for a wide variety of research operations and housed two experimental reactors between 1956 and 1964: the Los Alamos Power Reactor Experiment (LAPRE) -I and the Los Alamos Molten Plutonium Reactor Experiment (LAMPRE). The building also housed a hot cell used for preparing kilocurie sources of radioactive lanthanum (^{140}La), for plutonium research laboratories, and as a facility in which lithium tritide components were developed and handled (DOE 1987, 8663).

The TA-35 wastewater treatment plant was operated from 1951 to 1963. Waste liquids, which were generated by washings of the hot cell, were stored in four tanks to allow decay of short-lived ^{140}La. When concentrations of other radionuclides with longer half-lives, such as ^{90}Sr, were discovered in the stored liquid wastes, a wastewater treatment plant with ion-exchange capabilities was constructed. The wastewater treatment plant was constantly beset with problems and required numerous retrofittings and additional equipment.

Other major facilities at TA-35 include the following:

- Fast Reactor Core Test Building (TA-35-27) built in 1968 to house the LAPRE-II reactor, which was never completed;
- Gas Laser Building (TA-35-29) built in 1961 to house a small reactor test pit and currently used to house the Gemini gas laser facility, which uses helium and nitrogen lasers;
- Sodium Testing Building (TA-35-34) built in 1958 and used as a high-voltage switching laboratory;
- Chemical Laser Facility (TA-35-85) completed in 1977 and used for research and development of krypton fluoride (KrF) lasers;
- Carbon Dioxide Laser Building (TA-35-86) that housed the Helios carbon dioxide (CO_2) laser facility and now houses the Z-Pinch machine, which is used to focus electron beams on targets;

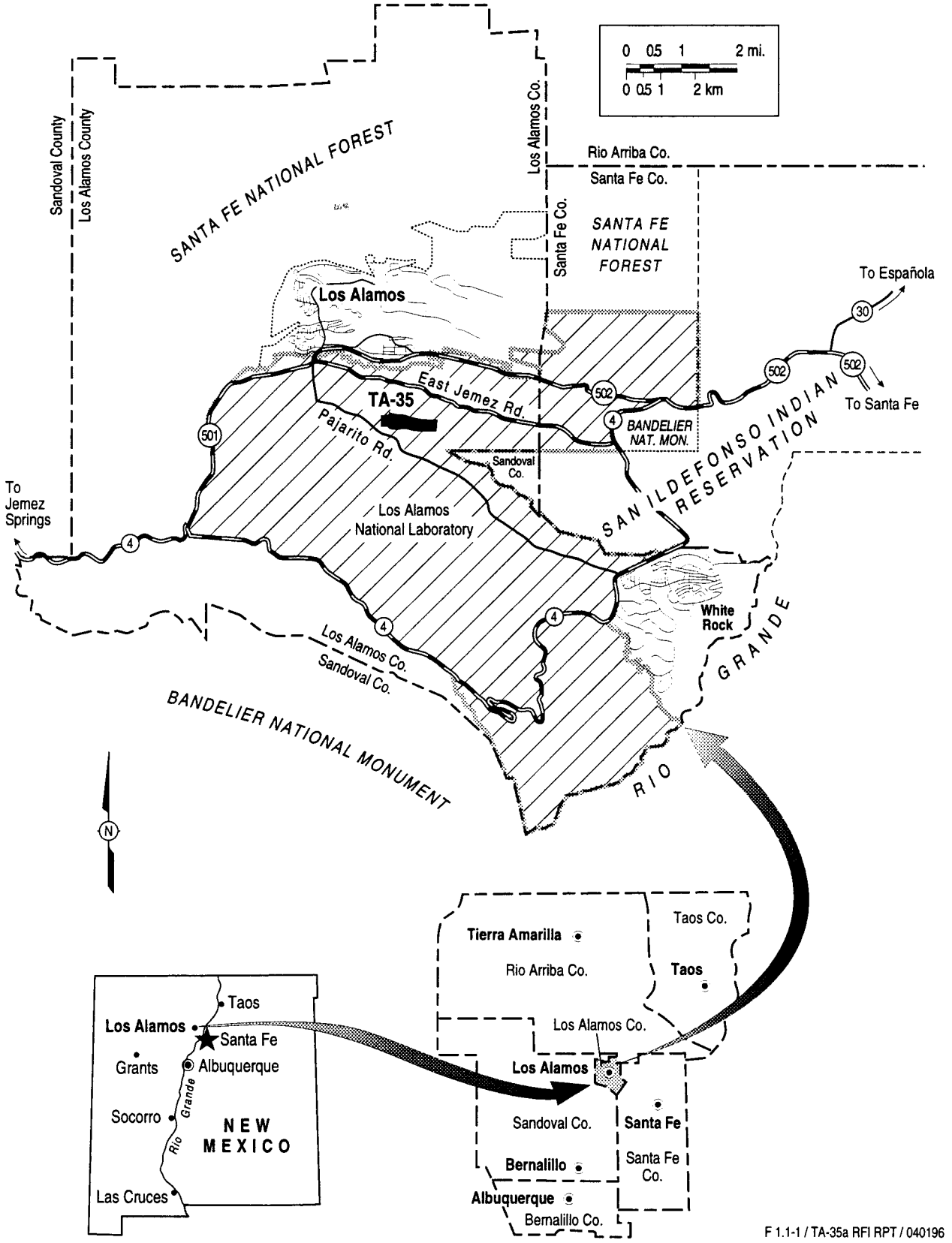


Figure 1.1-1. Location map of TA-35 within Los Alamos National Laboratory.

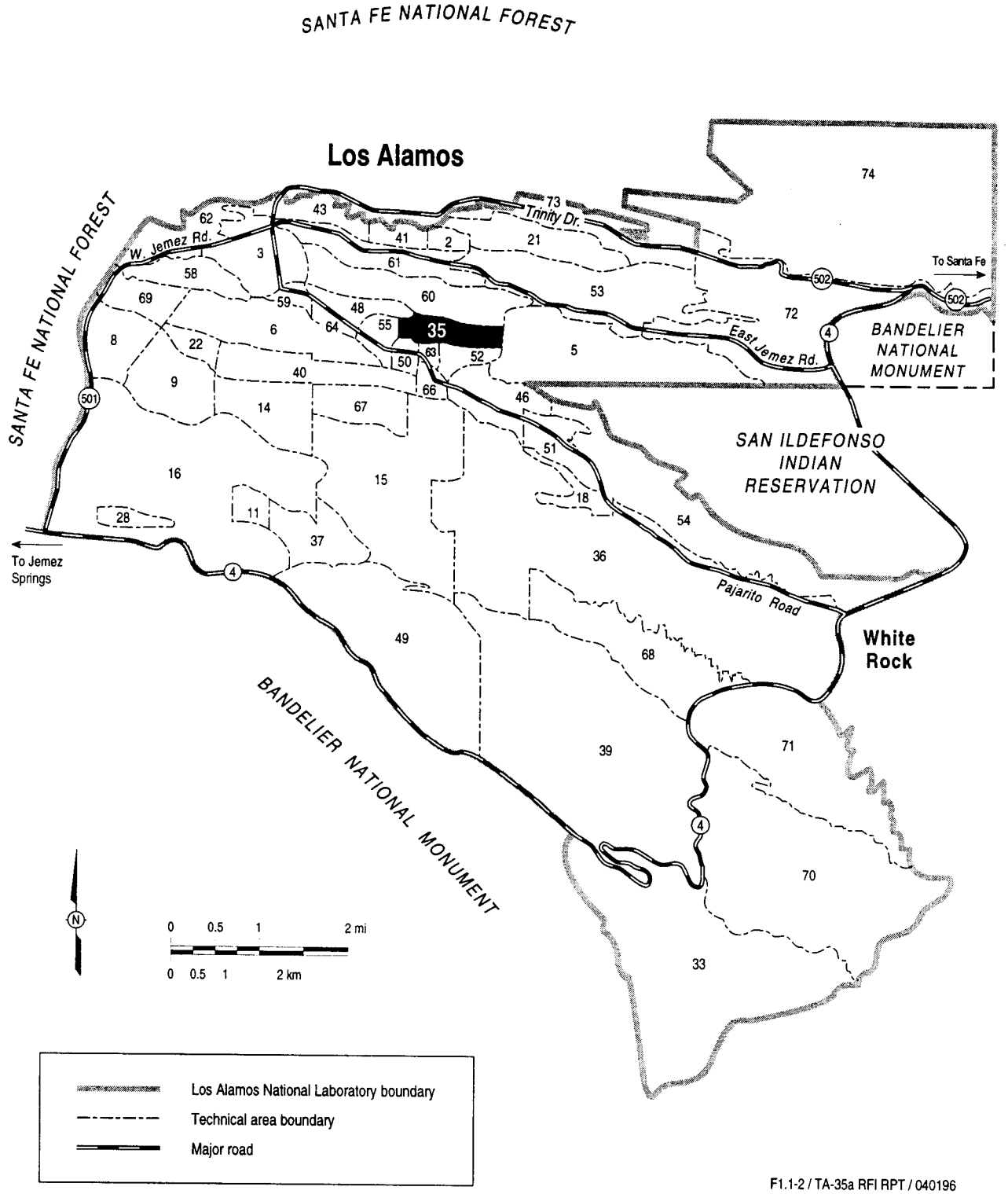


Figure 1.1-2. Location of TA-35 with respect to Laboratory technical areas and surrounding land holdings.

- buildings TA-35-124, -125, and -126 completed in the mid-1980s that housed the Antares CO_2 laser experiments, which used large CO_2 lasers and tritium/deuterium microsphere targets;
- High-Voltage Development Laboratory (TA-35-188) completed in 1976 in which the components for the KrF laser facility are assembled; and
- Target Fabrication Facility (TA-35-213) completed in 1976 and used for processing deuterium and tritium microsphere targets for various laser operations at TA-35 and also for processing beryllium.

Effluent routes from TA-35 include ventilation stacks, septic systems, storm sewer lines and discharge channels, industrial waste lines and outfalls, and leaking storage structures such as underground and above ground tanks and surface compounds. Chemicals and other constituents used at the site that contributed to the chemicals of potential concern investigated during Phase I include metals, volatile organic compounds, semivolatile organic compounds, polychlorinated biphenyl (PCB) compounds, and radionuclides. Radionuclides were investigated as part of this RFI, although radiological contamination is not regulated by RCRA.

In the work plan (LANL 1992, 7666) PRSs were aggregated based on several criteria including proximity, type (for example, outfalls or septic systems), or the operational history of the facility. However, in many cases the aggregation of PRSs in the work plan is not appropriate for the screening assessment, reporting, or recommendations for remedial action. For example, Aggregate U contains a storage area, two oil spills, and five outfalls that are widely separated on the mesa top.

For the purposes of the assessments in this RFI report, the PRSs at TA-35 have been organized into the decision sets listed in Table 1.1-1. Where appropriate, PRSs have been reported individually. For example, two of the PRSs in Aggregate U (Section 7.23 of the work plan) have been evaluated separately because they are attributable to two different types of releases, Phase I data were collected on the mesa edge and at the points of discharge, and the Phase I data are clustered at specific location points. PRS No. 35-016(g) is an active outfall that handles cooling tower blowdown. PRS No. 35-016(h) consists of several active storm drains and brine discharge from a water deionizer. Phase I samples for these PRSs were collected at four distinct discharge points. Also, where PRSs are in such close proximity that contamination from one release would be intermingled with contamination from another release or where several PRSs will be evaluated in one exposure unit during human health risk assessment, the PRSs have been combined to create a single decision set. For example, PRS Nos. 35-003(e, f, g, m, and o) spacially overlap, they are all located on the mesa top east of TA-35-7, and an industrial use scenario is clearly applicable in that decision set.

TABLE 1.1-1

POTENTIAL RELEASE SITE DECISION SETS

RFI Report Section	Work Plan Section	PRSs Included in Decision Set	Description
5.1	7.8	35-003(d, l, and q)	Former holding tanks, storage tank, pump pit, and associated piping
5.2	7.8	35-003(e, g, m, and o)	Former flocculator tank, regenerant tank, sludge tank, and manhole
5.3	7.8	35-003(r)	Site of effluent discharge and spills from holding tanks
5.4	7.25	35-016(g)	Active NPDES-permitted outfall
5.5	7.25	35-016(h)	Outfalls

1.2 RFI Overview

The purpose of the Phase I investigation was to determine whether chemicals of concern (COCs) are present in the PRSs at TA-35. Results of the investigation are used to determine if a site

- requires additional investigation (Phase II),
- may be removed from the RCRA Hazardous and Solid Waste Amendments Module VIII Permit and recommended for no further action, or
- is a candidate for expedited cleanup or voluntary corrective action.

A complete description of the conceptual model is discussed in Chapter 4 of the work plan (LANL 1992, 7666). The conceptual model was based on three contaminant transport scenarios: resuspension and possible transport of soil particles by the action of wind, vapor- or liquid-phase transport in the vadose zone, and surface water runoff and erosion.

Site-specific factors such as contaminant type(s), contaminant volume(s), release history, and physical conditions also govern the movement of contaminants from a release. Primary release mechanisms consist of two types: operational and accidental. An operational loss of contaminants includes the release of constituents through either routine process operations or intentional but unplanned releases. These release mechanisms include system discharges, outfalls, septic systems, air emissions, and test procedures. An accidental loss of contaminants may include unintentional releases such as leaking underground storage tanks, surface overflows, spills, leaks, and operational accidents. Secondary release mechanisms are those processes that mobilize contaminants within a medium or among media. Mobilizing processes for contaminants in water include surface water bulk flow, percolation and migration in the vadose zone, ground water transport, and volatilization. Mobilizing processes for soil include aeolian processes, biotic uptake, and soil erosion. Aeolian processes are the mobilizing processes for airborne particulates or vapor phase contamination.

Because the purpose of the Phase I investigation was to determine whether COCs are present, the conceptual model used site-specific information for the above processes to determine a potential worst-case contaminant migration as the basis for developing a sampling and analysis plan (SAP). SAP development included the use of models, such as the EPA-sponsored personal computer graphical exposure modeling system (SESOIL and AIRDOS-EPA) and contouring software (SURFER). In addition to the use of models, judgmental sampling combined with search sampling was the method chosen to select the number and location of samples to be collected for most PRSs at TA-35.

1.3 Field Activities

Field activities followed the SAPs that were submitted as part of the work plan, except as noted in Chapter 5 of this RFI report. Field activities began on January 6, 1994, and ended on December 22, 1995. The SAPs called for field surveys to be performed at the PRSs before collecting samples. These surveys included site engineering surveys to locate the PRSs and associated features, and environmental surveys to initially screen for environmental concerns at each site. All survey activities and sampling activities followed applicable Laboratory Environmental Restoration Project standard operating procedures (LANL-ER-SOPs).

Site engineering surveys generally included a review of archival data, engineering drawings provided by the Laboratory's Facility Project Delivery Group (FSS-6), aerial photographs, and site visits. These engineering surveys were conducted by the field team leader, geologists, and environmental scientists with support from the field team sampling technicians. During the surveys, the PRSs were located, staked, and documented. If the results of these reviews corresponded accurately to the original SAPs, then predetermined sample locations were staked. However, if the engineering surveys found discrepancies between actual site conditions and the original SAPs, then environmental surveys, geophysical surveys, and other field surveys were used to determine appropriate sample locations. These discrepancies and changes to the original SAPs were documented through memoranda to file. The results of the engineering surveys were documented in daily activity logs, and

when appropriate the changes were incorporated into the database at the Laboratory's Facility for Information Management, Analysis, and Display.

Environmental surveys and health and safety surveys were conducted at each PRS and usually consisted of walking surveys using field screening instruments to screen for radiation and organic compounds. These surveys were performed by the field team health and safety officer or radiation control technician with support from field team geologists, environmental scientists, and sampling technicians. Preliminary health and safety radiological surveys were conducted at each site using an Eberline ESP-1 beta/gamma meter with probe model HP-260 and the Ludlum Model 39 alpha meter. Radiation grid surveys were conducted using an Eberline ESP-1 beta/gamma meter with probe model HP-260 and the Ludlum Model 39 alpha meter following the grid pattern specified in the SAP or by the engineering survey. If warranted by the topography of a specific site, environmental surveys were also conducted in erosion cuts or outfalls to complement the data collected using grid patterns. Some SAPs required that environmental survey results be used to select sample locations for biased sampling at a specific PRS. In those cases, the sample sites were located, staked, mapped, and documented in daily activity logs. Information obtained as a result of the engineering and environmental surveys allowed for directed sampling, when appropriate.

As described in the work plan (LANL 1992, 7666), judgmental sampling combined with search sampling was used as the primary method for determining the quantity and location of samples. Judgmental sampling is the subjective selection of sample locations based on professional knowledge of contaminant behavior in the media being sampled. Search sampling is the selection of strategic sampling locations based on archival information and the results of surveys that indicate where potential contamination may be located.

The following LANL-ER-SOPs were followed during sampling activities.

- Surface soil samples were collected from the ground surface to a depth of 6 in. using a stainless steel scoop in accordance with LANL-ER-SOP-6.09, "Spade and Scoop Method for Collection of Soil Samples."

- Subsurface soil samples were collected from 1-ft intervals of 3-in.-diameter cores using either hand augers for near-surface samples in accordance with LANL-ER-SOP-6.10, "Hand Auger and Thin-Wall Tube Sampler," or hollow-stem augers with split-spoon core barrels for sample recovery using a drill rig in accordance with LANL-ER-SOP-6.24, "Sample Collection from Split-Spoon Samplers and Shelby Tube Samplers."

Chapter 5 of this RFI report describes in detail the specific field activities performed for each PRS.

2.0 ENVIRONMENTAL SETTING

The environmental setting of the Laboratory is described in Section 2.4 of the *Installation Work Plan for Environmental Restoration Program* (IWP) (LANL 1995, 52009). A detailed discussion of the environmental setting of Technical Area (TA) -35, including climate, geology, hydrology, and a conceptual hydrogeologic model for the area and its surroundings, is presented in the *RFI Work Plan for Operable Unit 1129* (LANL 1992, 7666). A summary is presented in the following sections.

TA-35 is located off Pajarito Road in the north-central part of the Laboratory. It is situated on a finger-like mesa known as Ten Site Mesa, which is bounded by Mortandad Canyon to the north and east and Ten Site Canyon, a branch of Mortandad Canyon, to the south. The elevation of TA-35 is approximately 7,200 ft above sea level.

2.1 Climate

Bowen (1990, 6899) has compiled and interpreted climatological data for the Los Alamos area. This information is summarized below.

Los Alamos County has a semiarid, temperate, mountain climate typical of the northern New Mexico area. Summers are generally sunny with moderate, warm days and cool nights. Maximum daily temperatures usually do not exceed 90°F. High altitude, light winds, clear skies, and dry atmosphere allow summer temperatures to range from 50°F to 95°F in the TA-35 area. During the winter, temperatures typically range from 15°F to 50°F. However, winter temperatures occasionally drop to 0°F or below.

The average annual rainfall in the TA-35 area is about 16 in. In a typical year, approximately 40% of the annual precipitation occurs during intense thunderstorms in July and August. Winter precipitation falls primarily as snow, with accumulations of about 51 in. annually. Snowfall is common in the TA-35 area, and accumulations exceeding 4 in. are not unusual. Individual snowfalls can occasionally exceed 12 in. and can be associated with frigid air and strong winds. Stream flow in canyons can occur as a result of summer thunderstorms and spring snowmelt runoff.

Winds are usually light and blow predominantly from the southwest to the northeast. However, strong winds are common in early spring, and winds can gust to more than 60 mph. Strong dust devils can develop on the mesa tops during the summer and can cause brief gusts of 75 mph or greater in the immediate area of the dust devils. Strong winds can also occur during summer thunderstorms and winter snowstorms.

2.2 Geology

2.2.1 Geologic Setting

A detailed discussion of the geology of the entire Los Alamos area can be found in Chapter 2 of the *RFI Work Plan for Operable Unit 1129* (LANL 1992, 7666) and in Section 2.5.1 of the IWP (LANL 1995, 52009). A summary of that material, emphasizing the conditions expected near TA-35, is presented below.

Figure 2.2.1-1 depicts a generalized stratigraphic cross section of the geologic units described in this section.

2.2.1.1 Stratigraphy

TA-35 is located on the Pajarito Plateau, which is a large volcanic feature composed of a series of deep east-west trending canyons and finger-like mesas on the western flanks of the Española Basin in the Rio Grande rift, a major tectonic feature of western North America. The Pajarito Plateau was formed by a massive outpouring of volcanic ash and tuffs from the Jemez volcanic field to the area immediately west of the plateau. The Jemez

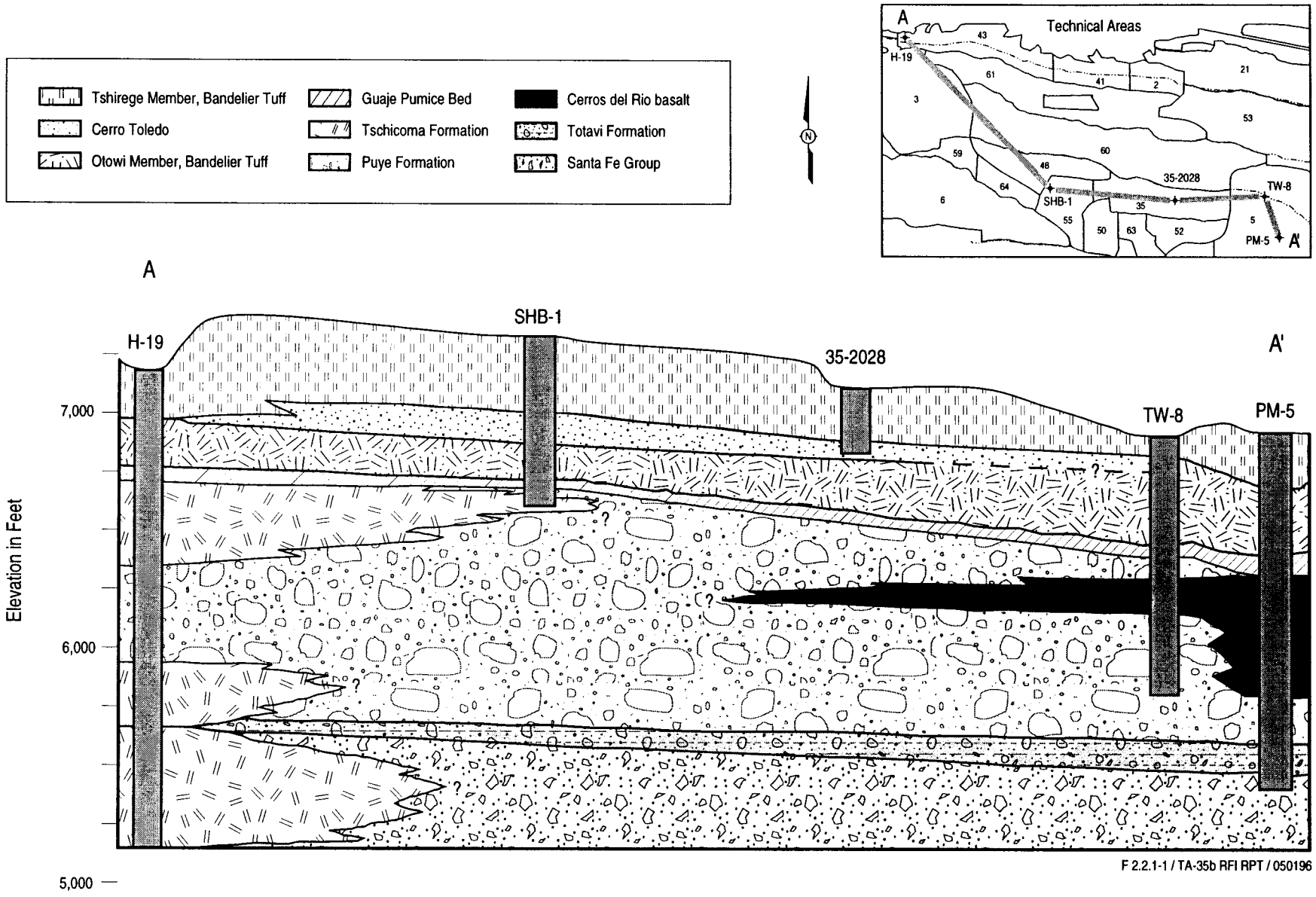


Figure 2.2.1-1. Generalized stratigraphy of TA-35.

volcanic field has been active for the last 13 million years (Myr), and the latest volcanic activity is estimated to have occurred about 60,000 years ago (Wolff and Gardner 1995, 48821).

The thicknesses of the stratigraphic units described below are derived from a constructed cross section, which was created from geologic logs from the following five borings: water supply well PM-5, located on the Mesita del Buey east of TA-35; test well TW-8, located in Mortandad Canyon; core hole SHB-1, located in TA-55; test hole H-19, located in Los Alamos Canyon near the Diamond Drive bridge; and the borehole drilled at PRS No. 35-003(r) (Location ID No. 35-2028). The stratigraphic units in PM-5, TW-8, and H-19 are described by Purtymun (1995, 45344). The stratigraphic units in SHB-1 are described by Gardner et al. (1993, 12582).

2.2.1.1.1 Bandelier Tuff

The Pajarito Plateau in the TA-35 area is capped by the Tshirege Member of the Bandelier Tuff. This unit is composed of crystal-rich ash-flow tuffs that were formed by multiple eruptions of the Valles Caldera in the Jemez Mountains about 1.22 Myr ago (Izett and Obradovich 1994, 48817). This unit is approximately 300 ft thick in the TA-35 area. The Tshirege Member is subdivided into four mappable cooling units. The area of TA-35 that is located on the mesa top lies on cooling unit 3 (Qbt3), a poorly welded cliff-forming tuff that forms the surface of the Mesita del Buey. The eastern part of TA-35, which is located on the canyon slope, lies on the uppermost, nonwelded section of cooling unit 2 (Qbt2) (Vaniman and Wohletz 1993, 48822).

Underlying the Tshirege Member is the Otowi Member of the Bandelier Tuff. The Otowi Member is composed of multiple flow units of soft, unwelded ash-flow tuffs that were formed by eruptions about 1.61 Myr ago (Izett and Obradovich 1994, 48817). This unit is approximately 210 ft thick in the TA-35 area.

At the base of the Otowi Member is the Guaje pumice bed. It is an ashfall of pumice with some water-laid or surge-bed pumiceous tuff that rests unconformably on older rocks (Purtymun 1995, 45344).

2.2.1.1.2 Cerro Toledo Rhyolite and Interbedded Sediments

An interbedded sequence of rhyolitic tuffs and sediments commonly occurs between the Otowi and Tshirege Members of the Bandelier Tuff. The rhyolitic tuffs were formed between 1.2 and 1.5 Myr ago, predominantly by eruptions from the Cerro Toledo domes in the northeastern Jemez Mountains (Heiken et al. 1986, 48638). The sediments are epiclastic sands and sandy gravels that lithologically resemble the fanglomerates of the Puye Formation, discussed in Section 2.2.1.1.4. A hollow-stem auger boring (Location ID No. 35-2028) that was drilled as part of this investigation encountered 77 ft of Cerro Toledo rocks.

2.2.1.1.3 Cerros del Rio Basalts

Basaltic flows, breccias, and scoria of the Cerros del Rio occur in the subsurface beneath much of the Pajarito Plateau (Dransfield and Gardner 1985, 6612), and nearby deep boreholes suggest that they are present beneath TA-35. These rocks have been dated at 2.0 to 4.6 Myr old (Gardner et al. 1986, 21527).

2.2.1.1.4 Puye Formation

Underlying the Bandelier Tuff is the Puye Formation (Turbeville et al. 1989, 21587), a volcanogenic alluvial fan sequence, which was formed by erosion of the Tschicoma volcanic center to the west. The Puye Formation was deposited between 1.9 and 3.5 Myr ago (Pliocene to Pleistocene age). Deep wells near the TA-35 area indicate that the Puye Formation is interstratified with basalt flows from the Cerros del Rio volcanic center. The thickness of the Puye Formation at TA-35 has not been determined; however, nearby deep wells indicate an overall thickness of as much as 1,000 ft.

2.2.1.1.5 Totavi Formation

The Totavi Formation (Turbeville et al. 1989, 21587) (formerly the Totavi Lentil) interfingers with the Puye Formation in the TA-35 area, thickening and possibly replacing the Puye Formation to the east. The Totavi Formation is a coarse, poorly consolidated conglomerate composed of granitic and metamorphic cobbles with an arkosic matrix. This formation wasprobably deposited between 2.5 and 3.5 Myr ago. A deep water supply well (PM-5) near TA-35 indicates that the Totavi Formation is 60 to 80 ft thick in the TA-35 area.

2.2.1.1.6 Tschicoma Formation

The Tschicoma Formation consists of a sequence of dacitic domes and lavas that erupted from vents in the central to northeastern Jemez Mountains between 3 and 7 Myr ago (Gardner et al. 1986, 21527). These rocks crop out extensively in the mountains west of TA-35, and some may be present in the subsurface near TA-35.

2.2.1.1.7 Santa Fe Group

Below the Totavi Formation are the formations of the Santa Fe Group (Galusha and Blick 1971, 21526), which were deposited during the Miocene and early Pliocene Age. The rocks of the Santa Fe Group are a thick series of terrestrial conglomerates, sandstones, and mudstones with minor limestones, evaporites, volcanic tuffs, and intercalated basalts. In the Los Alamos area, the Santa Fe Group is divided into the Chaquehi Formation, the Chamita Formation, and the Tesuque Formation. The Chaquehi Formation and the Chamita Formation have been dated at 4.5 to 6 Myr old, and the Tesuque Formation is estimated to be 7 to 21 Myr old. The total thickness of the Santa Fe Group in the area of TA-35 has not been determined.

2.2.1.2 Geological Structure

The Pajarito Plateau dips gently several degrees to the east and southeast. Most of the stratigraphic units that comprise the plateau reflect this gentle regional dip.

The plateau is bounded on the west by the Pajarito fault system, which also describes the western boundary of the Española basin referred to above. The Pajarito fault system consists of three active, or potentially active, fault segments: the Frijoles Canyon, Rendija Canyon, and Guaje Mountain segments. The Guaje Mountain segment is projected through TA-35 and is located immediately west of building 35-002 (Vaniman and Wohletz 1993, 48822). Although little or no vertical offset has been documented in the TA-35 area, the fault system is often expressed as an area of increased fracturing of the Bandelier Tuff.

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, 52009). A summary of that material specific to TA-35 is presented below.

A large variety of soils has developed on the Pajarito Plateau because of interactions among the underlying bedrock, the slope of the area, and the climate (Nyhan et al. 1978, 5702). The mineral components of the soil are primarily derived from the Bandelier Tuff, with some contribution from Tschicoma Formation rocks and from younger pumice eruptions from the Jemez Mountains. Windblown sediments from other areas in northern New Mexico may also contribute to the soil composition. Mesa-top soils in the TA-35 area are generally poorly developed because of the arid climate.

The predominant soils at TA-35, as described by Nyhan et al. (1978, 5702), are the Hackroy sandy loam, the Tocal very fine sandy loam, the Totavi gravelly loamy sand, and a small amount of the Carjo loam. The Hackroy soils consist of very shallow to shallow, well-drained soils that formed from material weathered from tuff on the mesa tops. Hackroy soil thickness ranges from 8 to 20 in. The Tocal series is similar to Hackroy soils and

consists of shallow, well-drained soils that formed from weathered tuff on slightly sloping mesa tops. Soil thickness ranges from 8 to 20 in. The Totavi soils consist of deep, well-drained soils that formed in the alluvium on the canyon floor. The thickness of Totavi soils is 60 in. (5 ft) or greater. The Carjo series is described as moderately deep, well-drained soils that formed from weathered tuff on slightly sloping mesa tops. Soil thickness ranges from 20 to 40 in.

No geomorphological surveys to determine the rate of soil accumulation have been conducted in the TA-35 area.

The soils over most of the mesa-top area of TA-35 have been disturbed and reworked by construction and road building. Much of the eastern portion of the mesa top has been leveled by adding large quantities of fill material, which ranges from 1 to 30 ft thick.

2.3 Hydrology

The hydrology of the Pajarito Plateau is summarized in Section 2.5.2 of the IWP (LANL 1995, 52009). Site-specific conditions are summarized below.

2.3.1 Surface Water

Surface waters drain generally eastward from the Jemez Mountains, across San Ildefonso Pueblo land, and down to the Rio Grande. They continue draining south to the Cochiti Reservoir through White Rock Canyon.

The surface water runoff from TA-35 flows directly into Mortandad Canyon (immediately north of TA-35), into Ten Site Canyon (immediately south of TA-35), and into a small tributary canyon informally known as Pratt Canyon (to the east of TA-35). Runoff occurs in drainage rills found on the mesa top and in the larger drainage gullies that are characteristic of the canyon walls. No perennial springs are present in Mortandad Canyon. However, perennial water flow is present in Mortandad Canyon; its source is storm water outfalls from Pajarito Road and outfalls from Laboratory facilities west of TA-35, which also flow into Mortandad Canyon (See Figure 2.3.1-1).

2.3.2 Ground Water

Ground water occurs under saturated conditions in the following three water-bearing zones in the Los Alamos area: shallow stream-associated alluvium in the canyons, perched water underlying the alluvium, and the main aquifer of the Los Alamos area.

The northern boundary of TA-35 includes the canyon floor and the associated intermittent stream in Mortandad Canyon. Four shallow observation and monitoring wells (MCO-3, MCM-3A, MCM-3B, and MCM-3.9) are present in the canyon floor within the TA-35 boundary. These wells indicate the presence of a shallow alluvial aquifer in the canyon floor. None of the potential release sites (PRSs) associated with TA-35 extend into the floor of Mortandad Canyon. The southern boundary of TA-35 includes the canyon floor in Ten Site Canyon. No wells are present in this part of Ten Site Canyon, and the presence of a shallow alluvial aquifer is unknown.

Studies performed near TA-35 have not indicated the presence of any other shallow or perched aquifers (Devaurs and Purtymun 1985, 7415); therefore, the saturated zone under the PRSs at TA-35 appears to be restricted to the deep main aquifer. Based on water level elevations in nearby wells TW-8 and PM-5, the top of the main aquifer at TA-35 is located in the lower Puye Formation about 950 ft beneath the surface. No evidence exists to indicate any direct interconnection between surface waters and the main aquifer in the TA-35 area.

Ground water in the main aquifer flows eastward toward the Rio Grande. The hydraulic gradient in the area of TA-35 is 60 to 80 ft per mile, and the rate of movement varies from 20 ft per year to more than 300 ft per year, depending on the permeability of the Puye Formation and the underlying Santa Fe Group rocks.

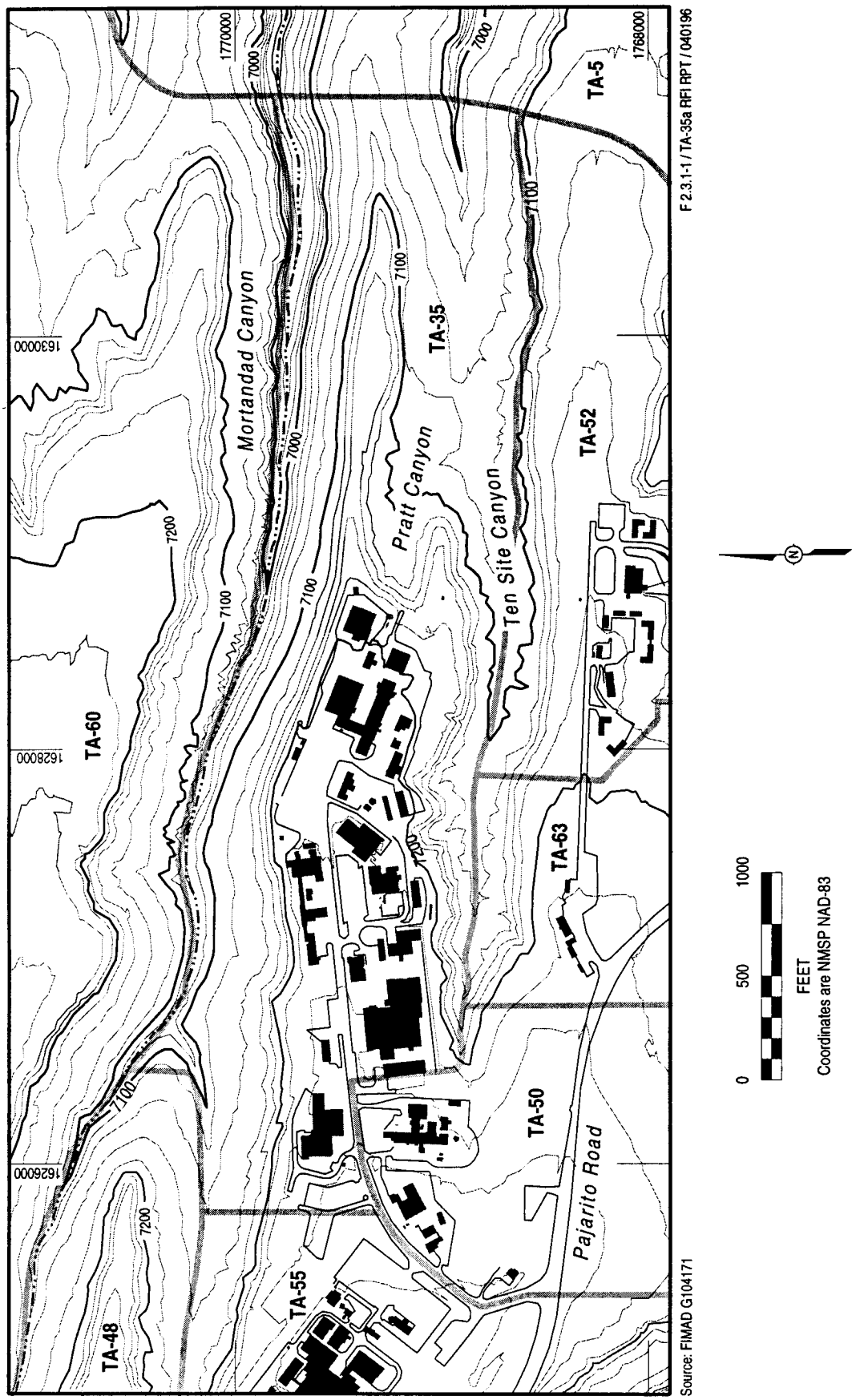


Figure 2.3.1-1. Topography of TA-35.

2.3.3 Vadose Zone

TA-35 overlies approximately 950 ft of unsaturated volcanic tuff, sediments, and basalts of the geologic formations discussed in Section 2.2.1.1. Studies of the moisture content of the Bandelier Tuff have not been conducted at TA-35; however, no shallow perched aquifers are known to be present beneath TA-35. The moisture content of the Tshirege Member of the Bandelier Tuff is expected to decrease dramatically with depth, so that the tuff is essentially dry a few tens of feet beneath the ground surface. Fractures in the tuff associated with the fault zones described above may allow moisture to penetrate locally somewhat deeper into the tuff, which allows higher moisture content in the more porous zones at depth.

2.4 Biological Surveys

Surveys to identify floodplains/wetlands and the presence of sensitive species or habitats in the vicinity of the sites discussed in this report were conducted during August and October 1991 (Dunham 1992, 31276). Critical habitat for the spotted bat (*Euderma maculatum*) was found in the area, but no specimens have been reported by the Laboratory. The area also includes wetlands and floodplains that could be impacted if contaminants are transported beyond PRS boundaries.

Each PRS was also evaluated to determine the potential for ecological receptors to be exposed to any chemicals of potential concern (COPCs) associated with the site. The assessment assigns scores that indicate overall landscape conditions at the site and site-specific conditions that influence the accessibility of any COPCs to ecological receptors. Results of the evaluation are provided in Table 2.4-1.

TABLE 2.4-1

SUMMARY OF SCREENING ASSESSMENT TO CATEGORIZE LANDSCAPE CONDITION AND RECEPTOR ACCESS POTENTIAL TO COPCS AT EACH PRS

RFI Report Section	PRS No.	Landscape Condition [a]	Receptor Access [b]	Description
5.1	35-003(e)	1	2	Has undergone D&D; wastewater treatment plant storage tank
5.1	35-003(f)	1	2	Has undergone D&D; wastewater treatment plant flocculation tank
5.1	35-003(g)	1	2	Has undergone D&D; wastewater treatment plant regenerant tank
5.1	35-003(m)	1	2	Has undergone D&D; wastewater treatment plant sludge tank
5.1	35-003(o)	1	2	Has undergone D&D; wastewater treatment plant manhole
5.2	35-003(d)	2	3	Has undergone D&D; wastewater treatment plant holding tank building
5.2	35-003(l)	2	3	Has undergone D&D; wastewater treatment plant surge tank
5.2	35-003(q)	2	3	Has undergone D&D; wastewater treatment plant pipe trench
5.3	35-003(r)	3	3	Inactive; wastewater treatment plant receiving canyon
5.4	35-016(g)	2	3	Active NPDES-permitted outfall
5.5	35-016(h)	2	3	Active storm drains

a. 1 = heavily disturbed/developed, 2 = moderately disturbed, 3 = lightly disturbed or not disturbed
b. 0 = no potential for receptor access to COPCs or for COPC transport, 1 = low potential for access or transport, 2 = moderate potential for access or transpo
3 = high potential for access or transport

3.0 APPROACH TO DATA ASSESSMENT AND ANALYSES

The objective of the Technical Area (TA) -35 Phase I Resource Conservation and Recovery Act facility investigation (RFI) is to determine if any chemicals of potential concern (COPCs) are present at a potential release site (PRS) decision set. The Phase I decision criteria may be qualitatively stated as follows. If no COPCs are identified at a PRS decision set as a result of a human health risk screening assessment, and if the quality of the data set is adequate, then no further action (NFA) will be proposed. If any COPCs are determined to be present, the PRS decision set will be considered for either accelerated remedial action, interim action, or further investigation based on the criteria used in the draft document *Risk-Based Corrective Action Process* (Environmental Restoration Decision Support Council 1996, 53751).

The decision approach used to meet the Phase I objective involves a series of qualitative and quantitative steps that occur after the field investigation, sample analysis, and data reporting steps have been completed. Sample analyses and the analytical methods employed are discussed in Sections 3.1 and 3.1.1, respectively. Before assembling the data set for a PRS decision set, analytical data are verified and validated according to the procedures described in Section 3.1.2. The verified and validated data set then undergoes a data quality assessment process, which begins with an exploratory data analysis. The exploratory data analysis facilitates the identification of suspect results that may require focused validation. The focused validation process is described in Section 3.1.2.

Following exploratory data analysis, site data are compared with the appropriate site-specific background data for trace metals, as described in Section 3.2. Organic constituents are evaluated separately according to the criteria discussed in Section 3.3. A human health risk screening assessment is then performed to determine if COPCs are present, following the procedure outlined in Section 3.4. An ecological assessment is performed by evaluating the potential for ecological receptors to be exposed to COPCs associated with the site (described in Section 3.5).

If no COPCs are identified during the screening assessment, the sufficiency of the data set to support an NFA decision is determined by examining certain attributes of the data for the decision set. For example, the sensitivity, bias, and precision of the analytical methods used should be adequate to detect COPCs at levels of concern and to accurately identify COPCs. Samples should have been analyzed for the appropriate analyte suites to determine the presence or absence of likely contaminants at the site based on the existing information. The degree of spatial characterization must be sufficient to support conclusions based on the data set. The assessment of the adequacy of the data set for decision-making purposes is a subjective process that requires the professional judgment of an interdisciplinary team comprising human health and ecological risk assessors, statisticians, geologists, biologists, and chemists. Other considerations in the decision-making process may include the site-specific land use scenario, potential pathways for contaminant migration, the involvement of regulatory authorities such as the New Mexico Environment Department, or regulatory guidelines such as the Toxic Substances Control Act or underground storage tank regulations.

3.1 Sample Analyses

All samples requiring chemical and radiological analyses were collected and handled following Environmental Restoration (ER) Project chain-of-custody protocols described in the standard operating procedure LANL-ER-SOP-01.04. Samples collected as part of this RFI were submitted to the Sample Management Office for shipment to a fixed-site laboratory facility or were submitted directly to an on-site mobile laboratory facility.

3.1.1 Analytical Methods

Table 3.1.1-1 summarizes the analytical methods employed by the fixed-site and mobile laboratory facilities for the organic, inorganic, and radiological analytical suites. The analytical protocols employed by the internal fixed-site laboratories are described in the Laboratory health and environmental chemistry manual (LANL 1993, 31794) and are based on Environmental Protection Agency (EPA) SW-846 methods for organic and inorganic

analyses. Analyses performed by external subcontractor laboratories follow the EPA SW-846 methods (or the equivalent EPA Contract Laboratory Program statements of work) for organic (EPA 1986, 31733) and inorganic (EPA 1986, 31732) analyses. The requirements for analyses performed by the external laboratories are described in the ER Project statement of work for analytical services (LANL 1995, 49738).

The analytical protocols employed for the radiological analyses were either Laboratory internal protocols (LANL 1993, 31794) or external protocols that have much in common with the Laboratory radiochemistry methods. The radiochemistry procedures will vary somewhat from laboratory to laboratory because of the lack of promulgated radiological protocols.

The analytical methods employed in the mobile laboratory facilities were modifications of the methods used by the laboratories at Los Alamos National Laboratory. Further details about the analytical procedures are given in Chapter 4.0 of this RFI report. On-site gamma spectroscopy measurements were performed by a Laboratory-operated mobile laboratory facility.

3.1.2 Data Validation

Before performing a screening assessment for a PRS or PRS aggregate, the data set underwent verification and routine validation procedures. Data verification and validation procedures are used to determine whether analytical data packages have been generated according to specifications, are of known quality, and contain the information necessary to determine data sufficiency for decision making. The data verification procedure checked that

- analytical results had been received for all samples submitted for analysis,
- the correct analysis had been performed for each sample,

TABLE 3.1.1-1

ANALYTICAL METHODS

Analyte Suite	Analytical Method	
	Fixed-Site Laboratory	Mobile Laboratory
Inorganic Constituents		
Trace metals	ICPES, GFAA, ICPMS	EDXRF
Organic Constituents		
Polychlorinated biphenyl compounds	GC/ECD	GC/ECD
Polycyclic aromatic compounds	N/A	GC/FID
Semivolatile organic compounds	GC/MS	GC/MS
Total petroleum hydrocarbons	GC/FID	N/A
Volatile organic compounds	GC/MS	GC/MS
Radionuclide Constituents		
^{3}H	Liquid scintillation	N/A
^{238}Pu, $^{239,240}Pu$	Alpha spectrometry	N/A
^{234}U, ^{235}U, ^{238}U	Alpha spectrometry	N/A
Gamma spectroscopy analytes	Gamma spectroscopy	Gamma spectroscopy
Gross-alpha	GPC	GPC
Gross-beta	GPC	GPC
Gross-gamma	NaI(Tl) or HPGe detection	NaI(Tl) or HPGe detection

- the analytical data had been reported correctly, and
- all analytical data had been correctly transmitted to the Facility for Information Management, Analysis, and Display.

Appropriate corrective actions were initiated to obtain missing analytical data and to correct errors in the data reporting.

The routine data validation process involved the comparison of quality indicators with clearly defined criteria or limits. Quality indicators such as surrogate recoveries, method blank measurements, holding times, and the differences between duplicate measurements were evaluated following EPA guidelines for inorganic data review (EPA 1994, 48639) and organic data review (EPA 1994, 48640), where applicable. Radiochemistry data were validated according to the acceptance criteria defined in the ER Project statement of work for analytical services (LANL 1995, 49738). During the validation process, data that did not meet quality criteria were designated by qualifier flags. Qualifiers resulting from the validation process are shown in the analytical data tables included in Chapter 5.0 of this RFI report. An explanation of the data qualifiers that appear in the data tables is given in Table 3.1.2-1.

As part of the data quality assessment process described in Section 3.0, focused data validation was performed when the data for a decision set contained an anomalous or outlying value that may have affected the screening assessment outcome. To determine the usability of the data, focused validation was also performed if a value that was qualified in the routine validation process was near or above an action level. In the focused validation process, the analytical data underwent varying levels of scrutiny, ranging from a check of the data reporting forms to an in-depth investigation of all the associated raw data in the data package. The results of required focused validation efforts are reported in Chapter 4.0 of this RFI report. Sample results may be further qualified as a result of focused validation.

3.1.3 Use of X-Ray Fluorescence Data

The use of the mobile laboratory facility x-ray fluorescence (XRF) data for inorganic chemicals follows the general procedures outlined in Sections 3.2 and 3.4.1. However, some modifications are required (particularly in making background comparisons) because XRF analyses do not produce results that are strictly comparable to the methods used in collecting Laboratory background data.

TABLE 3.1.2-1

EXPLANATION OF DATA QUALIFIERS USED IN THE DATA VALIDATION PROCEDURE

Qualifier	Explanation
U	The analyte was analyzed for but not detected. Reported value is the sample quantitation limit or detection limit.
J	The analyte was positively identified, and the associated numerical value is the approximate concentration of the analyte in the sample.
J+	Reported value is an estimate and likely biased high.
J–	Reported value is an estimate and likely biased low.
UJ	The analyte was analyzed for and was not detected. The reported value is an estimate of the sample quantitation limit or detection limit.
R	The sample results are rejected because of serious deficiencies in the ability to analyze the sample and meet quality control criteria; presence or absence cannot be verified.
S	The sample results were obtained using a screening analytical method performed in a mobile laboratory facility.

Longmire et al. (1995, 48818; 1995, 52227) have published upper tolerance limit (UTL) values for the Los Alamos area background soil concentrations for inorganic chemicals as measured by both partial digestion (primarily nitric acid) and total digestion (hydrofluoric acid) sample preparation and SW-846 analytical methods. The partial digestion data represent concentrations of elements localized in the surface coatings of soil and tuff particles, whereas the total digestion data also include the portion of these elements contained in the primary silicate minerals that comprise these particles.

Background soil concentrations measured by XRF are not available. However, the data published by Longmire et al. can be used to supplement XRF data collected during RFIs at TA-48 and TA-35 to permit UTL comparisons of all inorganic chemicals measured by XRF in this RFI. The XRF data are similar to the Longmire et al. total digestion data because XRF is sensitive to most or all of the quantity of an element present in silicate minerals (not just to that fraction that is soluble by nitric acid). Table 3.1.3-1 provides UTL values for partial and total digestion samples from Longmire et al. and XRF UTLs calculated using TA-48 and TA-35 data (as described below). The table shows that the percent difference among total digestion and XRF UTLs ranges from 0 to 27%, with an average of 10%, for the nine elements that have both UTLs (barium, calcium, chromium, copper, iron, lead, manganese, potassium, and zinc).

Because the total digestion and XRF UTL values are well correlated, total digestion UTLs published by Longmire et al. will be used as surrogates for XRF UTLs for those elements for which paired XRF data are either unavailable (thorium and uranium) or insufficient to calculate a statistic because they are mostly nondetects (antimony, arsenic, and nickel). Neither total digestion nor XRF UTLs are available for cadmium, mercury, and selenium. For these three elements, which frequently have background concentrations below the detection limits of the standard laboratory methods as well as XRF, it can safely be assumed that an XRF-detected value is above background.

TABLE 3.1.3-1

UTLs FOR INORGANIC ANALYTES AS MEASURED BY SW-846 METHODS AND XRF

Analyte	SW-846, Partial Digestion (mg/kg)	SW-846 Total Digestion (mg/kg)	XRF (mg/kg)
As	7.82	18.1	not calculated
Ba	315	766	561
Ca	6,120	11,900	10,900
Cd	2.7	N.A.	not calculated
Cr	19.3	45.8	45.1
Cu	15.5	16.7	16.7
Fe	21,300	31,600	27,400
Hg	0.1*	N.A.	not calculated
K	3,410	34,200	38,700
Mn	714	771	681
Ni	15.2	22.5	not calculated
Pb	23.3	35.2	28.4
Sb	1*	1.45	not calculated
Se	1.7	N.A.	not calculated
Th	14.6	22.1	N.A.
U	1.87	5.33	N.A.
Zn	50.8	72.4	76.6

* Based on maximum detected value rather than UTL when data are mostly nondetect. Background detection levels for antimony by SW-846 methods range up to 5 mg/kg.

RFIs at TA-48 and TA-35 include a total of 48 samples for which measurements were made by both XRF and SW-846 partial digestion analytical methods. Those paired samples for which the SW-846 measurement are below the ER Project's background UTLs (which is most or all of the paired samples for most analytes) provide a background XRF data set. In particular, for the nine analytes listed earlier for which at least one-third of these XRF results are reported above detection limits, these data can be used to estimate UTLs for the XRF method. These UTLs are shown in the "XRF" column of Table 3.1.3-1. In addition, these XRF background data can be used in two-sample statistical tests (see Attachment 1 of this RFI report, which shows data in box plots).

The computation of the XRF UTL for chromium is illustrated in Figure 3.1.3-1. Of the 48 paired chromium results, 44 have SW-846 results below the SW-846 UTL of 19.3 mg/kg, and 15 of these are reported above the detection limit by XRF. Figure 3.1.3-1 is a lognormal probability plot of the 44 XRF chromium results, including the 29 that are below the detection limit of 10 to 12 mg/kg. The positive upper tail, above 12 mg/kg, is well fit by a straight line, from which a (.95,.95) UTL is estimated at 45.1 mg/kg, very close to the UTL based on the total digestion Laboratory background data.

XRF data will also be used in the human health screening assessment. However, XRF data are biased high relative to standard SW-846 data (obtained using a partial digestion sample preparation technique). The partial digestion SW-846 method is taken as the standard for risk assessment data both because it is the EPA-recommended sample preparation and analysis methodology and because the partial digestion values are likely to correspond more closely to the sample fraction that is soluble in gastrointestinal and acidic intercellular fluids. The relative bias between the two methods at naturally occurring concentration levels is illustrated by the differences between the partial digestion UTLs and the XRF UTLs shown in Table 3.1.3-1. Any anthropogenic contamination, defined as contamination above the UTL value, is assumed to be soluble by partial digestion methods. This information may be used when evaluating human health risks associated with COPCs measured by XRF methods.

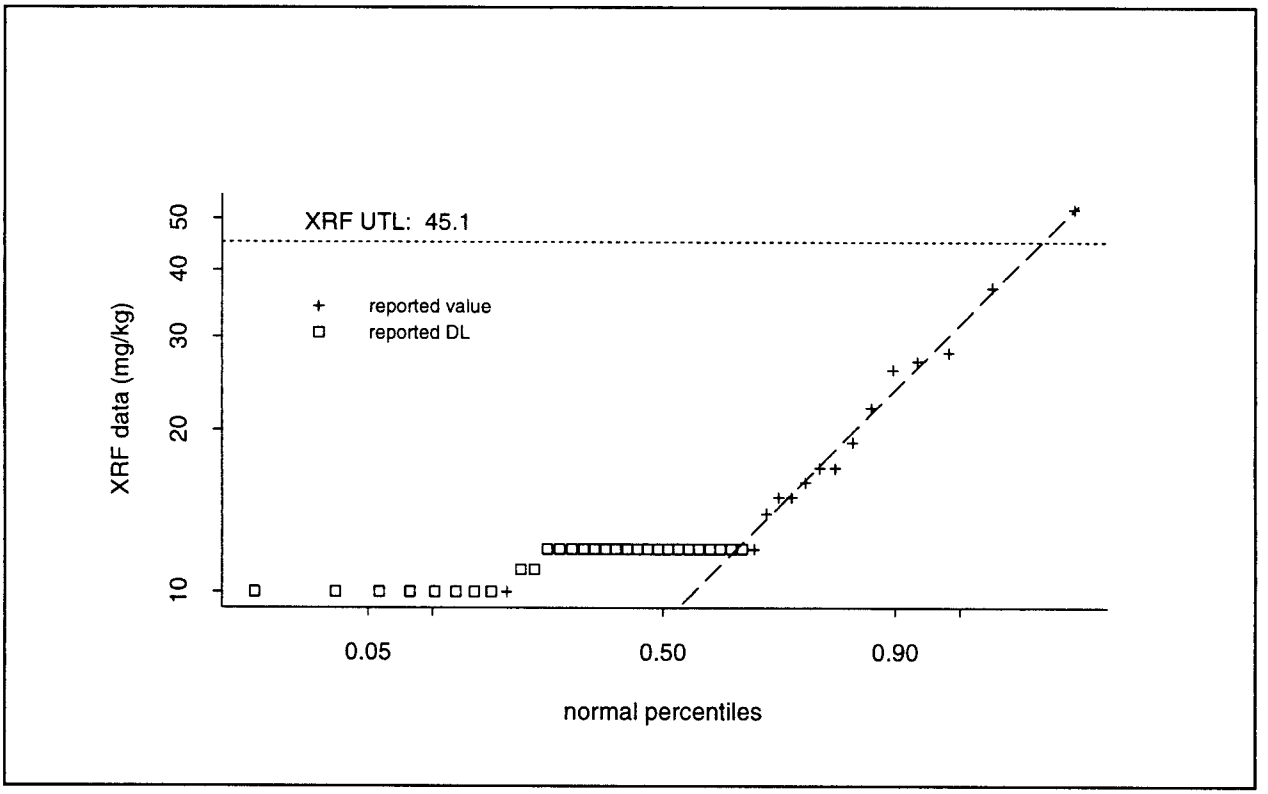


Figure 3.1.3-1. Lognormal probability plot of XRF chromium data for 44 background samples at TA-35 and TA-48.

3.2 Background Comparisons

After the data validation process is complete and the site data are finalized, the next step in the process is to compare site data with available background data. The results of a focused data validation should exclude from consideration for background comparison any contaminant that is identified as an artifact of an analytical laboratory or field contamination, analytical interference, or improper analyte identification or quantitation. The purpose of this decision step is to determine if chemicals for which natural or anthropogenic background distributions are available should be retained as COPCs or eliminated from further consideration. Background data used in this report were obtained from the following sources:

- soil samples collected throughout Los Alamos County for which chemical analyses were performed for certain inorganic chemicals (metals) and naturally occuring radionuclides (Longmire et al. 1995, 48818; Longmire et al. 1995, 52227);
- soil samples analyzed for anthropogenic radionuclides reported in the Laboratory's environmental surveillance reports (Purtymun et al. 1987, 6687; ESG 1988, 6877; ESG 1989, 6894; ESG 1990, 6995; Environmental Protection Group 1992, 7004); and
- soil samples collected during RFIs at TA-48 and TA-35 and analyzed by XRF, for which confirmatory SW-846 samples indicated that inorganic chemical concentrations were indicative of natural background.

Comparisons between site data and background data are initially performed by comparing each observed concentration datum with a UTL value estimated from the background data (calculated as the 95% upper confidence limit of the 95th percentile of the background distribution). Details of statistical methods used to generate UTL values from the background data sets and suggestions for statistical methods for comparing site and background concentration distributions are presented in the guidance document *Application of LANL Background Data to ER Project Decision-Making, Part I: Inorganics* (Ryti et al. 1996, 53953) and are also discussed in Attachment I of this RFI report. Because the surface of TA-35 has been disturbed and distinct soil horizons are not evident, the "all data" soil UTL is used for background comparisons of soil samples. When samples are collected from tuff, the UTL value for the specific tuff unit from which the sample was collected is specified.

Background comparisons for anthropogenic radionuclides associated with global fallout from atmospheric nuclear testing (^{137}Cs, ^{238}Pu, and ^{239}Pu) are performed only for PRS No. 35-003(r). This PRS is located in Pratt Canyon, and surface soils in the canyon are not believed to have been physically disturbed by Laboratory activities. Therefore, background concentrations of fallout radionuclides should be comparable to the undisturbed soils sampled for the environmental surveillance reports. Similar background comparisons are not appropriate for the mesa-top PRSs at TA-35 because the mesa has been extensively graded and backfilled during the latter half of this century when fallout radionuclides have impacted surface soils.

If a chemical has a reported concentration that exceeds its UTL value, then that chemical is carried forward to the screening assessment process. If a chemical does not have a reported concentration that exceeds the UTL value, then that chemical is removed from further consideration. Attachment I of this RFI report contains distribution plots for the XRF data for inorganic chemicals. The statistical test results are indicated next to the PRS table (see Figures AI-1 through AI-18). If a chemical has one or more measured values exceeding its UTL value but does not fail other statistical background comparison tests (that is, if the site concentration data are statistically greater than background data), it is generally removed from further consideration.

The ER Project has developed UTL values for the most commonly sampled chemicals and the most commonly analyzed media. For chemicals and/or media not included in the Longmire or Laboratory environmental surveillance reports, UTL values will be developed by the Decision Support Council as needed.

3.3 Evaluation of Organic Chemicals

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. The purpose of this decision step is to determine if organic chemicals should be retained as COPCs or eliminated from further consideration based on detection status. Detection status is determined by the analytical laboratory on a sample-by-sample, analyte-by-analyte basis. Estimated quantitation limit (EQL) values based on method performance have been established for each analyte as reporting limits when the analyte is not detected. It should be noted that the specific EQL values 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 value for a chemical, rather than the generic EQL, must be used in this comparison.

If a chemical is reported as detected, then that chemical is generally carried forward through the screening assessment process. If a chemical is not reported as detected in any sample analyses, then that chemical is generally removed from further consideration. Exceptions to these general rules may be made if site-specific process knowledge so indicates. A chemical that is detected may be removed from further consideration if it can be determined that its presence is not due to Laboratory operations. A chemical that is not detected in any sample may be carried through the decision process if the chemical can be expected to be present at the site based on historical operation and if sample data are limited.

3.4 Human Health Assessment

3.4.1 Screening Assessment

The data assessment process consists of sequential decisions that are used to determine if chemicals that may have been released to the environment as a result of historical Laboratory operations are present at levels that may be hazardous to human health. The decisions include the following.

- Can reported concentrations be attributed solely to positive analytical laboratory or field bias?
- Are site concentration data greater than background values?
- Is the maximum site concentration greater than the screening action level (SAL) value?

The purpose of the screening assessment is to determine if chemicals carried forward to this point in the data assessment process should be retained as COPCs or eliminated from further human health consideration based on comparison with SAL values. If COPCs remain after this step, then further action may be proposed. If no COPCs remain after this step, then NFA may be proposed based on human health concerns. SAL values are risk-based, medium-specific concentrations that are calculated using chemical-specific toxicity information and conservative, default exposure assumptions. A general description of the methods used to generate SAL values is provided in *Risk-Based Corrective Action Process* (Environmental Restoration Decision Support Council 1996, 53751). If a chemical does not have a reported concentration greater than its SAL value, then that chemical is generally removed from further consideration. If more than one chemical is present at the site, this decision is deferred pending the results of the multiple chemical evaluation (MCE) described below. The decision to identify a chemical as a COPC when a SAL value is not available is made on a case-by-case basis, taking into account the availability of process knowledge and toxicological information.

It is possible that COPCs for which no reported concentration exceeds the SAL value should be retained because of the combined adverse health effects of several chemicals. This possibility is evaluated in the MCE, in which the maximum reported concentration for each chemical at any site location is divided by its respective SAL value, and the resulting normalized values are incorporated into a simple additive model. If the sum of the normalized values (that is, the total normalized value) is less than one, then the chemicals are removed from

further consideration. If the total normalized value is greater than one, then chemicals having an individual normalized value greater than or equal to 0.1 are retained as COPCs pending further evaluation.

Only those chemicals that exceed background concentration thresholds (certain inorganic chemicals and radionuclides) or are detected (organic chemicals) in at least one sample, and whose highest value is below the SAL value, are included in the MCE. When background comparisons are performed for two or more geologic units or when multiple analytical methods are used to generate the data set, it is possible that the highest absolute value measured at a site may be below the UTL for that particular sample. In these cases, the highest detected concentration above the sample-specific UTL is used in the MCE calculation. If only one background UTL is identified for a data set, the highest measured value will always be used in the MCE if that value is above the UTL and below the SAL. If an inorganic chemical or radionuclide having no UTL is measured above detection limits, the highest value will also be used in the MCE calculation.

Chemicals are divided into three classes for the MCE calculation: noncarcinogens, chemical carcinogens, and radionuclides. Additive effects are assumed within each class, but each class is evaluated separately. For further information on the calculation of MCEs, see *Risk-Based Corrective Action Process* (Environmental Restoration Decision Support Council 1996, 53751).

3.4.2 Risk Assessment

The human health risk assessments presented in Chapter 5.0 of this RFI report follow the guidance document *Risk-Based Corrective Action Process* (Environmental Restoration Decision Support Council 1996, 53751). A quantitative human health risk assessment process generally consists of the following four steps:

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

Although COPCs were identified at several PRSs described in this RFI report, quantitative risk assessments have not been performed because additional data are required to define the nature and extent of contamination at these PRSs.

3.5 Ecological Assessment

An ecological risk assessment will be conducted when an approach has been approved by the regulators. Threatened and endangered species and sensitive habitats have been identified based on field surveys (see Section 2.4 in Chapter 2.0 of this RFI report). A qualitative habitat screening model was applied to each PRS to evaluate the potential for exposure to ecological receptors. The model evaluates potential ecological risk by ranking general landscape condition (development and disturbance) and the potential for receptors to access COPCs, as described in a draft policy paper (Environmental Restoration Decision Support Council 1996, 53751). The criteria for retaining COPCs as sources for the ecological risk assessment were that the media was soil (not tuff) collected from depths less than 5 ft and that COPCs were not eliminated by the background comparison.

4.0 RESULTS OF QUALITY ASSURANCE/QUALITY CONTROL ACTIVITIES

The objective of the Technical Area (TA) -35 Phase I Resource Conservation and Recovery Act facility investigation (RFI) is to determine if any chemicals of potential concern (COPCs) are present at a potential release site (PRS) decision unit. To meet this objective, the analytical methods that are summarized in Table 3.1.1-1 in Chapter 3.0 of this RFI report were applied. Quality control (QC) procedures were implemented in the analytical laboratory to provide estimates of the bias and precision of the analytical measurements. The following specific QC samples and procedures were used to assess bias: laboratory blank samples, system monitoring compound (surrogate) recovery, matrix spike recovery, and laboratory control samples (LCSs). The specific QC samples and procedures used to assess precision were laboratory duplicate samples and matrix spike duplicate samples. In addition, technical holding time criteria were applied to ensure that the analytical results were not biased because of sample degradation or loss.

QC samples were also collected in the field to provide information regarding sampling procedure bias. Field QC samples included the following: bottle blanks, equipment rinsate blanks, and trip blanks (for volatile organic compound [VOC] analysis only). The results of analysis of the field QC samples indicated that no bias or false positive results were introduced because of field sampling procedures.

In the following sections, estimates of the precision and bias of the main analyte suites are presented by evaluating the specific quality indicators listed above. The effectiveness of the analytical methods for detecting COPCs in soil matrices is also assessed. Potential limitations in the analytical data that may impact their intended use are noted. The results for individual samples were qualified by evaluation of the above listed QC parameters as described in Section 3.1.2 in Chapter 3.0 of this RFI report. Qualifiers resulting from the validation process are defined in Table 3.1.2-1 in Chapter 3.0 of this RFI report and are shown in the analytical tables in Chapter 5.0 of this RFI report. Details regarding the qualification of analytical results for individual samples are given in Appendix B of this RFI report.

4.1 Inorganic Analyses

Trace metals in soil samples collected at TA-35 were analyzed by either SW-846 methods (EPA 1986, 31732; EPA 1986, 31733) (or the Contract Laboratory Program equivalent) or energy dispersive x-ray fluorescence (XRF), as summarized in Table 4.1-1. The four SW-846 methods chosen were inductively coupled plasma emission spectroscopy (ICPES), inductively coupled plasma mass spectrometry (ICPMS), graphite furnace atomic absorption (GFAA), and cold vapor atomic absorption (CVAA). The XRF protocol chosen is described in the Laboratory internal method EI-732 (LANL 1993, 31794). All XRF analyses were carried out in a mobile laboratory facility. The SW-846 analyses were performed by either internal or external fixed-site laboratories. Technical holding times were met for all analyses.

TABLE 4.1-1

ANALYTICAL METHODS FOR TRACE METAL ANALYSIS

Analytical Protocol	Analytical Method	Analyte Suite
LANL EI-732	EDXRF	As, Ba, Ca, Cd, Cr, Cu, Fe, Hg, K, Mn, Ni, Pb, Sb, Se, Th, Ti, U, and Zn
SW-846 Method 6010	ICPES	Al, Sb, Ba, Be, Cd, Ca, Cr, Co, Cu, Fe, Li*, Mg, Mn, Mo*, Ni, K, Ag, Na, Sr*, V, and Zn
SW-846 Method 6020	ICPMS	Pb, Sb, and Tl
SW-846 Method 7000-series	GFAA	As, Pb, Se, and Tl
SW-846 Method 7470	CVAA	Hg

* Analyte reported by internal fixed-site laboratory only

Of the 354 soil samples collected at TA-35 that were analyzed for trace metals, 278 (79%) were analyzed by XRF; the remaining 76 (21%) were analyzed by SW-846 methods. To provide confirmation of the XRF results, 12% of the soil samples (34 of 278) that were analyzed by XRF were also submitted for SW-846 analysis. In the screening assessment of inorganic constituents, the SW-846 results are reported when results by both XRF and SW-846 methods are available.

4.1.1 Comparison of SW-846 and XRF Methods

The SW-846 methods employed for soil sample analysis require acid digestion of the sample before the instrumental analysis. Sample digestion was not required for the XRF method because of the nature of the physical phenomenon on which the measurement is based. The only sample preparation required for soils using the XRF method is drying followed by milling and sieving. Therefore, trace metal analysis of soils using this method is faster, less labor-intensive, and less expensive than using the SW-846 methods. For these reasons, the use of XRF for Phase I sample analysis was an attractive alternative to the SW-846 methods.

As discussed in Section 3.1.4 in Chapter 3.0 of this RFI report, analytical results obtained by both XRF and SW-846 methods are not directly comparable. The XRF results are generally significantly higher than SW-846 results, particularly for barium, calcium, chromium, copper, iron, lead, potassium, and zinc. The higher levels measured for certain analytes by XRF are a consequence of the penetrating nature of x-rays. Fluorescence is observed from soil matrix analytes, such as mineral crystals, as well as surface-adsorbed analytes. The acid digestion procedure used in sample preparation for SW-846 methods dissolves surface-adsorbed compounds but does not efficiently dissolve the mineral compounds that compose the soil matrix. Therefore, site-specific background levels determined using SW-846 methods of analysis cannot be compared with the XRF results. Rather, the XRF results are more nearly comparable to the "whole rock" background measurements obtained when the sample is completely digested using hydrofluoric acid.

The estimated detection limits (EDLs) for both SW-846 and XRF methods are compared with the analyte-specific upper tolerance limits (UTLs) and screening action levels (SALs) for soil samples in Table 4.1.1-1. For SW-846 methods, both the mixed soil and Qbt3 UTL values are given because soil samples collected at TA-35 were predominantly from one of these two background units. For the XRF method, the UTL value listed is that presented in Section 3.1.4 in Chapter 3.0 of this RFI report. For the XRF analytes arsenic, nickel, antimony, thorium, and uranium, the "whole rock" UTL value is used as a surrogate background level. As discussed in Section 3.1.4, the "whole rock" UTL value is based on the ICPES or GFAA analysis of samples that underwent complete digestion using hydrofluoric acid.

The target analyte list for the SW-846 methods, as implemented by the Environmental Restoration (ER) Project, differs from the analyte list for the XRF method. The following six analytes were not determined by XRF but were determined by ICPES or ICPMS: beryllium, cobalt, magnesium, silver, sodium, and thallium. The XRF technique is not sensitive to elements with an atomic number of 11 (sodium) or less; therefore, detecting beryllium or sodium by the XRF method is not possible.

The analytes thorium, titanium, and uranium were not determined by SW-846 but were determined by XRF. Isotopic uranium measurements were also performed by alpha spectrometry. Neither a SAL value nor a UTL background level has been established for titanium. The "whole rock" UTL value is used as a surrogate background level for thorium, but a SAL value is not available. The decision to identify a chemical as a COPC when a SAL value is not available is made on a case-by-case basis, taking into account the availability of process knowledge and toxicological information.

The SW-846 analyte EDLs are element-dependent and range from 0.1 mg/kg to 1,000 mg/kg. The XRF analyte EDLs are also element-dependent and generally greater than the corresponding SW-846 EDLs, ranging from 3 mg/kg to 100 mg/kg. The sensitivity of either method is sufficient to detect trace metals in soil samples at levels below the background UTLs for those constituents for which UTL values are available. XRF UTL values are not

TABLE 4.1.1-1

COMPARISON OF ESTIMATED DETECTION LIMITS WITH UPPER TOLERANCE LIMITS AND SCREENING ACTION LEVELS FOR INORGANIC ANALYTES

Analyte	SW-846 Method (mg/kg)			XRF Method (mg/kg)		Soil SAL (mg/kg)
	EDL	Mixed Soil UTL	Qbt3 UTL	EDL	XRF UTL	
Aluminum	40	38,700	3,700	NA	N/A	77,000
Antimony	12	1	0.4	4	1.45*	31
Arsenic	2.0	7.82	5	4	18.1*	N/A
Barium	40	315	28	10	561	5,300
Beryllium	1	1.95	1.53	NA	N/A	N/A
Cadmium	1	2.7	N.A.	3	N.A.	38
Calcium	1,000	6,120	1,520	100	10,900	N.A.
Chromium	2	19.3	2.1	12	45.1	210
Cobalt	10	19.2	27.4	NA	N/A	4,600
Copper	5	15.5	2	8	16.7	2,800
Iron	20	21,300	9,040	10	27,400	N.A.
Lead	0.2	23.3	16.2	7	28.4	400
Magnesium	1,000	4,610	628	NA	N/A	N.A.
Manganese	3	714	426	16	681	N/A
Mercury	0.1	0.1	N.A.	5	N.A.	23
Nickel	8	15.2	2.6	13	22.5*	1,500
Potassium	1,000	3,410	735	100	38,700	N.A.
Selenium	1.0	1.7	N.A.	4	N.A.	380
Silver	2	N.A.	1.9	NA	N/A	383
Sodium	1,000	915	1,940	NA	N/A	N.A.
Strontium	2	317	N.A.	NA	N/A	46,000
Thallium	2.0	1	1.7	NA	N/A	N.A.
Thorium	NA	14.6	9.29	8	22.1*	N.A.
Titanium	NA	N.A.	N.A.	30	N.A.	N.A.
Uranium	NA	1.87	1.64	8	5.33*	29
Vanadium	10	41.9	4.01	NA	N/A	540
Zinc	4	50.8	55.5	5	76.6	23,000

* "Whole rock" UTL used as a surrogate for XRF UTL. See Section 3.1.4 in Chapter 3.0 of this RFI report.

available for cadmium, mercury, or selenium; however, the XRF method can readily detect concentrations of these analytes well below their respective SAL values.

4.1.2 Evaluation of Quality Control Data for SW-846 Analyses

The accuracy of the SW-846 measurements was monitored by the concurrent analysis of aqueous and solid LCSs. Results for individual soil samples were qualified on the basis of the LCS that was analyzed in the same batch, according to the criteria given in the national functional guidelines for data review (EPA 1994, 48639).

The bias of the SW-846 measurements was assessed by the analysis of matrix spike samples. The results for 22 soil matrix spike samples (11 mercury spike samples) were reported with the TA-35 data set and are summarized in Table 4.1.2-1. The average recovery and the 1-sigma standard error indicate acceptable recovery with no apparent bias for all trace metal analytes that were spiked into soil matrices. The analytical results for individual samples were qualified according to Environmental Protection Agency (EPA) guidelines if the individual matrix spike recoveries indicated an unacceptable bias in the measurement of individual analytes.

The precision of the SW-846 measurements was assessed by the analysis of laboratory duplicate samples. The results for 24 laboratory duplicate soil samples were reported with the TA-35 data set. The relative percent differences (RPDs) for duplicate measurements of the target analytes are summarized in Table 4.1.2-2. The average RPD values do not exceed 26%, which indicates acceptable method precision. The EPA guidelines suggest a control criteria of ± 35% RPD for the assessment of duplicate sample results because laboratory variability arising from the subsampling of heterogeneous soil samples is a common occurrence. The analytical results for individual samples were qualified according EPA guidelines if duplicate sample analysis indicated precision control problems with the measurement.

TABLE 4.1.2-1

SW-846 RESULTS FOR MATRIX SPIKE SAMPLES

Analyte	Average Percent Recovery*
Arsenic	106 ± 12
Barium	102 ± 8
Beryllium	103 ± 19
Cadmium	99 ± 8
Chromium	113 ± 32
Cobalt	102 ± 4
Copper	99 ± 14
Mercury	86 ± 17
Potassium	97 ± 5
Manganese	105 ± 43
Nickel	108 ± 22
Lead	86 ± 21
Antimony	79 ± 18
Selenium	90 ± 23
Silver	98 ± 9
Thallium	99 ± 5
Vanadium	102 ± 6
Zinc	113 ± 23

* Average percent recovery and 1-sigma standard error are based on analysis of 22 soil matrix spike samples (11 mercury spike samples).

TABLE 4.1.2-2

SW-846 RESULTS FOR DUPLICATE SAMPLES

Analyte	Average Percent Difference*
Aluminum	16 ± 14
Arsenic	21 ± 18
Barium	14 ± 11
Beryllium	12 ± 13
Cadmium	24 ± 30
Calcium	14 ± 14
Chromium	23 ± 19
Cobalt	13 ± 16
Copper	26 ± 33
Iron	24 ± 41
Mercury	6 ± 9
Potassium	13 ± 12
Magnesium	16 ± 14
Manganese	17 ± 16
Sodium	12 ± 11
Nickel	22 ± 21
Lead	15 ± 12
Antimony	1 ± 2
Selenium	2 ± 10
Silver	23 ± 45
Thallium	9 ± 22
Vanadium	15 ± 11
Zinc	14 ± 9

* Average percent difference and 1-sigma standard error are based on analysis of 24 laboratory duplicate soil samples.

4.1.3 Evaluation of Quality Control Data for XRF Analyses

Initial calibration of the XRF instrument was accomplished using the following seven Canadian Certified Reference Material Program (CCRMP) and National Institute of Standards and Technology (NIST) standard reference materials (SRMs): CCRMP-SY-2, CCRMP-BL-4, and NIST-SRMs1648 (urban particulate); 2704 (Buffalo River sediment); 2709 (San Joaquin soil); 2710 (Montana soil); and 2711 (Montana soil). This number of calibration standards was required to bracket a reasonable range of concentrations for all the analytes. The accuracy of the XRF measurements was monitored daily by the analysis of at least one solid LCS sample with each analytical batch. The following CCRMP or NIST SRMs were used to check the instrument performance: CCRMP-SO-1, CCRMP-SO-2, CCRM-SO-4, CCRM-SY-3, and NIST-SRM-1646 (estuarine sediment).

The XRF results for the daily LCS measurements performed for the TA-35 RFI are summarized in Table 4.1.3-1. The average recovery and the 1-sigma standard error based on 26 measurements are presented. The results indicate that the instrument control status of cadmium, mercury, antimony, selenium, and uranium was not adequately monitored during sample measurement. Consequently, the XRF results for these analytes should be regarded as estimates, although the direction of any possible bias is unknown. The results for nickel indicate a low bias for this analyte. The results for the remaining analytes indicate no apparent or slightly high biases in the measurements.

TABLE 4.1.3-1

XRF RESULTS FOR SOLID LABORATORY CONTROL SAMPLES

Analyte	Average Percent Recovery*
Arsenic	108 ± 60
Barium	111 ± 11
Calcium	111 ± 29
Cadmium	<EDL
Chromium	102 ± 10
Copper	113 ± 29
Iron	105 ± 7
Mercury	<EDL
Potassium	97 ± 5
Manganese	106 ± 12
Nickel	74 ± 9
Lead	90 ± 16
Antimony	<EDL
Selenium	<EDL
Thorium	121 ± 24
Titanium	98 ± 7
Uranium	<EDL
Zinc	102 ± 7

* Average percent recovery and 1-sigma standard error are based on 26 measurements of laboratory control samples.

4.2 Organic Analyses

Soil samples collected at TA-35 were analyzed for VOCs, semivolatile organic compounds (SVOCs), polychlorinated biphenyl compounds (PCBs), polycyclic aromatic hydrocarbons (PAHs), and total petroleum hydrocarbons (TPH) using the methods described in Table 3.1.1-1 in Chapter 3.0 of this RFI report. Samples were analyzed at either internal or external fixed-site laboratories or at a mobile laboratory facility. In the following sections, which focus on the laboratory QC activities, the differences between the fixed-site and mobile laboratory methods are also discussed. The mobile laboratory methods generally used less effective extraction methods and abbreviated QC procedures to save time and costs. Consequently, the mobile laboratory sample results should be considered screening level data with a possible low bias (compared with SW-846 methods) and are qualified with an "S" flag in the tables in Chapter 5.0 of this RFI report. Samples collected at the PRSs evaluated in this RFI report were analyzed for VOCs, SVOCs, PCBs, and PAHs. No TPH analyses were performed.

4.2.1 Volatile Organic Compound Analysis

Soil samples were analyzed for VOCs at either fixed-site or mobile laboratory facilities. Sample analyses performed at fixed-site laboratories used either SW-846 Method 8260 or the Contract Laboratory Program OLM01.8 protocol to detect low-level contamination. Samples were extracted using the SW-5030 purge and trap method. The ER Project analytical services statement of work (LANL 1995, 49738) contains the detailed analyte lists, estimated quantitation limits (EQLs), required QC procedures, and the acceptance criteria for analyses performed by external laboratories. The required QC procedures for the analyses performed by the internal laboratory are described in the Laboratory health and environmental chemistry manual (LANL 1993, 31794). The required QC procedures are based on guidelines given in the EPA SW-846 laboratory manuals. The sample EQLs reported by the internal laboratory were not corrected for dry weight and therefore exhibited low bias. The EQLs for soil samples are less than the soil SALs for all VOC analytes.

Soil samples were analyzed in the mobile laboratory facility according to Laboratory Method No. MLO720, which is a modification of the SW-846 Method 8260 gas chromatography/mass spectrometry (GC/MS) procedure. Samples were extracted using the SW-5030 purge and trap method. Tier 1 QC procedures were implemented, where Tier 1 requirements consist of a daily 1-point calibration check and a daily method blank analysis. System performance was monitored by the addition of three surrogate compounds. Sample results were reported on a wet weight basis. The EQLs for this method are generally the same as for the fixed-site laboratory method.

Of the 173 VOC analyses requested for the TA-35 RFI, 128 samples (74%) were analyzed at the mobile laboratory facility and 45 samples (26%) at fixed-site laboratories. Of the samples analyzed at the mobile laboratory facility, 19 (15%) were also submitted for analysis to a fixed-site laboratory. If sample results are available by both fixed-site and mobile laboratory analysis, the higher result has been used for screening purposes.

Average surrogate recoveries for four surrogate compounds, which are reported in Table 4.2.1-1, indicate acceptable method accuracy for both the fixed-site and mobile laboratory measurements. Only two soil matrix spike and matrix spike duplicate pairs were analyzed for this RFI. The average recoveries of the five spike compounds, reported in Table 4.2.1-2, indicated acceptable method bias. The average relative percent differences between recoveries of all five spike compounds from the soil duplicate pairs did not exceed 14%, which indicates acceptable method precision.

For the PRSs evaluated in this RFI report, only 13 soil samples collected from PRS Nos. 35-016(g, h and l) were analyzed for VOCs. All VOC analyses were performed at the mobile laboratory facility; with one confirmatory sample submitted for fixed-site laboratory analyses. No target analytes were detected in any samples. The results for the method blank sample were not reported for the mobile laboratory measurements, but there is no impact on data usability because no target analytes were detected in the soil samples. Low internal standard areas were reported for two samples from PRS No. 35-016(h) (see Appendix B); therefore the sample EQLs should be regarded as estimated and biased low.

TABLE 4.2.1-1

RECOVERY OF VOLATILE ORGANIC SURROGATE COMPOUNDS FROM SOIL SAMPLES

Surrogate Compound	Average Percent Recovery	
	Fixed-Site Laboratory	Mobile Laboratory
4-Bromofluorobenzene	101 ± 17	107 ± 28
Dibromofluoromethane	104 ± 9	NA
1,2-Dichloroethane-d4	103 ± 14	116 ± 15
Toluene-d8	98 ± 7	101 ± 8

All technical holding times for analysis were met for the samples evaluated in this RFI report. No contamination above the EQL was detected in any of the trip blank samples.

4.2.2 Semivolatile Organic Compound Analysis

Soil samples were analyzed for SVOCs at either fixed-site or mobile laboratory facilities. Sample analyses performed at fixed-site laboratories used either SW-846 Method 8270 or the Contract Laboratory Program OLM01.8 protocol to detect low-level contamination. The ER Project analytical services statement of work (LANL 1995, 49738) contains the detailed analyte lists, EQLs, required QC procedures, and the acceptance criteria for analyses performed by external laboratories. The required QC procedures for the analyses performed by the internal laboratory are described in the Laboratory health and environmental chemistry manual (LANL 1993, 31794). The required QC procedures are based on guidelines given in the EPA SW-846 laboratory manuals. The sample EQLs reported by the internal laboratory were not corrected for dry weight and therefore exhibited low bias.

Seven SVOC analytes have soil EQLs for the fixed-site laboratory analysis (0.330 mg/kg) that are greater than the soil SAL: m-benzidine (0.0019 mg/kg), benzo[a]pyrene (0.061 mg/kg), bis(2-chloroethyl) ether (0.074 mg/kg), dibenzo[a,h]anthracene (0.061 mg/kg), hexachlorobenzene (0.280 mg/kg), N-nitrosodi-n-propylamine (0.063 mg/kg), and N-nitrosodimethylamine (0.0087 mg/kg). No standard, readily available method exists that could achieve EQLs as low as several parts per billion in soil for these compounds.

TABLE 4.2.1-2

RECOVERY OF VOLATILE ORGANIC MATRIX SPIKE COMPOUNDS FROM SOIL SAMPLES

Spike Compound	Average Percent Recovery	Average Relative Percent Difference*
Benzene	106 ± 11	12
Chlorobenzene	113 ± 12	6
1,1-Dichloroethane	87 ± 21	14
Toluene	124 ± 19	11
Trichloroethene	95 ± 2	2

* Relative percent difference is calculated based on the recovery of spike compound from matrix spike and matrix spike duplicate sample pair.

Soil samples were analyzed in the mobile laboratory facility according to Laboratory Method No. MLO500, which is a modification of the SW-846 Method 8270 GC/MS procedure. The samples were extracted into methylene chloride using rotary table agitation according to the procedure described in Laboratory Method No. MLO510. Tier 1 QC procedures were implemented, where Tier 1 requirements consist of a daily 1-point calibration check and a daily method blank analysis. System performance was monitored by the addition of surrogate compounds. Sample results were reported on a wet weight basis. A nominal EQL of 1.0 mg/kg is cited for this method. In addition to the seven SVOC analytes listed above, the soil EQL exceeds the SAL value for the following five compounds: benz[a]anthracene (0.610 mg/kg), benzo[b]fluoranthene (0.610 mg/kg), benzo[a]pyrene (0.061 mg/kg), indeno[1,2,3-cd]pyrene (0.610 mg/kg), and 3,3'-dichlorobenzidine (0.990 mg/kg).

Of the 420 SVOC analyses requested for the TA-35 RFI, 283 samples (67%) were analyzed at the mobile laboratory facility and 137 samples (33%) at fixed-site laboratories. Of the samples analyzed at the mobile laboratory facility, 33 (12%) were also submitted for analysis to a fixed-site laboratory. If sample results are available for both fixed-site and mobile laboratory analysis, the higher result has been used for screening purposes.

Average surrogate recoveries for six surrogate compounds (three base/neutral and three acid) are reported in Table 4.2.2-1 for both the fixed-site and mobile laboratory measurements. There are no significant differences in the surrogate recoveries between the two laboratories. The recovery of all six surrogates from soil matrices is biased low. However, either method was adequate for the detection and reliable quantitation at concentrations near or above the SAL of those compounds for which the EQL is less than the SAL.

Ten soil matrix spike and matrix spike duplicate pairs were analyzed for this RFI. The average recoveries of the 11 spike compounds, reported in Table 4.2.2-2, generally indicated the same low method bias seen in the surrogate recovery measurements. The average relative percent differences between recoveries of the 11 spike compounds from the soil duplicate pairs did not exceed 18%, which indicates acceptable method precision.

For the PRSs evaluated in this RFI report, only soil samples collected at PRS No. 35-003(d, e, f, g, l, m, o, q, and r) and 35-016(l) were analyzed for SVOCs: 117 samples at the mobile laboratory facility and 19 confirmatory samples at fixed-site laboratories. Laboratory-introduced phthalate contamination was a recurrent problem at the mobile laboratory facility. Phthalate contamination detected in soil samples analyzed in the mobile laboratory has been attributed to laboratory contamination, and the sample results have been qualified according to EPA guidelines (see Appendix B of this RFI report).

TABLE 4.2.2-1

RECOVERY OF SEMIVOLATILE ORGANIC SURROGATE COMPOUNDS FROM SOIL SAMPLES

Surrogate Compound	Average Percent Recovery	
	Fixed-Site Laboratory	Mobile Laboratory
Base/Neutral		
2-Fluorobiphenyl	73 ± 13	71 ± 14
Nitrobenzene-d5	67 ± 17	61 ± 15
Terphenyl-d14	77 ± 15	84 ± 15
Acid		
2-Fluorophenol	69 ± 17	55 ± 12
Phenol-d6	69 ± 15	61 ± 13
2,4,6-Tribromophenol	77 ± 15	77 ± 11

TABLE 4.2.2-2

RECOVERY OF SEMIVOLATILE ORGANIC MATRIX SPIKE COMPOUNDS FROM SOIL SAMPLES

Spike Compound	Average Percent Recovery	Average Relative Percent Difference*
Base/Neutral		
Acenaphthene	73 ± 16	11
1,4-Dichlorobenzene	63 ± 21	16
2,4-Dinitrotoluene	71 ± 12	10
N-Nitrosodi-n-propylamine	65 ± 13	17
Pyrene	84 ± 18	9
1,2,4-Trichlorobenzene	69 ± 20	13
Acid		
4-Chloro-3-methylphenol	84 ± 35	9
o-Chlorophenol	76 ± 32	17
4-Nitrophenol	78 ± 25	11
Pentachlorophenol	93 ± 30	10
Phenol	77 ± 36	18

* Relative percent difference is calculated based on the recovery of spike compound from matrix spike and matrix spike duplicate sample pair.

Extraction holding times were missed by one to three days for five sample delivery groups submitted to the mobile laboratory. Because the 14-day holding time was not grossly exceeded, the sample results have not been qualified.

4.2.3 Polychlorinated Biphenyl Compound Analysis

Soil samples were analyzed for PCBs at either fixed-site or mobile laboratory facilities. Sample analyses performed by external fixed-site laboratories used either the SW-8081 gas chromatography/electron capture detection (GC/ECD) method (dual column option) or the Contract Laboratory Program OLM01.8 protocol. The ER Project analytical services statement of work (LANL 1995, 49738) contains the detailed analyte lists, EQLs, required QC procedures, and the acceptance criteria for analyses performed by external laboratories. The statement of work requires analysis for Aroclors 1016, 1221, 1232, 1242, 1248, 1254, and 1260. The QC requirements include external calibration, monitoring of the recovery of either of two surrogate compounds (decachlorobiphenyl or tetrachloro-m-xylene), and second-column confirmation of any detected Aroclors. The required EQL is 0.033 mg/kg for soil samples, which is less than the soil SAL of 1 mg/kg for mixed PCBs.

Samples were analyzed by the internal laboratory using the Laboratory protocol EO-430 (LANL 1993, 31794), which is a single-column GC/ECD method. Internal calibration methods were used. Surrogate compounds were not added to the samples; therefore, no statement regarding the accuracy of the method can be made. Samples were analyzed for Aroclors 1242, 1254, and 1260. The method EQL is 0.050 mg/kg for soil samples, which is less than the soil SAL of 1 mg/kg for mixed PCBs. The sample EQLs reported by the internal laboratory were not corrected for dry weight and therefore exhibited low bias.

Soil samples were analyzed in the mobile laboratory facility according to Laboratory Method No. MLO410, which is a modification of the SW-846 Method 8081 GC/ECD (single column option) procedure. The samples were extracted into hexane using rotary table agitation according to the procedure described in Laboratory Method No. MLO510. Tier 1 QC procedures were implemented, where Tier 1 requirements consist of a daily

1-point calibration check and a daily method blank analysis. System performance was monitored by the addition of a surrogate compound (2,4,5-tribromobiphenyl), but surrogate recovery was not consistently monitored. Samples were analyzed for Aroclors 1242, 1254, and 1260. The soil EQL is 1 mg/kg, which is equivalent to the SAL value for mixed PCBs. Sample results were reported on a wet weight basis.

Of the 327 PCB analyses requested for the TA-35 RFI, 216 samples (66%) were analyzed by the mobile laboratory facility and 111 (34%) at fixed-site laboratories. Of the samples analyzed at the mobile laboratory facility, 18 (8%) were also submitted to a fixed-site laboratory for analysis. If sample results are available by both fixed-site and mobile laboratory analysis, the higher result has been used for screening purposes. The only PCBs that were detected at TA-35 were Aroclors 1254 and 1260. One sample delivery group from PRS No. 35-003(r), which was submitted to a fixed-site laboratory, was inadvertently also analyzed for pesticides using the SW-8081 method. Trace amounts of two pesticides were detected, and the results are reported in Chapter 5.0 of this RFI report.

Table 4.2.3-1 summarizes the average recovery of surrogate compounds by both external fixed-site and mobile laboratory facilities. In the fixed-site laboratory analyses, the recovery of tetrachloro-*m*-xylene exhibited a low, but acceptable, bias; the recovery of decachlorobiphenyl exhibited no apparent bias. The recovery of 2,4,5-tribromobiphenyl in the mobile laboratory analyses exhibited no apparent bias.

For the PRSs evaluated in this RFI report, only soil samples collected from PRS Nos. 35-003(d, e, f, g, l, m, o, q, and r) were analyzed for PCBs: 25 samples at the mobile laboratory facility and 107 samples at fixed-site laboratories (including 3 confirmatory samples). Extraction holding times were missed by one to two days for the sample delivery groups submitted to the mobile laboratory facility. The impact on data quality is minimal because no target analytes were detected in any of the effected samples.

4.2.4 Polycyclic Aromatic Hydrocarbon Analysis

To screen for the presence of SVOCs, 58 soil samples collected from PRS Nos. 35-004(b), 35-014(e1 and e2), 35-014(f), and 35-016(e, f, g, h, and l) were analyzed for PAH compounds at the mobile laboratory facility. The gas chromatography/flame ionization detector (GC/FID) method used is a modification of SW-846 Method 8100. The samples were extracted into methylene chloride using rotary table agitation according to the procedure described in Laboratory Method No. MLO510. Tier 1 QC procedures were implemented, where Tier 1 requirements consist of a daily 1-point calibration check and a daily method blank analysis. Sample results were reported on a wet weight basis.

The analyte list consisted of the 14 PAHs listed in Table 4.2.4-1. Benzo[b]fluoranthene and benzo[k]fluoranthene are not resolved. Dibenz[a,h]anthracene is not included as a target analyte. A nominal EQL of 0.1 mg/kg is cited for this method, which is less than the soil SALs for all the target analytes (for which SALs are available) except benzo[a]pyrene. Other extractable organic compounds present in the sample, but not identified as target analytes, are quantitated to an EQL of 5 mg/kg using the response factor for naphthalene and reported as "Total Extractable Organic Compounds."

TABLE 4.2.3-1

AVERAGE SURROGATE RECOVERIES FOR ANALYSIS OF POLYCHLORINATED BIPHENYL COMPOUNDS IN SOIL SAMPLES

Surrogate Compound	Average Percent Recovery	
	Fixed-Site Laboratory	Mobile Laboratory
Decachlorobiphenyl	99 ± 38	NA
Tetrachloro-*m*-xylene	77 ± 12	NA
2,4,5-Tribromobiphenyl	NA	104 ± 21

TABLE 4.2.4-1

ANALYTE LIST FOR POLYCYCLIC AROMATIC HYDROCARBON ANALYSIS USING MODIFIED SW-8100 METHOD

Analyte	EQL (mg/kg)	SAL (mg/kg)
Naphthalene	0.1	800
Acenaphthylene	0.1	N.A.
Acenaphthene	0.1	360
Fluorene	0.1	300
Phenanthrene	0.1	N.A.
Fluoranthene	0.1	2,600
Anthracene	0.1	19
Pyrene	0.1	2,000
Benzo[a]anthracene	0.1	0.61
Chrysene	0.1	24
Benzo[b]fluoranthene/Benzo[k]fluoranthene	0.1	0.61/6.1
Benzo[a]pyrene	0.1	0.061
Indeno[1,2,3-cd]pyrene	0.1	0.61
Benzo[g,h,i]perylene	0.1	N.A.

System performance was monitored by the addition of a surrogate compound, tetradecane. The average surrogate recovery was 89 ± 13%, which indicates acceptable method bias. In several of the samples, the surrogate recovery could not be determined because of the presence of petroleum hydrocarbon interferences.

Of the 58 soil samples analyzed in the mobile laboratory facility, target analytes were detected only in the sample collected at PRS No. 35-016(l). A large peak consistent with motor oil was also reported for this sample. Seven confirmatory samples (12%) were analyzed for full-site SVOCs at a fixed-site laboratory. PAHs were detected only in the confirmatory sample collected at PRS No. 35-016(l).

Analysis holding times were exceeded by 5 to 18 days for four soil samples. The impact on data quality is minimal because no target analytes were detected in any of the effected samples.

4.3 Radiochemical Analyses

Soil samples collected at TA-35 underwent the radiochemical analyses listed in Table 3.1.1-1 in Chapter 3.0 of this RFI report. Gross-alpha, -beta, and -gamma radiation measurements and a screening-level gamma spectroscopy analysis were performed in a mobile laboratory facility operated by the Laboratory (also known as the "Rad Van"). A sample of Bandelier tuff was counted as a blank sample with each batch of soil samples, and the blank sample counts were subtracted from the soil sample counts. The Bandelier tuff sample was not an appropriate background for TA-35 geological units, and the background correction has introduced an unknown bias into the reported activities for gross radioactivity and individual radionuclides. A high false positive rate was noted for the gamma spectroscopy results. The gamma spectroscopy software was set for very wide energy windows within which to search for specific energy peaks. As a result, many of the reported activities for certain radionuclides were actually false positives. Therefore, the Rad Van measurements are not presented in this RFI report.

This RFI report presents the fixed-site laboratory data sets for those PRSs that are being recommended for further investigation. Radiochemical analyses were performed for samples collected from PRS Nos. 35-003(d,

e, f, g, l, m, o, q, and r). The fixed-site laboratory sample results indicate the presence of gross radioactivity and radionuclides at levels that require further investigation.

The analyte list, EQLs, and analytical methods employed for the fixed-site laboratory radiochemical analyses are given in Table 4.3-1. Gamma spectroscopy, alpha spectrometry, and liquid scintillation counting for tritium were employed for analyzing radionuclide constituents in soil samples. The radionuclides analyzed by alpha spectrometry were ^{238}Pu, ^{239,240}Pu (unresolved isotopes), ^{234}U, ^{235}U, and ^{238}U. The required QC procedures and acceptance criteria are given in the ER Project analytical services statement of work (LANL 1995, 49738). The analytical protocols used were either Laboratory internal protocols (LANL 1993, 31794) or external protocols, which have much in common with the Laboratory radiochemistry methods. The radiochemistry procedures will vary somewhat from laboratory to laboratory because of the lack of promulgated radiological protocols. No holding time requirements exist for the radiological analyses.

Gamma spectroscopy was performed for either a limited suite or a full suite of analytes. Samples collected from PRS Nos. 35-003(d, e, f, g, l, m, o, and q) were analyzed for the limited suite of analytes. The limited suite consisted of the following nine radionuclides: ^{241}Am, ^{60}Co, ^{22}Na, ^{237}Np (activation products), ^{140}Ba, ^{144}Ce, ^{137}Cs, ^{152}Eu, and ^{106}Ru (fission products). Samples collected from PRS No. 35-003(r) were analyzed for the full suite of analytes. The full-suite analyte list, which is given in the ER Project analytical services statement of work (LANL 1995, 49738), includes the decay series of the naturally occurring radionuclides ^{235}U, ^{238}U, and ^{232}Th as well as fission and activation products and their progeny.

TABLE 4.3-1

ANALYTE LIST, ESTIMATED QUANTITATION LIMITS, AND ANALYTICAL METHODS FOR RADIONUCLIDE CONSTITUENTS IN SOIL SAMPLES

Analyte	Half-Life (yr)	Detected Emission	EQL (pCi/g)	Analytical Method
Tritium	12.3	β	300 pCi/L[a]	LSC
^{238}Pu	87.7	α	0.1	α-Spectrometry
^{239,240}Pu[b]	2.410×10^4	α	0.1	α-Spectrometry
^{234}U	2.46×10^5	α	0.1	α-Spectrometry
^{235}U	7.04×10^8	α	0.1	α-Spectrometry
^{238}U	4.47×10^9	α	0.1	α-Spectrometry
Gamma spectroscopy analytes[c]	–	γ	1[d]	γ-Spectroscopy
Gross-alpha	–	α	10.0	GPC or LSC
Gross-beta	–	β	10.0	GPC or LSC
Gross-gamma	–	γ	2.0	NaI(Tl) or HPGe detection

a. All soil samples submitted for tritium analysis are also analyzed for gravimetric moisture content. Tritium results for soil samples are converted to a dry weight basis (pCi/g) using the percent moisture content.
b. The ^{239}Pu and ^{240}Pu isotopes cannot be distinguished by alpha spectrometry. The half-life of ^{239}Pu is given.
c. The gamma spectroscopy analyte list is given in the ER Project analytical services statement of work (LANL 1995, 49738).
d. The minimum detectable activity for ^{241}Am and ^{137}Cs is 1 pCi/g; the value for other analytes will vary.

TABLE 4.3-2

RADIONUCLIDES IN TA-35 SOIL SAMPLES DETECTED BY GAMMA SPECTROSCOPY

Radionuclide	Half-life [a]	Emissions	EQL[b] (pCi/g)	SAL (pCi/g)
^{232}Th decay series (Thorium series)				
^{228}Ac	6.13 h	α,β,γ	10.0	N.A.
^{212}Pb	10.64 h	β,γ	0.9	N.A.
^{224}Ra	3.66 d	α,γ	10.0	N.A.
^{228}Ra	5.76 y	β,γ	N.A.	1.3
^{208}Tl	3.053 m	β,γ	1.9	N.A.
^{228}Th	1.913 y	α,γ	N.A.	1.7
^{235}U decay series (Actinium series)				
^{211}Bi	2.14 m	α,β,γ	3.2	N.A.
^{223}Ra	11.434 d	α,γ	4.0	N.A.
^{227}Th	18.72 d	α,γ	3.7	N.A.
^{235}U	7.04×10^{8} y	α,γ	0.5	10
^{238}U decay series (Uranium series)				
^{214}Bi	19.9 m	α,β,γ	4.5	N.A.
^{210}Pb	22.3 y	β,γ	3.7	N.A.
^{214}Pb	26.8 m	β,γ	1.1	N.A.
^{226}Ra	1600 y	α,γ	8.0	0.10
^{234}Th	24.10 d	β,γ	4.2	N.A.
Activation products (and their decay products)				
^{241}Am	432.7 y	α,γ	0.5	22
^{60}Co	5.271 y	β,γ	1.1	1.1
^{22}Na	2.605 y	β,γ	0.5	1.3
^{237}Np	2.14×10^{6} y	α,γ	2.7	1.9
^{233}Pa	27.0 d	β,γ	1.0	N.A.
^{229}Th	7.3×10^{3} y	α,γ	N.A.	N.A.
Fission products				
^{140}Ba	12.75 d	β,γ	2.0	N.A.
^{144}Ce	284.6 d	β,γ	6.2	56
^{137}Cs	30.17 y	β,γ	1.4	5.1
^{152}Eu	13.48 y	β,γ	9.0	2.6
^{106}Ru	372.6 d	β	10.5	13
Other				
^{40}K	1.25×10^{9} y	β,γ	N.A.	12

a. m = minutes, h = hours, d = days, y = years
b. Estimated quantitation limit based on counting a 100 g sample aliquot for 60 minutes.

The half-lives, emissions, approximate EQLs, and SAL values for radionuclides detected in TA-35 soil samples by gamma spectroscopy are listed in Table 4.3-2. Of the 27 radionuclides detected, 12 have half-lives less than 180 days and are not considered to be COPCs. The shorter-lived radionuclides are usually included in the analyte list to verify the presence of longer-lived parent isotopes. The radionuclides ^{228}Ac (6.13 hours), ^{212}Pb (10.64 hours), ^{224}Ra (3.66 days), and ^{208}Tl (3.053 minutes) are in the decay series of the naturally occurring radionuclide ^{232}Th. The radionuclides ^{211}Bi (2.14 minutes), ^{223}Ra (11.434 days), and ^{227}Th (18.72 days) are in the decay series of the naturally occurring radionuclide ^{235}U. The radionuclides ^{214}Bi (19.9 minutes), ^{214}Pb (26.8 minutes), and ^{234}Th (24.10 days) are in the decay series of the naturally occurring radionuclide ^{238}U. The radionuclide ^{233}Pa (27.0 days) is the short-lived progeny of the activation product ^{237}Np.

The radionuclide ^{140}Ba (12.75 days), a fission product, was included in both the limited-suite and full-suite analyte lists because it is known to have been released at the TA-35 wastewater treatment plant, PRS Nos. 35-003(a through q). The wastewater treatment plant ceased operation in 1963; therefore, the last possible release from the facility occurred more than 30 years ago. Because of its very short half-life, no residual ^{140}Ba can remain at the site related to releases from the wastewater treatment plant. However, some relatively high concentrations of ^{140}Ba were reported for samples collected at the site of the wastewater treatment plant. The uncertainties (one standard deviation about the mean) associated with these measurements were approximately equal to or greater than the reported result; therefore, the results are highly uncertain.

If the measured activity of a particular radionuclide is at or near background levels, the analytical results will exhibit a statistical distribution of both positive and negative numbers near zero activity. Negative values may result when the measured value for the Laboratory background, usually determined by analysis of a blank sample, is subtracted from the measured value for the sample. Both the blank (background) value and the sample value have an associated uncertainty; therefore, a finite probability exists that a negative value may result when the background correction is performed. A negative value has no physical significance for an individual measurement but may be included in a larger data set to establish the distribution of values. The data set for TA-35 includes some negative activity values; however, in many cases negative values were simply reported as "zero" activity.

Some of the reported sample results may be less than the EQL for the method. Values that are less than the EQL have a lower level of statistical confidence than values above the EQL. Values that are less than the EQL should be regarded as estimates; the true value lies in the range between zero activity and the EQL. The data set for TA-35 includes values that are less than the EQL for a particular isotope or a particular technique; however, in many cases the measured values were reported as "<EQL" by the analytical laboratory.

The accuracy of the radiochemical measurements was monitored by the analysis of single-blind performance evaluation (PE) samples (submitted by the ER Project Sample Management Office) or NIST-traceable LCSs (supplied by the laboratory). If the recovery from the LCS or PE sample was not within ±20% of the true value, the associated sample results were qualified as estimated (J flag). The precision of the measurements was monitored by the analysis of laboratory duplicate samples. If the relative percent difference between the regular and duplicate sample results exceeded 25%, the samples results were qualified as estimated (J flag).

The accuracy of the alpha spectrometry measurements was monitored by the addition of tracer isotopes during the sample preparation steps. The reported sample results are corrected for the chemical yield of the tracer isotope to account for matrix effects and losses during sample preparation. Sample results were qualified as estimated and biased low (J- flag) if the tracer recovery was less than 30% because a very low tracer recovery may indicate an unusual occurrence during analysis.

The analytical protocols for measuring alpha-emitting radionuclides require that a method blank be prepared and analyzed concurrently with the samples. Blank contamination should not exceed the EQL. In keeping with guidance given in *Risk Assessment Guidance for Superfund, Volume I* (EPA 1989, 8021), the sample results were qualified as estimated and biased high (J+ flag) if blank contamination was present.

5.0 SPECIFIC RESULTS, CONCLUSIONS, AND RECOMMENDATIONS

5.1 PRS Nos. 35-003(e, f, g, m, and o)

The potential release sites (PRSs) in this decision set include PRS No. 35-003(e), the site of the former underground storage tank (TA-35-36); PRS No. 35-003(f), the site of the former flocculator tank (TA-35-37); PRS No. 35-003(g), the site of the former ion exchange columns regenerant tank (TA-35-38); PRS No. 35-003(m), the site of the former sludge tank (TA-35-22); and PRS No. 35-003(o), the site of the former manhole (TA-35-12). These PRSs are associated with the former Technical Area (TA) -35 wastewater treatment plant that was operated at buildings TA-35-3 and TA-35-7 during the 1950s and early 1960s. Figure 5.1-1 shows the locations of the PRSs and structures at the site. These PRSs were grouped into one decision set because they are located in the same area and are associated with the same process source term.

Chemicals of potential concern (COPCs) identified as a result of the screening assessment include benzo[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, ^{152}Eu, ^{234}U, ^{235}U, and ^{238}U. In addition, high levels of beta-emitting radiation were measured during screening activities.

Further investigations are proposed for PRS Nos. 35-003(e, f, g, m, and o). The sampling and analysis plan (SAP) for these PRSs is included in Section 5.1.10.

5.1.1 History

PRS Nos. 35-003(e, f, g, m, and o) are described in Section 3.3.2 of the *RFI Work Plan for Operable Unit 1129* (the work plan) (LANL 1992, 7666).

The former structures associated with PRS Nos. 35-003(f and g), TA-35-37 and TA-35-38, were added to the wastewater treatment plant in 1956 when ion exchange columns were installed. The flocculated material was drained to TA-35-22. The regenerant and flocculator tanks were used as part of the plant until 1963 when the plant was abandoned. The tanks were removed in 1980 in preparation for decontamination and decommissioning (D&D) of the underground liquid waste lines. A 25,000-gal. tank (TA-35-36) was added to the wastewater treatment plant in 1960 and was used for the temporary storage of radioactive liquid waste. This tank was removed in August 1981 during the Radioactive Liquid Waste Lines Removal Project (Elder et al. 1986, 3089).

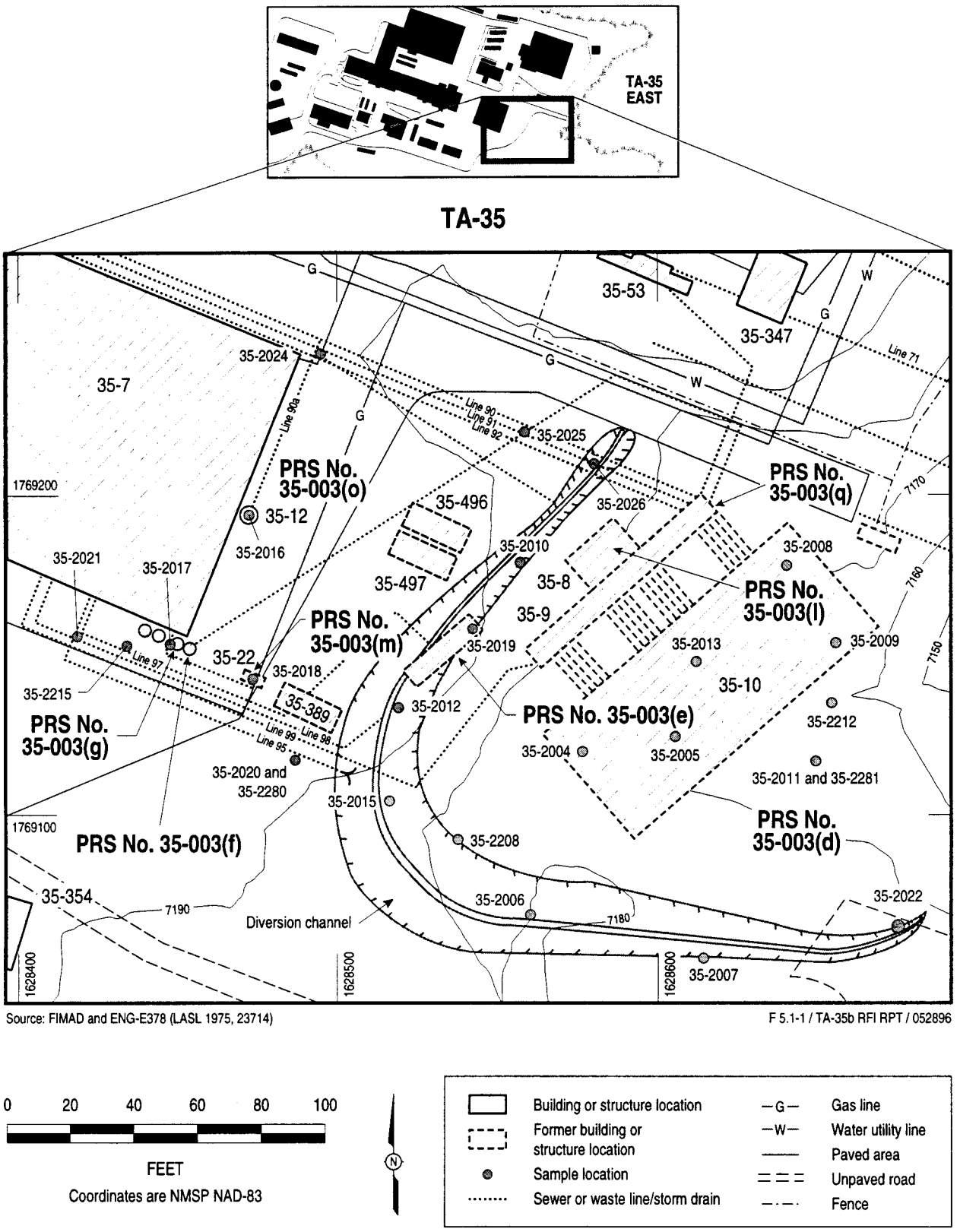
The radioactively contaminated air filter wash water from TA-35-7 drained to floor drains accessed by TA-35-12 at the east side of the building. The wash water then flowed via Lines 90A and 90 to the concrete storage tanks where the radionuclides decayed. TA-35-12 and the associated lines were removed in January 1985.

The contaminants that were potentially present (and therefore investigated during this Resource Conservation and Recovery Act [RCRA] facility investigation [RFI]) include gross-alpha, -beta, and -gamma radiation; volatile organic compounds (VOCs); semivolatile organic compounds (SVOCs); metals; and polychlorinated biphenyls (PCBs).

5.1.2 Description

These PRSs are located east of TA-35-7 near the end of Ten Site Mesa. Surface storm water drainage from the area flows eastward into a tributary of Ten Site Canyon. The tributary canyon has been called the waste-receiving canyon and is hereafter referred to as Pratt Canyon.

PRS Nos. 35-003(e, f, g, and m) are located near the southeast corner of TA-35-7. At the time of the RFI, the site of PRS Nos. 35-003(f and g) was an asphalt-paved temporary storage area outside the south wall of the building. The only evidence of the former tanks was patched areas on the wall. No spills or leaks associated with these tanks were reported when the tanks were removed (Elder et al. 1986, 3089).



Source: FIMAD and ENG-E378 (LASL 1975, 23714)

F 5.1-1 / TA-35b RFI RPT / 052896

Figure 5.1-1. Location of PRSs and former structures associated with the TA-35 wastewater treatment plant.

PRS No. 35-003(e) is located about 70 ft east of the southeast corner of TA-35-7 (see Figure 5.1-1). The tank was situated so that the contents drained to the north end of the tank. In August 1981 the tank was removed in one piece; no soil contamination was noted when the tank was removed (Elder et al. 1986, 3089). At least 15 ft of backfill material had been placed on the site after the tank was removed to extend the parking area east of TA-35-7.

PRS No. 35-003(m) is located about 25 ft east of the southeast corner of TA-35-7 (see Figure 5.1-1) under an asphalt roadway. The former tank had a capacity of 1,000 gal. and was buried about 2 ft below the ground surface. After the tank was removed and contaminated soil was excavated, the bottom of the excavation was reported to be 10 ft below the ground surface (Elder et al. 1986, 3089).

PRS No. 35-003(o) is located about 4 to 5 ft east of TA-35-7 (see Figure 5.1-1). After TA-35-12 was removed, the excavation was reported to be 8 ft 8 in. below the ground surface (Cox 1985, 781). At the time of the RFI, the site was discernible by the new asphalt patch. The asphalt patch matched the drawings of the excavation shown by Cox (1985, 781). Lines 90A and 90 connected the manhole to the holding tanks (TA-35-10). After these lines were removed in January 1985, soil contamination remained in the excavation trenches (Cox 1985, 781; Cox 1985, 785).

5.1.3 Previous Investigations

Previous investigations are discussed in Sections 3.3.2.3 and 3.3.2.4 of the work plan.

Previous investigations have been documented as far as back as 1952 and have included surveys for radioactivity in the soil. During the 1981 to 1985 Radioactive Liquid Waste Lines Removal Project, most of the industrial waste lines were removed, and sampling and analyses were performed to determine the extent of contamination and the success of contaminant removal (Elder et al. 1986, 3089). In some instances, analyses included hazardous chemical analysis, although the emphasis was usually on radioactive contamination.

After TA-35-22 was removed, the soil around and beneath the tank had ^{90}Sr and ^{137}Cs activity levels as high as 46,000 dpm/g. Soil was excavated laterally until above-background activity could not be detected and downward to solid bedrock (about 4 ft beneath the bottom of the tank or about 10 ft below the ground surface). At this depth, fractures in the bedrock contained activity levels as high as 5,000 pCi/g gross-beta radiation (McAtee 1981, 872). The excavation pit was backfilled with clean soil. Laboratory personnel determined that the area was decontaminated, and a decision of "as low as reasonably achievable" (ALARA) was made (McAtee 1981, 872).

The extent of soil contamination, if any, in the vicinity of the underground storage tank, TA-35-36 (PRS 35-003[e]), after removal of the tank is not known.

After TA-35-12 and the associated Line 90A were removed, 15 soil samples were collected. The soil beneath TA-35-12 contained 1,876 pCi/g beta activity. Soil on the sides of the pipeline excavation contained up to 7,145 pCi/g beta activity adjacent to the east footing wall of TA-35-7 at a depth of about 9 ft. Because continued excavation was thought to endanger the integrity of the footing wall, which was also contaminated, the area was backfilled, and an ALARA decision was made (Cox 1985, 781).

Several sections of radioactive waste lines and associated soils, many of which were contaminated, were also removed in 1985. Gross-beta contamination as high as 3,243 pCi/g (^{90}Sr and ^{90}Y) was found in the soil at depths of 17 to 20 ft below the ground surface in the trench from where Lines 90, 90B, 91, and 92 were removed at the northeast corner of TA-35-7. The highest levels of contamination were removed, and an ALARA decision was made concerning the decontamination of these lines; however, up to 1,100 pCi/g beta activity was left in the soil in the backfilled trench near the northeast corner of TA-35-7 (Cox 1985, 785).

5.1.4 Field Investigation

The objective of the Phase I RFI was to characterize the nature of potential contamination associated with these PRSs.

The conceptual model for the RFI took into account the following factors.

- Previous D&D activities removed most contamination, but not all of it.
- Contaminated liquids and sludge leaked from some of the former structures into the surrounding soils and bedrock. D&D information provides some insight into the depths where contaminants may be found. The location of the remaining contamination is assumed to be near the backfill/bedrock interface.
- Leakage from underground tanks and waste lines into surrounding soils is assumed. The transport of contaminants is localized.

Field activities included a health and safety (H&S) radiation survey, engineering surveys, and environmental surveys including a radiation grid survey.

Field screening during site surveys and sample collection activities was performed using a Hazco 1256 organic vapor analyzer (OVA), a Ludlum Model 39 alpha meter, and an Eberline ESP-1 beta/gamma meter. Using this instrumentation, background radiation measurements at TA-35 range from 200 to 500 cpm beta/gamma radiation depending on the location and substrate rock type. Field screening measurements greater than 500 cpm beta/gamma radiation were generally considered to be above background levels. No beta/gamma radiation measurements above background levels were obtained during field screening at the surface of these PRSs, and no alpha radiation or organic vapors were detected at the surface. Field screening for organic vapors during sample collection generally recorded 0 parts per million (ppm) or very low levels ranging up to a maximum of 2.2 ppm, which is not significantly above background levels. The significant field screening results of the borehole samples are summarized below; all results are shown on the geological logs in Attachment II of this RFI report.

5.1.4.1 Environmental and Engineering Surveys

The H&S radiation survey was performed on January 6, 1994. The beta/gamma radiation measurements ranged from 210 to 350 counts per minute (cpm), which are within background levels.

Engineering surveys were performed from January 6, 1994, through March 15, 1994. The surveys consisted of reviews of archival information, oblique photographs, aerial photographs, and engineering drawings of TA-35 as well as a field site inspection and a description of the PRSs. Each PRS was located, and the condition of the site was documented on daily activity logs. Registered professional surveyors located most of the former structures.

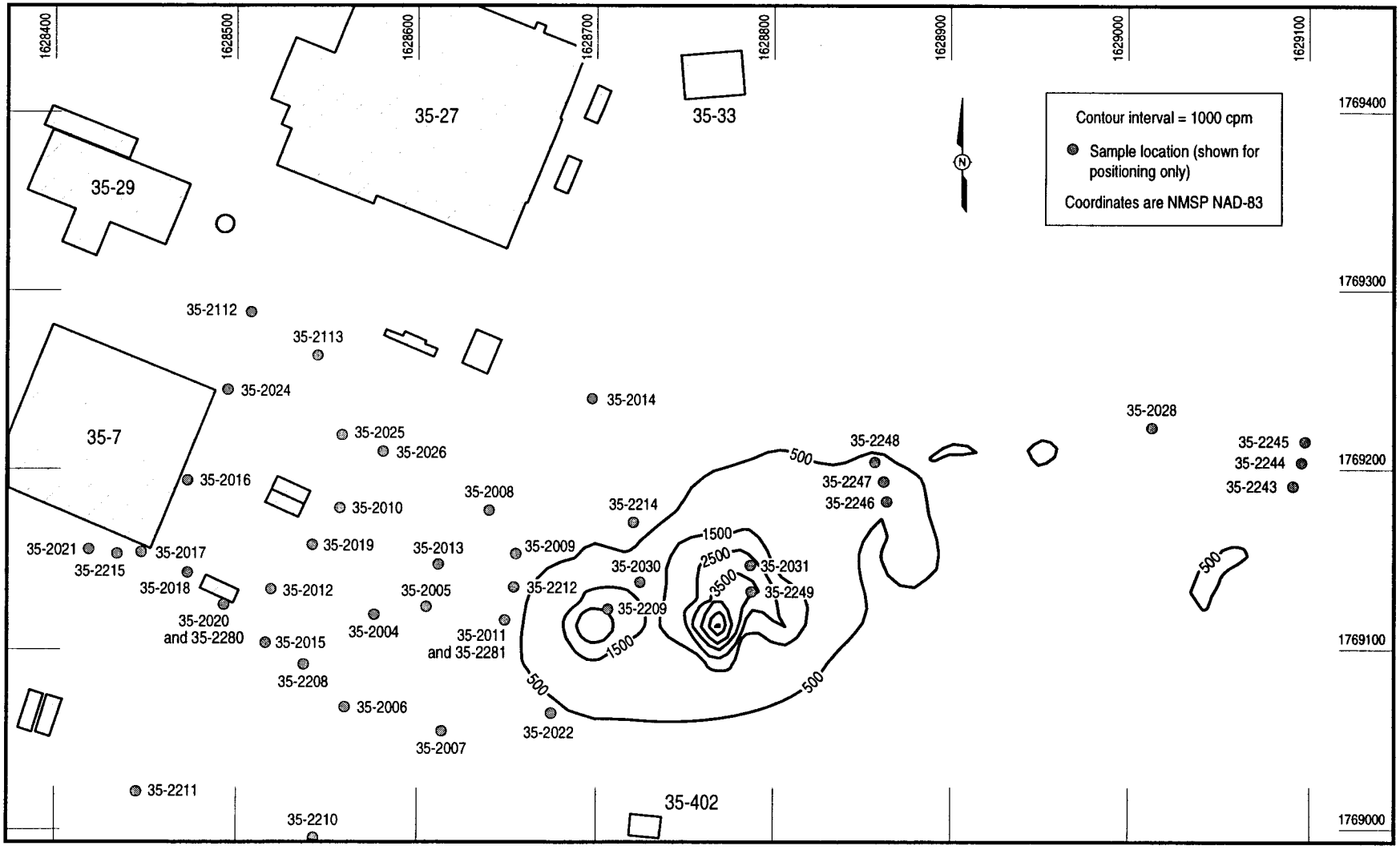
The radiation grid survey was performed on January 12 and 13, 1994. A total of 127 radiation measurements were obtained from grid locations east of TA-35-7. The radiation grid locations were spaced at approximately 20-ft intervals. Beta/gamma radiation measurements ranged from 160 to 370 cpm, and the average was 250 cpm, which is within background levels. An isopleth map created by gridding (using inverse distance interpolation) the survey data (and data from PRS Nos. 35-003[d, l, q, and r]) is shown in Figure 5.1.4-1. Sample location ID numbers are shown on figure for positioning purposes only.

Patterns of observed radioactivity distribution indicated that asphalt areas and backfilled areas had lower count rates than natural soil areas.

5.1.4.2 Deviations from the Sampling and Analysis Plan

The original SAP is described in Section 7.8 of the work plan (LANL 1992, 7666). However, the SAP was modified based on information gathered during the engineering surveys. The changes to the SAP, which are summarized below, are documented in the March 28, 1994, memorandum to the Operable Unit 1129 file (Koch 1994, 46647).

- The engineering surveys indicated that leaks or spills from the PRSs would have collected in the diversion channel. Therefore, one borehole (Location ID No. 35-2012) was relocated to the site of the former diversion channel.



F5.1.4-1 / TA-35b RFI RPT / 052296

Figure 5.1.4-1. Isopleth map of beta/gamma survey data at PRS Nos. 35-003(d, e, f, g, l, m, q, and r).

- Archival information (Elder et al. 1986, 3089) noted that contamination was present in the bedrock directly beneath TA-35-22 and was concentrated in the rock fractures. Therefore, one borehole (Location ID No. 35-2018) was relocated to the center of the former location of TA-35-22.

- An engineering drawing of the underground storage tank and associated excavation at PRS No. 35-003(e) shows that the tank and trench were deeper at their north end to allow the contents to drain to the end of the tank. Additional information indicated that the tank had overflowed from an open bung on the lower end. Any leaks or spills from the tank would have been concentrated at the north end of the tank trench; therefore, one borehole (Location ID No. 35-2019) was relocated to the north end of the site.

- Line 95 was used to discharge effluents from the wastewater treatment plant to the canyon, and Line 99 was used to recirculate fluids from the wastewater treatment plant to TA-35-10. Line 95 corroded because of the high acidity of the effluent and was replaced in December 1960 (LASL 1961, 12312). Based on this information, one borehole (Location ID No. 35-2020) was relocated to sample possible contamination from the site of former Lines 95 and 99. The samples from Location ID No. 35-2020 are in the area of the exposure unit that this decision set includes, and therefore were included in the decision set for the screening assessment.

- The engineering surveys revealed that relocating one borehole (Location ID No. 35-2021) by approximately 15 ft to the east of the original sample location would allow samples to be collected from PRS Nos. 35-003(f and g) and from the site of four former waste lines (Lines 95, 97, 98, and 99). The borehole was changed to a hand-auger hole that was drilled as deep as possible because overhead power lines made the site inaccessible to a drill rig.

- One borehole (Location ID No. 35-2023) was not completed because buried electrical lines were encountered at a depth of 2 ft. The borehole was abandoned at this depth for safety purposes.

- One borehole (Location ID No. 35-2215) was added to the SAP when it was discovered that a hand-auger hole (Location ID No. 35-2021) did not intersect a pipeline trench and drilling could not proceed beyond 10.8 ft. This additional 30-ft-deep borehole was located near the site of the flocculator and regenerant tanks and former waste Lines 95, 97, 98, and 99.

- Supplemental sampling was performed to recollect one sample that was lost by the analytical laboratory (Location ID No. 35-2020).

These changes to the SAP did not adversely impact the success of the field activities; they were planned to enhance the success of the investigation.

5.1.4.3 Sampling Activities

Phase I sampling was performed from March 15, 1994, through April 19, 1994, and supplemental sampling was performed on December 8, 1995. A total of 13 locations were sampled, and 50 subsurface samples were collected (not including duplicate quality assurance/quality control [QA/QC] samples). Table 5.1.4-1 summarizes samples taken and target analytical suites for PRS Nos. 35-003(e, f, g, m, and o); Figure 5.1.4-2 shows the sample locations. The soil materials encountered in the boreholes and the field screening results are described on the geological logs for each borehole in Attachment II of this RFI report.

Nine boreholes (Location ID Nos. 35-2016, 35-2017, 35-2018, 35-2019, 35-2020, 35-2024, 35-2025, 35-2026, and 35-2215) were drilled to a depth of 30 ft. One hand-auger hole (Location ID No. 35-2021) was drilled to a depth of 10.8 ft. Two boreholes (Location ID Nos. 35-2010 and 35-2012) were drilled to a depth of 100 ft.

TABLE 5.1.4-1

SUMMARY OF SAMPLES TAKEN AT PRS Nos. 35-003(e, f, g, m, and o)

Location ID	Sample ID	Depth (ft)	Matrix	SVOC Mobile Lab	SVOC Fixed Lab	PCB Mobile Lab	PCB Fixed Lab	INORG Mobile Lab	INORG Fixed Lab	Rad Van	Rad Fixed Lab
35-2010	AAB0961	1-2	mixed soil	17070	NR	NR	17070	17182	NR	18054	17188
35-2010	AAB0962	13.2-14.2	mixed soil	17070	NR	NR	17070	17182	17185	18054	17188
35-2010	AAB0963	38-39	Qbt3	17070	NR	NR	17070	17182	NR	18054	17188
35-2010	AAB0964	90-95	Qbt3	17075	NR	NR	17075	17232	NR	17957	17247
35-2010	AAB0965	95-100	Qbt2	17075	NR	NR	17075	17232	NR	17957	17247
35-2012	AAB0969	1-2	mixed soil	17075	NR	NR	17075	17232	NR	17957	17247
35-2012	AAB0971	20.5-21.5	mixed soil	17075	NR	NR	17075	17232	NR	17957	17247
35-2012	AAB0970	25.8-26.8	Qbt3	17075	NR	NR	17075	17232	NR	17957	17247
35-2012	AAB0972	30-35	Qbt3	17075	NR	NR	17075	17232	NR	17957	17247
35-2012	AAB0973	99-100	Qbt2	17146	NR	NR	17146	NR	17153	1	17155
35-2016	AAA6589	1-2	mixed soil	16975	NR	NR	16975	16984	NR	18031	17017
35-2016	AAA6590	8-9	Qbt3	16975	NR	NR	16975	16984	NR	18031	17017
35-2016	AAA6591	13.8-14.8	Qbt3	NR	16978	16978	NR	1	NR	18031	17016
35-2016	AAA6592	18.5-19.5	Qbt3	NR	16978	16978	NR	1	NR	18031	17016
35-2016	AAA6581	29-30	Qbt3	NR	16975	NR	16975	16984	NR	18031	17017
35-2017	AAA6537	1.3-2.3	mixed soil	16951	16957	NR	16957	16960	NR	16945	17360
35-2017	AAA6538	5-6	Qbt3	16951	NR	NR	16951	16960	NR	16945	17360
35-2017	AAA6539	19-20	Qbt3	16951	NR	NR	16951	16960	NR	16945	17360
35-2017	AAA6540	28.5-29.5	Qbt3	16951	NR	NR	16951	16960	17215	16945	17360
35-2018	AAA6633	1-2	mixed soil	17041	NR	17041	NR	17233	NR	21850	17246
35-2018	AAA6634	8.5-9.5	mixed soil	17041	NR	17041	NR	17233	NR	21850	17246
35-2018	AAA6635	14-15	Qbt3	17041	NR	17041	NR	17233	NR	21850	17246
35-2018	AAA6636	20-21	Qbt3	NR	17042	NR	17042	1	NR	21854	1
35-2019	AAA6621	1-2	mixed soil	17038	NR	NR	17038	17224	NR	21849	17301
35-2019	AAA6622	19-20	mixed soil	17038	NR	NR	17038	17224	NR	21849	17301
35-2019	AAA6623	24-25	Qbt3	17038	NR	NR	17038	17224	NR	21849	17301
35-2019	AAA6624	29-30	Qbt3	17038	NR	NR	17038	17224	17218	21849	17301
35-2020	AAA6625	1.5-2.5	mixed soil	NR	NR	17080	NR	17226	NR	18053	17245
35-2020	AAA6626	7-8	mixed soil	17080	17081	17080	17081	17226	17217	18053	17245
35-2020	AAA6627	10-11	Qbt3	NR	NR	17080	NR	17226	NR	18053	17245
35-2020	AAA6628	26.5-27.5	Qbt3	17080	NR	17080	NR	17226	NR	18053	17245
35-2021	AAA6574	3-4	mixed soil	16951	NR	16951	NR	16960	NR	16945	17360
35-2021	AAA6575	9-10	Qbt3	16951	NR	16951	NR	16960	NR	16945	17360
35-2024	AAA6601	1-2	mixed soil	17051	17052	NR	17051, 17052	17231	NR	18033	17293
35-2024	AAA6602	14-15	mixed soil	17051	NR	NR	17051	17231	NR	18033	17293
35-2024	AAA6603	24-25	Qbt3	17051	NR	NR	17051	17231	NR	18033	17293
35-2024	AAA6604	29-30	Qbt3	17051	NR	NR	17051	17231	NR	18033	17293
35-2025	AAA6613	1-2	mixed soil	17038	NR	NR	17038	17224	17218	21849	17301
35-2025	AAA6614	9-10	mixed soil	17038	NR	NR	17038	17224	NR	21849	17301
35-2025	AAA6615	11-12	mixed soil	17038	NR	NR	17038	17224	NR	21849	17301
35-2025	AAA6616	27.5-28.5	Qbt3	17038	NR	NR	17038	17224	NR	21849	17301
35-2026	AAA6617	2-3	mixed soil	17269	NR	NR	17269	17324	NR	1	17357
35-2026	AAA6618	9-10	Qbt3	17269	NR	NR	17269	17324	NR	1	17357
35-2026	AAA6619	24-25	Qbt3	17269	NR	NR	17269	17324	NR	1	17357
35-2026	AAA6620	28.5-29.5	Qbt3	17269	NR	NR	17269	17324	NR	1	17357
35-2215	AAB1009	1-2	mixed soil	17080	NR	17080	NR	17226	NR	18053	17245
35-2215	AAB1011	5-6	mixed soil	17080	17081	17080	17081	17226	NR	18053	17245
35-2215	AAB1012	21.7-22.7	Qbt3	17080	NR	17080	NR	17226	NR	18053	17245
35-2215	AAB1013	28-29	Qbt3	17080	NR	17080	NR	17226	NR	18053	17245
35-2280	0435-95 - 0195	1.5-2.5	mixed soil	NR	1678	NR	NR	NR	NR	NR	NR

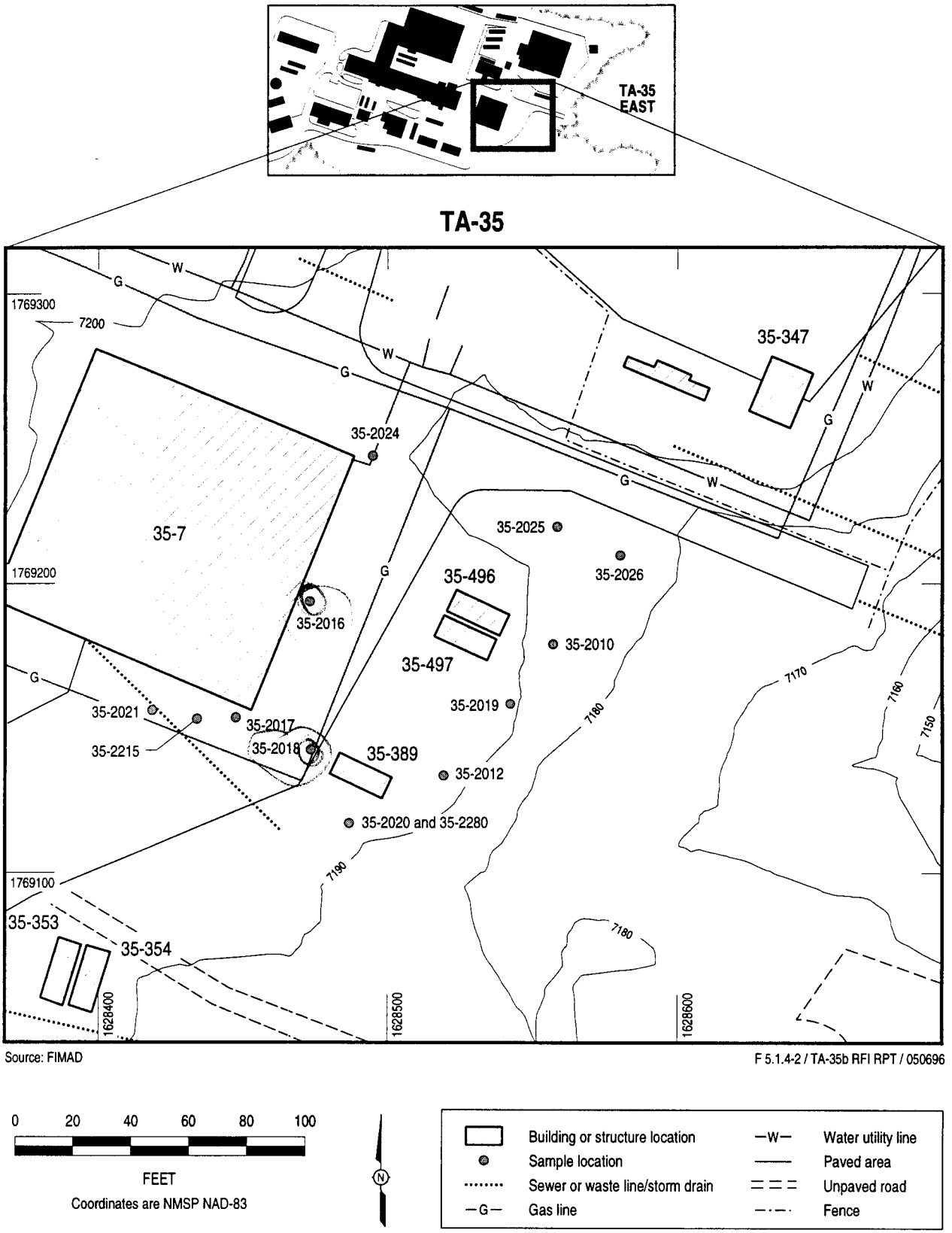


Figure 5.1.4-2. Location of samples at PRS Nos. 35-003(e, f, g, m, and o).

Sampling information including the depth to the tuff interface and a summary of beta/gamma screening results is presented in Table 5.1.4-2. Detailed screening results are presented in the geological logs in Attachment II of this RFI report.

5.1.5 Background Comparisons

Background comparisons were performed for inorganic chemicals and radionuclides for which upper tolerance limit (UTL) values are available, as discussed in Section 3.2 in Chapter 3.0 of this RFI report. For inorganic chemicals analyzed by x-ray fluorescence (XRF) in the mobile laboratory facility, the UTL values have been corrected for some analytes to account for method differences that generally result in higher measured background concentrations by XRF. Derivation of corrected UTL values for XRF data is discussed in Section 3.1.3 in Chapter 3.0 of this RFI report. If data are available by both methods, the data reported by the fixed-site laboratory will be given precedence because more confidence is placed in fixed-site laboratory data than in the XRF analyses.

TABLE 5.1.4-2

SUMMARY OF SAMPLING ACTIVITIES INFORMATION

			Beta/Gamma Screening		
Location ID	Total Depth of Hole (ft)	Depth to Tuff Interface (ft)	No. of Measurements	Results (cpm)	Depth of Measurement (ft)
35-2010	100	14.2	36	498 (max)	14.2
35-2012	100	21	30	550 (max)	25
35-2016	30	8	7	400	10
				3000	14
				1700	15
				2600	18.5
				4800	19
				2500	19.5
				1000	22.5
35-2017	30	5	10	170 (max)	all
35-2018	30	9.5	8	1111	8.5
				14000	10.8
				5000	20
				700	25
35-2020	30	7.5	9	600 (max)	10
35-2021	10.8	4	10	170 (max)	all
35-2024	30	18.8	13	400	10
				450	14
				1000	15
35-2025	30	11.5	12	700	11
				450	28
35-2026	30	5	12	700	2.5
				500	3
35-2215	30	7.2	7	500 (max)	8

Forty-eight samples from twelve locations were analyzed by alpha spectrometry in a fixed-site laboratory for plutonium and uranium isotopes. Eight samples from eight locations were analyzed by gamma spectroscopy in a fixed-site laboratory for an analyte suite that included ^{241}Am, ^{140}Ba, ^{144}Ce, ^{60}Co, ^{137}Cs, ^{152}Eu, ^{22}Na, ^{237}Np, and ^{106}Ru. In addition, thirteen samples from five locations were analyzed for tritium by liquid scintillation. Radionuclide data from samples submitted to the mobile laboratory facility are not available, for reasons discussed in Section 4.3 in Chapter 4.0 of this RFI report.

Forty-eight samples from twelve locations were analyzed by XRF in the mobile laboratory facility for an analyte suite that included antimony, arsenic, barium, cadmium, calcium, chromium, copper, iron, lead, manganese, mercury, nickel, potassium, selenium, thorium, titanium, uranium, and zinc. As discussed in Section 4.1.3 in Chapter 4.0 of this RFI report, XRF data for antimony, cadmium, mercury, selenium, and uranium should be regarded as estimated, and nickel data may have a low bias. Six soil samples from six locations were also analyzed in a fixed-site laboratory for an inorganic chemical analyte suite that included aluminum, antimony, arsenic, barium, beryllium, cadmium, calcium, chromium, cobalt, copper, iron, lead, lithium, magnesium, manganese, molybdenum, nickel, potassium, selenium, silver, sodium, strontium, thallium, vanadium, and zinc using the Environmental Protection Agency (EPA) methods described in Section 3.1.1 in Chapter 3.0 of this RFI report.

Samples from two locations were collected at depths of up to 100 ft below the ground surface. These deeper samples were collected to provide information about the potential vertical migration of contaminants released at these PRSs. Background comparisons are performed only for samples collected at depths of 30 ft or less below the ground surface. This depth was selected as the maximum likely depth at which human activities could result in contact with contaminated soil based on the depth of footings and buried tanks associated with TA-35-7. Eliminating data below 30 ft is intended to provide a reasonable data set for the human health screening assessment, which is based on exposure to surface soils, and does not imply that these data are irrelevant for evaluating contaminant transport.

The mixed-soil UTL values were used for background comparison for the sample intervals that contained any matrix other than, or in addition to, tuff. The UTL for the geologic tuff unit (either Qbt3 or, at greater depths, Qbt2) was used for background comparison when the sample matrix was tuff alone. As discussed in Section 3.2 of Chapter 3.0 of this RFI report, UTL values for tritium, ^{137}Cs, and plutonium isotopes are not applied to the data set for these PRSs. In Tables 5.1.5-1 and 5.1.5-2 the values in the boxes indicate inorganic chemicals and radionuclides (respectively) that were detected in soil at concentrations greater than or equal to their respective UTL values, or for which UTL values are unavailable. Sample locations where inorganic chemicals or radionuclides exceeded UTL values are shown in Figure 5.1.5-1. The highest observed concentrations above a UTL value at each location are summarized below.

- Barium was detected in one sample at a concentration of 37 mg/kg, which is above the Qbt3 UTL of 28 mg/kg.
- Chromium was detected in one sample at a concentration of 2.8 mg/kg, which is above the Qbt3 UTL of 2.1 mg/kg.
- Copper was detected in five samples at five locations at maximum concentration of 22 mg/kg, which is above the XRF UTL of 16.7 mg/kg.
- Iron was detected in one sample at a concentration of 35,500 mg/kg, which is above the XRF UTL of 27,400 mg/kg.
- Lead was detected in two samples at two locations at a maximum concentration of 79 mg/kg, which is above the XRF UTL of 28.4 mg/kg.
- Thorium was detected in nine samples at five locations at a maximum concentration of 28 mg/kg, which is above the XRF UTL of 22.1 mg/kg.

TABLE 5.1.5-1

INORGANIC CHEMICALS WITH CONCENTRATIONS* GREATER THAN BACKGROUND UTLs FOR PRS Nos. 35-003(e, f, g, m, and o)

Location ID	Sample ID	Depth (ft)	Ag	Ba	Cd	Cr	Cu	Fe	Hg	Li	Mo	Ni
SAL	N/A	N/A	383	5300	38	210	2800	N.A.	23	1500	380	1500
Mixed soil UTL	N/A	N/A	N.A.	315	2.7	19.3	15.5	21300	0.1	N.A.	N.A.	15.2
Qbt2 UTL	N/A	N/A	N.A.	28	N.A.	1.6	2	9040	N.A.	N.A.	N.A.	N.A.
Qbt3 UTL	N/A	N/A	1.9	28	N.A.	2.1	2	9040	N.A.	N.A.	N.A.	2.6
XRF UTL	N/A	N/A	N/A	561	N.A.	45.1	16.7	27400	N.A.	N/A	N/A	22.5
35-2010	AAB0961	1-2	NA	314	<3	<12	<8	15500	<5	NA	NA	<13
35-2010	AAB0962	13.2-14.2	<1	92	<.4	6.7	6.1	7000	<5	6.4	<.9	4.1
35-2010	AAB0963	38-39	NA	92	<3	<12	<8	9100	<5	NA	NA	<13
35-2010	AAB0964	90-95	NA	79	<3	<12	11	8300	<5	NA	NA	<13
35-2010	AAB0965	95-100	NA	77	<3	<12	<8	9400	<5	NA	NA	<13
35-2012	AAB0969	1-2	NA	216	<3	<12	<8	13400	<5	NA	NA	<13
35-2012	AAB0971	20.5-21.5	NA	127	<3	<12	<8	11300	<5	NA	NA	<13
35-2012	AAB0970	25.8-26.8	NA	50	<3	<12	<8	10600	<5	NA	NA	<13
35-2012	AAB0972	30-35	NA	60	<3	15	<8	9500	<5	NA	NA	<13
35-2012	AAB0973	99-100	<1 UJ	11 J-	<.4 UJ	<.5 UJ	<.5 UJ	4100 J-	<5	1.1 J-	<.9 UJ	<2 UJ
35-2016	AAA6589	1-2	NA	398	<3	<12	13	15000	<5	NA	NA	<13
35-2016	AAA6590	8-9	NA	186	4	<12	<8	12000	<5	NA	NA	<13
35-2016	AAA6581	29-30	NA	87	<3	<12	<8	9900	<5	NA	NA	<13
35-2017	AAA6537	1.3-2.3	NA	519	<3	16	22	21500	<5	NA	NA	<13
35-2017	AAA6538	5-6	NA	133	<3	<12	<8	10700	<5	NA	NA	<13
35-2017	AAA6539	19-20	NA	106	<3	<12	<8	9500	<5	NA	NA	<13
35-2017	AAA6540	28.5-29.5	<1	37	<.4	1.6	1.7	2200	<5	1.9	<.9	<14
35-2018	AAA6633	1-2	NA	508	<3	17	19	20800	<5	NA	NA	<13
35-2018	AAA6634	8.5-9.5	NA	227	<3	<12	<8	13100	<5	NA	NA	<13
35-2018	AAA6635	14-15	NA	147	<3	<12	<8	13200	<5	NA	NA	<13
35-2019	AAA6621	1-2	NA	328	<3	<12	<8	15100	<5	NA	NA	<13
35-2019	AAA6622	19-20	NA	324	<3	<12	14	16200	<5	NA	NA	<13
35-2019	AAA6623	24-25	NA	62	<3	<12	<8	10700	<5	NA	NA	<13
35-2019	AAA6624	29-30	<1	7.3	<.4	2.8	0.93	1500	<5	3.7	<.9	<2
35-2020	AAA6625	1.5-2.5	NA	316	<3	<12	13	15600	<5	NA	NA	<13
35-2020	AAA6626	7-8	<1 UJ	89 J-	<.4 UJ	6.3 J-	4.3 J-	7700 J-	<5	8.2 J-	<.9 UJ	3.8 J-
35-2020	AAA6627	10-11	NA	122	<3	<12	19	13200	<5	NA	NA	<13
35-2020	AAA6628	26.5-27.5	NA	60	<3	<12	<8	10700	<5	NA	NA	<13
35-2021	AAA6574	3-4	NA	400	<3	31	12	18300	<5	NA	NA	17
35-2021	AAA6575	9-10	NA	134	<3	36	<8	10100	<5	NA	NA	14
35-2024	AAA6601	1-2	NA	249	<3	<12	<8	12700	<5	NA	NA	<13
35-2024	AAA6602	14-15	NA	67	<3	<12	<8	10700	<5	NA	NA	<13
35-2024	AAA6603	24-25	NA	327	<3	34	20	35500	<5	NA	NA	<13
35-2024	AAA6604	29-30	NA	122	<3	<12	<8	11800	<5	NA	NA	<13
35-2025	AAA6613	1-2	<1	46	<.4	8.9	2.5	6300	<5	8.3	<.9	<2
35-2025	AAA6614	9-10	NA	122	<3	<12	<8	8800	<5	NA	NA	<13
35-2025	AAA6615	11-12	NA	157	<3	<12	<8	12600	<5	NA	NA	<13
35-2025	AAA6616	27.5-28.5	NA	50	<3	<12	<8	10600	<5	NA	NA	<13
35-2026	AAA6617	2-3	NA	195	<3	<12	<8	11900	<5	NA	NA	<13
35-2026	AAA6618	9-10	NA	128	<3	<12	<8	9400	<5	NA	NA	<13
35-2026	AAA6619	24-25	NA	107	<3	<12	<8	9200	<5	NA	NA	<13
35-2026	AAA6620	28.5-29.5	NA	126	<3	<12	<8	9500	<5	NA	NA	<13
35-2215	AAB1009	1-2	NA	469	<3	26	19	20400	<5	NA	NA	<13
35-2215	AAB1011	5-6	NA	418	<3	21	16	20500	<5	NA	NA	<13
35-2215	AAB1012	21.7-22.7	NA	110	<3	<12	<8	9400	<5	NA	NA	<13
35-2215	AAB1013	28-29	NA	65	<3	<12	<8	10300	<5	NA	NA	<13

* mg/kg

TABLE 5.1.5-1 (continued)

INORGANIC CHEMICALS WITH CONCENTRATIONS*
GREATER THAN BACKGROUND UTLs FOR PRS Nos. 35-003(e, f, g, m, and o)

Location ID	Sample ID	Depth (ft)	Pb	Sb	Se	Sr	Th	Ti	U	Zn
SAL	N/A	N/A	400	31	380	46000	N.A.	N.A.	230	23000
Mixed soil UTL	N/A	N/A	23.3	1	1.7	N.A.	14.6	N.A.	1.87	50.8
Qbt2 UTL	N/A	N/A	16.2	0.3	N.A.	N.A.	11.5	N.A.	2.48	55.5
Qbt3 UTL	N/A	N/A	16.2	0.4	N.A.	N.A.	9.29	N.A.	1.64	55.5
XRF UTL	N/A	N/A	28.4	1.45	N.A.	N/A	22.1	N.A.	5.33	76.6
35-2010	AAB0961	1-2	22	<4	<4	NA	16	1850	<8	47
35-2010	AAB0962	13.2-14.2	11	0.7 J+	<.3	16	18	2590	<8	33
35-2010	AAB0963	38-39	20	<4	<4	NA	24	520	<8	47
35-2010	AAB0964	90-95	18	<4	<4	NA	16	431	<8	53
35-2010	AAB0965	95-100	20	<4	<4	NA	24	485	<8	61
35-2012	AAB0969	1-2	14	<4	<4	NA	19	1120	<8	54
35-2012	AAB0971	20.5-21.5	23	<4	<4	NA	14	702	<8	67
35-2012	AAB0970	25.8-26.8	28	<4	<4	NA	25	602	<8	73
35-2012	AAB0972	30-35	25	<4	<4	NA	23	533	<8	55
35-2012	AAB0973	99-100	<4	<.25 UJ	<.3	1.6 J-	20	436	<8	29 J-
35-2016	AAA6589	1-2	23	<4	<4	NA	19	1760	<8	46
35-2016	AAA6590	8-9	23	<4	<4	NA	21	1030	10	52
35-2016	AAA6581	29-30	18	<4	<4	NA	16	579	<8	50
35-2017	AAA6537	1.3-2.3	24	<4	<4	NA	15	3280	<8	78
35-2017	AAA6538	5-6	17	<4	<4	NA	15	682	10	48
35-2017	AAA6539	19-20	13	<4	<4	NA	15	574	<8	37
35-2017	AAA6540	28.5-29.5	10 J-	<.3 UJ	<.3	3.1	19	610	<8	27
35-2018	AAA6633	1-2	19	<4	<4	NA	14	3110	<8	60
35-2018	AAA6634	8.5-9.5	18	<4	<4	NA	21	1240	<8	57
35-2018	AAA6635	14-15	17	<4	<4	NA	19	783	<8	50
35-2019	AAA6621	1-2	26	<4	<4	NA	22	1530	<8	48
35-2019	AAA6622	19-20	21	<4	<4	NA	11	1910	<8	60
35-2019	AAA6623	24-25	11	<4	<4	NA	24	584	9	30
35-2019	AAA6624	29-30	0.84	<.3 UJ	<.3	1.7	28	661	10	14
35-2020	AAA6625	1.5-2.5	20	<4	<4	NA	18	1620	<8	53
35-2020	AAA6626	7-8	6.4	<.3 UJ	<.3	16 J-	17	1330	<8	47 J-
35-2020	AAA6627	10-11	24	<4	<4	NA	15	690	<8	70
35-2020	AAA6628	26.5-27.5	15	<4	<4	NA	22	629	<8	31
35-2021	AAA6574	3-4	24	<4	<4	NA	16	2400	<8	59
35-2021	AAA6575	9-10	15	<4	<4	NA	20	629	<8	42
35-2024	AAA6601	1-2	26	<4	<4	NA	28	1170	<8	67
35-2024	AAA6602	14-15	20	<4	<4	NA	19	625	12	55
35-2024	AAA6603	24-25	29	<4	<4	NA	27	2010	11	131
35-2024	AAA6604	29-30	15	<4	<4	NA	12	682	<8	42
35-2025	AAA6613	1-2	9	<.3 UJ	0.3	9.1	23	1300	<8	34
35-2025	AAA6614	9-10	18	<4	<4	NA	18	518	<8	47
35-2025	AAA6615	11-12	17	<4	<4	NA	17	988	<8	92
35-2025	AAA6616	27.5-28.5	26	<4	<4	NA	22	606	<8	49
35-2026	AAA6617	2-3	79	<4	<4	NA	15	1050	134	69
35-2026	AAA6618	9-10	19	<4	<4	NA	11	603	<8	54
35-2026	AAA6619	24-25	21	<4	<4	NA	14	574	11	59
35-2026	AAA6620	28.5-29.5	22	<4	<4	NA	19	558	<8	40
35-2215	AAB1009	1-2	27	<4	<4	NA	19	3110	<8	66
35-2215	AAB1011	5-6	26	<4	<4	NA	21	2830	15	88
35-2215	AAB1012	21.7-22.7	11	<4	<4	NA	<8	635	<8	45
35-2215	AAB1013	28-29	12	<4	<4	NA	13	589	10	55

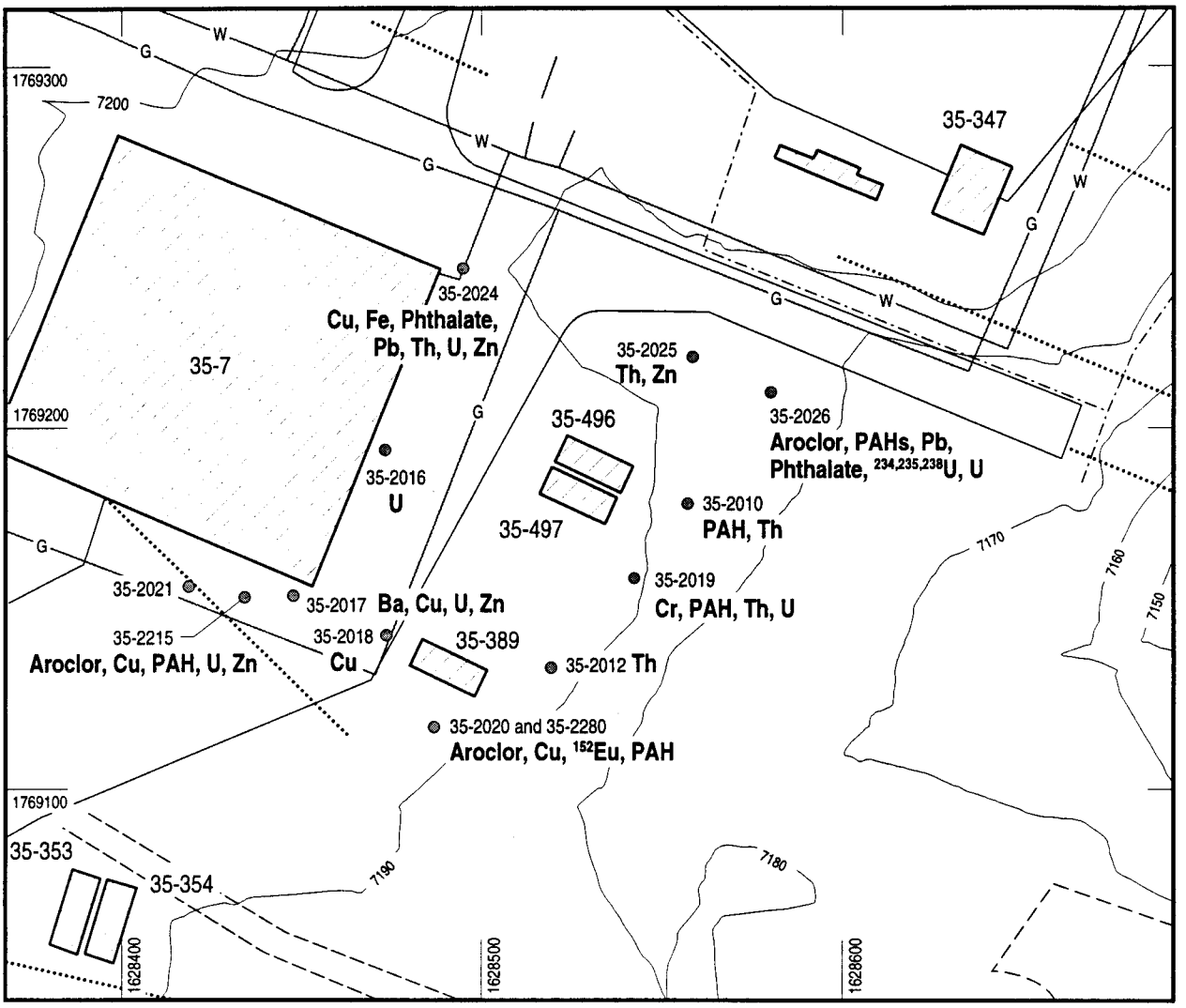
* mg/kg

TABLE 5.1.5-2

RADIONUCLIDES WITH ACTIVITIES GREATER THAN BACKGROUND ACTIVITIES* FOR PRS Nos. 35-003(e, f, g, m, and o)

Location ID	Sample ID	Depth (ft)	Am-241	Ba-140	Ce-144	Co-60	Cs-137	Eu-152	H-3	Na-22	Np-237	Pu-238	Pu-239, 240	Ru-106	U-234	U-235	U-238
SAL	N/A	N/A	22	N.A.	56	1.1	5.1	2.6	260	1.3	1.9	27	24	13	13	10	67
Mixed soil UTL	N/A	N/A	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	1.94	0.084	1.82
Qbt2 UTL	N/A	N/A	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	2.53	0.109	2.37
Qbt3 UTL	N/A	N/A	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	1.55	0.067	1.46
35-2010	AAB0961	1-2	NA	NA	NA	NA	NA	NA	0.11627	NA	NA	0.011	0.011	NA	0.676	0.027	0.689
35-2010	AAB0962	13.2-14.2	NA	NA	NA	NA	NA	NA	0.57253	NA	NA	0.025	0.099	NA	1.005	0.05	1.014
35-2010	AAB0963	38-39	NA	NA	NA	NA	NA	NA	0.19619	NA	NA	0.007	0.001	NA	0.755	0.032	0.743
35-2010	AAB0964	90-95	NA	NA	NA	NA	NA	NA	0.00468	NA	NA	0.02	0.007	NA	0.932	0.065	0.869
35-2010	AAB0965	95-100	NA	NA	NA	NA	NA	NA	0.00595	NA	NA	0.002	0.001	NA	0.718	0.036	0.752
35-2012	AAB0969	1-2	NA	NA	NA	NA	NA	NA	0.00052	NA	NA	0.001	0.005	NA	0.892	0.027	0.777
35-2012	AAB0971	20.5-21.5	NA	NA	NA	NA	NA	NA	0.00078	NA	NA	0.009	0.001	NA	0.669	0.041	0.613
35-2012	AAB0970	25.8-26.8	NA	NA	NA	NA	NA	NA	0.00199	NA	NA	0.001	0.001	NA	0.773	0.018	0.694
35-2012	AAB0972	30-35	NA	NA	NA	NA	NA	NA	0.00164	NA	NA	0.045	0.005	NA	0.75	0.036	0.734
35-2012	AAB0973	99-100	0.006	0.385	-0.005	-0.022	0.01 J	0.155	0.17228	0.028	0.01	0.002	0.002	0.326	0.788	0.027	0.743
35-2016	AAA6589	1-2	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.005	0.032	NA	0.865	0.041	0.707
35-2016	AAA6590	8-9	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.001	0.02	NA	0.658	0.045	0.685
35-2016	AAA6591	13.8-14.8	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.047	0.116	NA	0.577	0.023	0.59
35-2016	AAA6592	18.5-19.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.036	0.087	NA	0.717	0.024	0.691
35-2016	AAA6581	29-30	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.005	0.005	NA	0.716	0.014	0.676
35-2017	AAA6537	1.3-2.3	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.005	0.023 J+	NA	0.779	0.038	0.815
35-2017	AAA6538	5-6	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.001	0.001 J+	NA	0.579	0.023	0.613
35-2017	AAA6539	19-20	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.029	0.005 J+	NA	0.631	0.032	0.646
35-2017	AAA6540	28.5-29.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.001	0.002 J	NA	0.804	0.043	0.793
35-2018	AAA6633	1-2	0.03	0.221	-0.03	0.037	0.399	0.162	0.00109	-0.026	-0.016	0.02	0.045	-0.192	0.847	0.056	0.953
35-2018	AAA6634	8.5-9.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.009	0.027	NA	0.667	0.034	0.658
35-2018	AAA6635	14-15	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.016	0.016	NA	0.831	0.029	0.874
35-2018	AAA6636	20-21	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
35-2019	AAA6621	1-2	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.002	0.001	NA	0.736	0.034	0.678
35-2019	AAA6622	19-20	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.002	0.054	NA	0.786	0.038	0.752
35-2019	AAA6623	24-25	-0.024	0.689	0.067	0.009	-0.001 J+	0.146	NA	0.03	-0.003	0.002	0.005	-0.022	0.676	0.025	0.678
35-2019	AAA6624	29-30	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.005	0.001	NA	0.764	0.023	0.73
35-2020	AAA6625	1.5-2.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.002	0.018	NA	0.827	0.032	0.818
35-2020	AAA6626	7-8	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.001	0.14	NA	0.813	0.034	0.939
35-2020	AAA6627	10-11	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.005	0.001	NA	1.336	0.065	1.209
35-2020	AAA6628	26.5-27.5	0.012	0.287	0.059	0.09	-0.014 J+	0.39	0.14101	0.035	-0.009	0.02	0.007	0.025	0.741	0.029	0.7
35-2021	AAA6574	3-4	0.034 J-	1.95	-0.071	0.033	0.184	0.14	NA	0.017	0.004	0.011	0.086 J+	-0.038	0.784	0.036	0.82
35-2021	AAA6575	9-10	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.088	0.002 J+	NA	0.635	0.029	0.574
35-2024	AAA6601	1-2	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.036	0.016	NA	0.599	0.034	0.529
35-2024	AAA6602	14-15	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.002	0.001	NA	0.703	0.054	0.707
35-2024	AAA6603	24-25	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.001	0.009	NA	1.104	0.045	1.32
35-2024	AAA6604	29-30	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.001	0.014	NA	0.707	0.038	0.732
35-2025	AAA6613	1-2	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.009	0.011	NA	0.73	0.009	0.644
35-2025	AAA6614	9-10	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.016	0.001	NA	0.838	0.045	0.775
35-2025	AAA6615	11-12	0.055	-0.108	0.053	0.056	0.11 J+	0.193	NA	0.008	0.006	0.001	0.001	0.322	0.703	0.036	0.77
35-2025	AAA6616	27.5-28.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.002	0.001	NA	0.723	0.036	0.682
35-2026	AAA6617	2-3	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.014	0.07 J+	NA	9.75	1.124	55.327
35-2026	AAA6618	9-10	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.034	0.005 J+	NA	0.671	0.036	0.691
35-2026	AAA6619	24-25	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.005	0.005 J+	NA	0.779	0.036	0.784
35-2026	AAA6620	28.5-29.5	0.138 J-	0.048	0.035	-0.009	-0.002	-0.077	NA	0.029	-0.028	0.009	0.014 J+	-0.226	0.732	0.038	0.705
35-2215	AAB1009	1-2	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.009	0.09	NA	0.899	0.054	1.018
35-2215	AAB1011	5-6	0.072	0.342	0.008	0.012	0.307 J+	-0.005	0.179	-0.012	-0.02	0.002	0.038	0.106	0.782	0.027	0.784
35-2215	AAB1012	21.7-22.7	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.011	0.005	NA	0.721	0.034	0.714
35-2215	AAB1013	28-29	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.001	0.001	NA	0.667	0.023	0.646

* pCi/g



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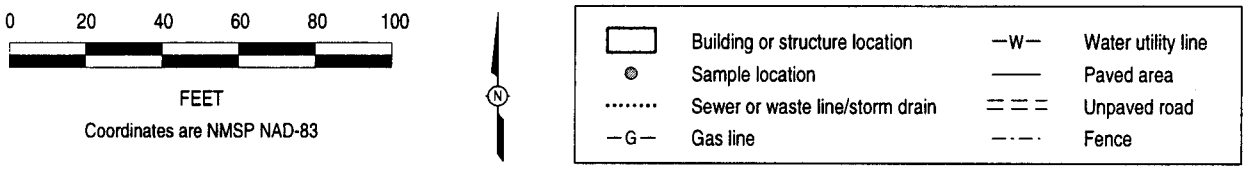


Figure 5.1.5-1. Locations of detected organic chemicals and analytes that exceed UTLs at PRS Nos. 35-003(e, f, g, m, and o).

- Total uranium was detected in ten samples at six locations at a maximum concentration of 134 mg/kg, which is above the XRF UTL of 5.33 mg/kg.
- Uranium-234 was detected in one sample at an activity of 9.75 pCi/g, which is above the mixed-soil UTL of 1.94 pCi/g.
- Uranium-235 was detected in one sample at an activity of 1.124 pCi/g, which is above the mixed-soil UTL of 0.084 pCi/g.
- Uranium-238 was detected in one sample at an activity of 55.327 pCi/g, which is above the mixed-soil UTL of 1.82 pCi/g.
- Zinc was detected in four samples at four locations at a maximum concentration of 131 mg/kg, which is above the XRF UTL of 76.6 mg/kg.

5.1.6 Evaluation of Organic Constituents

The organic chemicals analyzed for at these PRSs include SVOCs and PCBs. Forty-four soil samples from twelve locations were analyzed for SVOCs in the mobile laboratory facility. Nine soil samples from six locations were also analyzed for SVOCs in a fixed-site laboratory. The SVOC sample at Location ID No. 35-2280 that was analyzed in a fixed-site laboratory is a replacement for a missing 1.5- to 2.5-ft SVOC sample at Location ID No. 35-2020; it is not considered to be a separate sample location. Thirty-six soil samples from eleven locations and fifteen soil samples from five locations were analyzed for PCBs in a fixed-site laboratory and the mobile laboratory facility, respectively.

For reasons described in Section 5.1.5, only samples collected at depths of 30 ft or less below the ground surface are included in this summary of detected organic constituents.

As discussed in Section 4.2 in Chapter 4.0 of this RFI report, the sample results from the mobile laboratory facility are qualified with an "S" flag and may be biased low because of less effective extraction methods.

Organic chemicals detected in soil are shown in Table 5.1.6-1 (mobile laboratory facility results are qualified with an "S" flag in the table) and are summarized below. The locations of these organic chemicals are shown in Figure 5.1.5-1.

- Aroclor 1260 was detected in three samples that were collected at three locations and analyzed in the mobile laboratory facility.
- Benzo[a]anthracene was detected in one sample that was analyzed at the mobile laboratory facility and one sample that was analyzed in a fixed-site laboratory.
- Benzo[a]pyrene was detected in one sample that was analyzed at the mobile laboratory facility.
- Benzo[b]fluoranthene was detected in one sample that was analyzed at the mobile laboratory facility.
- Bis(2-ethylhexyl)phthalate was detected in one sample that was analyzed at the mobile laboratory facility.
- Butyl benzyl phthalate was detected in one sample that was analyzed at the mobile laboratory facility.
- Chrysene was detected in one sample that was analyzed at a fixed-site laboratory.

TABLE 5.1.6-1

PRS Nos. 35-003(e, f, g, m, and o) SOIL CONCENTRATIONS* FOR DETECTED ORGANIC CHEMICALS

Location ID	Sample ID	Depth (ft)	Mixed Aroclors	Benzo[a] anthracene	Benzo[a] pyrene	Benzo[b] fluoranthene	Bis(2-ethylhexyl) phthalate
SAL	N/A	N/A	1	0.61	0.061	0.61	32
CRQL	N/A	N/A	0.033	0.33	0.33	0.33	0.33
35-2010	AAB0961	1-2	ND	ND	ND	ND	ND
35-2019	AAA6621	1-2	ND	ND	ND	ND	ND
35-2020	AAA6625	1.5-2.5	0.9	NA	NA	NA	NA
35-2024	AAA6601	1-2	ND	ND	ND	ND	ND
35-2026	AAA6617	2-3	0.42	1.095 S	0.556 S	1.278 S	0.645 S
35-2215	AAB1009	1-2	0.47	ND	ND	ND	ND
35-2215	AAB1011	5-6	ND	ND	ND	ND	ND
35-2280	0439-95-0195	1.5-2.5	NA	0.027 J	ND	ND	ND

* mg/kg

TABLE 5.1.6-1 (continued)

PRS Nos. 35-003(e, f, g, m, and o) SOIL CONCENTRATIONS* FOR DETECTED ORGANIC CHEMICALS

Location ID	Sample ID	Depth (ft)	Butyl benzyl phthalate	Chrysene	Di-n-butyl phthalate	Fluoranthene	Phenanthrene	Pyrene
SAL	N/A	N/A	13000	24	6500	2600	N.A.	2000
CRQL	N/A	N/A	0.33	0.33	0.33	0.33	0.33	0.33
35-2010	AAB0961	1-2	ND	ND	ND	0.67 S	ND	0.69 S
35-2019	AAA6621	1-2	ND	ND	ND	ND	ND	0.42 S
35-2020	AAA6625	1.5-2.5	NA	NA	NA	NA	NA	NA
35-2024	AAA6601	1-2	1.6	ND	1.8	ND	ND	ND
35-2026	AAA6617	2-3	ND	ND	ND	ND	0.458 S	1.991 S
35-2215	AAB1009	1-2	ND	ND	ND	ND	ND	ND
35-2215	AAB1011	5-6	ND	ND	ND	ND	ND	0.37
35-2280	0439-95-0195	1.5-2.5	ND	0.039 J	ND	0.056 J	ND	0.055 J

* mg/kg

- Di-n-butyl phthalate was detected in one sample that was analyzed in a fixed-site laboratory.
- Fluoranthene was detected in one sample that was analyzed at a fixed-site laboratory and one sample that was analyzed at a mobile laboratory facility.
- Phenanthrene was detected in one sample that was analyzed at the mobile laboratory facility.
- Pyrene was detected in three samples that were analyzed at the mobile laboratory facility and two samples that were analyzed at a fixed-site laboratory.

5.1.7 Human Health Assessment

5.1.7.1 Screening Assessment

Eight inorganic chemicals, three radionuclides, and eleven organic chemicals were carried forward from the background and estimated quantitation limit (EQL) comparisons, in addition to inorganic chemicals and radionuclides for which UTL values are unavailable. As described in Section 3.4.1 in Chapter 3.0 of this RFI report, analytes are divided into three classes for the screening assessment, depending on whether a reference dose (noncarcinogens), slope factor (chemical carcinogens), or dose conversion factor (radionuclides) is used to calculate their screening action level (SAL), to evaluate possible additive effects within each class of chemical.

Benzo[a]anthracene, benzo[a]pyrene, and benzo[b]fluoranthene exceeded SAL values in the 2- to 3-ft interval at Location ID No. 35-2026 (Figure 5.1.7-1). The multiple chemical evaluation (MCE) results for noncarcinogens and chemical carcinogens are 0.91 and 0.97, respectively. The MCE values for noncarcinogens and chemical carcinogens are less than unity; therefore, a potential human health risk based on additive effects is not identified for these classes of chemicals. The MCE value for radionuclides is 2.1. The radionuclides ^{234}U, ^{235}U, and ^{238}U exceeded 10% of their SAL values in one sample, and ^{152}Eu exceeded 10% of its SAL value in another sample (data below UTL values are not incorporated in MCE calculations) (see Figure 5.1.7-1). Therefore, these four radionuclides are also identified as COPCs in the screening assessment. The screening assessments for chemical carcinogens and radionuclides are presented in Tables 5.1.7-1 and 5.1.7-2, respectively. Sample results that exceeded SAL values are highlighted with black in Table 5.1.7-1. Sample results that exceeded 10% of their SAL value and contributed to MCE exceedance are highlighted with a box in Table 5.1.7-2.

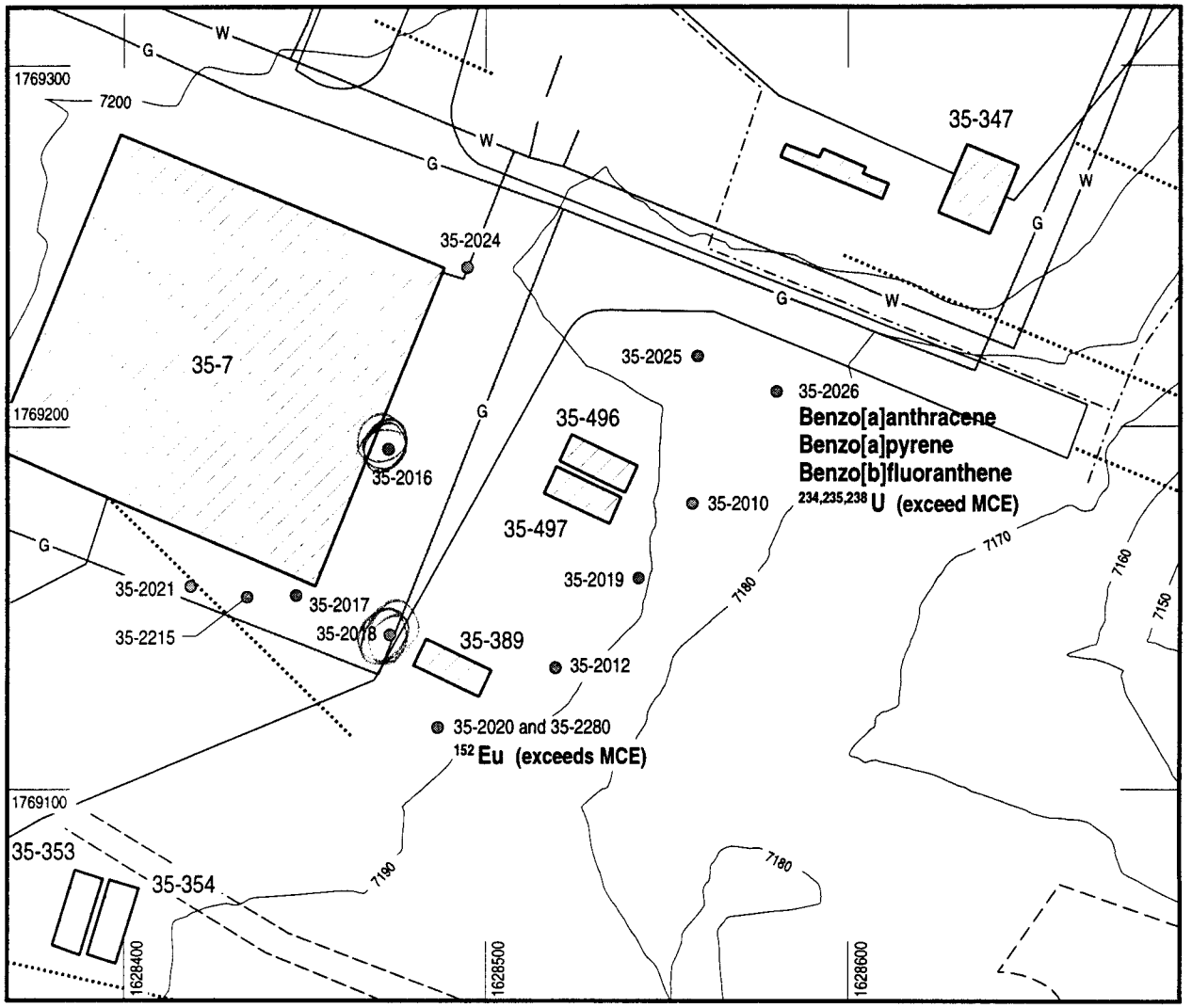
All the COPCs identified in Sections 5.1.5 and 5.1.6 have soil SALs for comparison except thorium, iron, and phenanthrene. Thorium was measured above its XRF UTL value in several samples, but at a maximum concentration that was only 20% higher than the UTL. The distribution of thorium at the PRSs in this decision set does not differ significantly from background, as shown in Figure AI-14 in Attachment I of this RFI report. Iron is among those essential elements that may be eliminated from further evaluation in a risk assessment based on professional judgment (EPA 1989, 8021). Iron is an essential element and was detected above background level in only 1 of 49 samples. Phenanthrene is structurally similar to pyrene and, like pyrene, is not suspected to be a carcinogen. Phenanthrene was detected in only 1 sample at a concentration of 0.01526 mg/kg, which is well below the SAL for pyrene of 2,000 mg/kg.

The only inorganic chemical for which neither a UTL nor a SAL value is available is titanium. Titanium is widely used as a food and cosmetics additive to whiten a product. It is generally considered to be physiologically inert in its common form as titanium dioxide (Amdur et al. 1991, 53961).

Barium-140, a fission product, is the only radionuclide analyzed that has no UTL or SAL value. This radionuclide was measured in several samples at activities up to 1.95 pCi/g. The radionuclide ^{140}Ba was included in the gamma spectroscopy analyte list because it is known to have been released at the wastewater treatment plant. The wastewater treatment plant ceased operation in 1963, so the last possible release from the facility occurred more than 30 years ago. Because of its very short half-life (12.75 days), no residual ^{140}Ba remains at the site related to historical releases from the wastewater treatment plant. The uncertainties (one standard deviation about the mean) associated with the reported values for ^{140}Ba were approximately equal to the reported results; therefore, the results are highly uncertain. For these reasons, ^{140}Ba is not considered to be a principal radionuclide for the purposes of evaluating historical releases at this site.

5.1.7.2 Risk Assessment

A quantitative human health risk assessment was not performed for these PRSs because additional data are required to confirm the nature and define extent of contamination, as described in Section 5.1.7.2.1.



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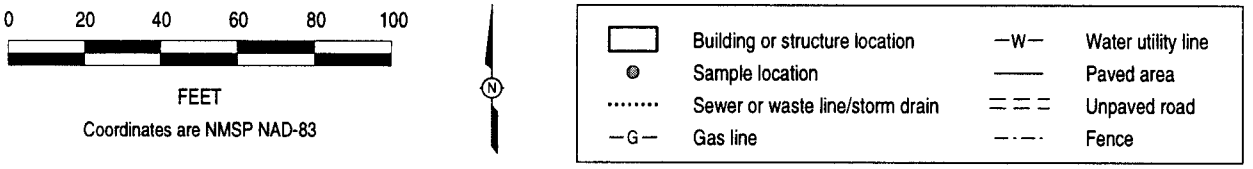


Figure 5.1.7-1. Locations of analytes that exceed SALs and MCE at PRS Nos. 35-003(e, f, g, m, and o).

TABLE 5.1.7-1

PRS Nos. 35-003(e, f, g, m, and o) CHEMICAL CARCINOGENS WITH CONCENTRATIONS* THAT EXCEED SALs

Location ID	Sample ID	Depth (ft)	Benzo[a]anthracene	Benzo[a]pyrene	Benzo[b]fluoranthene
SAL	N/A	N/A	0.61	0.061	0.61
35-2026	AAA6617	2-3	1.095 S	0.556 S	1.278 S

* mg/kg

5.1.7.2.1 Review of Chemicals of Potential Concern and Extent of Contamination

Three organic chemical carcinogens and four radionuclides were identified as COPCs in the screening assessment. Benzo[a]anthracene, benzo[a]pyrene, and benzo[b]fluoranthene exceeded SAL values, and ^{234}U, ^{235}U, and ^{238}U were identified as COPCs at Location ID No. 35-2026 during the MCE process. In addition, ^{152}Eu was identified as a COPC in the MCE process at a second sample location (Figure 5.1.7-1).

Additional data are required to confirm the nature and determine the extent of contamination at these PRSs. As described in Sections 5.1.1 through 5.1.4, activities associated with these PRSs are known to have resulted in releases of radionuclides to the environment. These releases have been documented in previous investigations and in the Phase I RFI. In particular, soil containing ^{90}Sr and ^{137}Cs was left in place following D&D between 1980 and 1985. The areal extent, volume, and soil concentrations associated with this residual contamination have not yet been determined. Although gross-beta/gamma activity was measured above background levels at several sample locations during field screening for Phase I activities, laboratory analyses of soil samples from these PRSs did not include ^{90}Sr. Gamma spectroscopy was performed for only a limited set of samples from these PRSs, and these samples do not necessarily correspond to locations where contamination is suspected. For example, gamma spectroscopy data are unavailable for intervals at Location ID Nos. 35-2018 and 35-2016 where the highest counts (up to 14,000 cpm) were recorded in the beta/gamma field screening (Table 5.1.4-1).

It appears unlikely that the COPCs identified at Location ID No. 35-2026 are associated with the waste lines removed between 1980 and 1985. COPCs were identified only in backfill in the 2- to 3-ft interval. Samples collected in tuff below the level of the historical waste line did not show evidence of contamination. The source of the COPCs measured at Location ID No. 35-2026 is unknown.

TABLE 5.1.7-2

PRS Nos. 35-003(e, f, g, m, and o) RADIONUCLIDES WITH ACTIVITIES* THAT EXCEED MCE

Location ID	Sample ID	Depth (ft)	Eu-152	U-234	U-235	U-238
SAL	N/A	N/A	2.6	13	10	67
35-2020	AAA6628	26.5-27.5	0.39	0.741	0.029	0.7
35-2026	AAA6617	2-3	NA	9.75	1.124	55.327

MCE = 2.07

* pCi/g

5.1.8 Preliminary Ecological Assessment

The general landscape condition around these PRSs is highly developed and disturbed, and a low potential exists for receptors to come in contact with chemicals above background levels associated with the site (see Table 2.4-1 in Chapter 2.0 of this RFI report). Therefore, no further ecological evaluation of this site is required.

5.1.9 Conclusions and Recommendations

The objective of the Phase I RFI for PRS Nos. 35-003(e, f, g, m, and o) was to determine the presence or absence of contamination associated with the former TA-35 wastewater treatment plant. COPCs identified in the human health screening assessment include benzo[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, ^{234}U, ^{235}U, ^{238}U, and ^{152}Eu.

Field measurements of gross radioactivity and organic vapors, as well as samples for specific analytes, were collected from twelve boreholes at or adjacent to the structures described in Section 5.1.1 that are the bases of the PRSs in this decision set. COPCs were identified primarily in one sample at Location ID No. 35-2026. Gross-beta/gamma activity was highest at Location ID Nos. 35-2016 and 35-2018 where residual contamination left in place during D&D has been documented in previous investigations.

Further sampling is recommended to determine the nature and extent of contamination identified in field measurements and laboratory analyses associated with the Phase I RFI. The objectives of further sampling, including specific sample locations and analytical suites, are identified in the SAP.

5.1.10 Sampling and Analysis Plan for PRS Nos. 35-003(d, e, f, g, l, m, o, q, and r)

Because areas of contaminant accumulation for PRS Nos. 35-003(e, f, g, m, and o) overlap with PRS Nos. 35-003(d, l, q, and r) and because of their geographical proximity, the sampling activities for these PRSs will be conducted as a combined event. Therefore, one SAP has been written for PRS Nos. 35-003(d, e, f, g, l, m, o, q, and r).

The PRSs in this SAP were grouped into three decision sets. The PRSs in each decision set are located in the same general area, are associated with the same process source term, and will be evaluated in one exposure unit during the human health risk assessment following the investigation. The decision sets are shown on Figure 5.1.10-1. The first decision set comprises the area closest to TA-35-7 on the mesa top on a mostly paved area; it includes PRS Nos. 35-003 (e, f, g, m, and o). The second decision set is an area covered with backfill material on a slope at the head of a small canyon informally known as Pratt Canyon; it includes PRS Nos. 35-003(d, l, and q). The third decision set is Pratt Canyon, which is PRS No. 35-003(r).

5.1.10.1 Problem Definition

The Phase I data for PRS Nos. 35-003(d, e, f, g, l, m, o, q, and r), discussed in Sections 5.1, 5.2, and 5.3 of this RFI report, are insufficient to guide the selection of interim or remedial actions or countermeasures for this decision set because not all significant analytes were included (the lack of ^{90}Sr data is a particularly significant gap) and because the biased sampling appropriate for a Phase I investigation provides little information about the extent and spatial distribution of contaminants. The investigations described below are intended to provide additional information to support decisions about future interim or remedial actions.

5.1.10.1.1 Area Between TA-35-7 and the Head of Pratt Canyon

The area between TA-35-7 and the head of Pratt Canyon, which is shown in Figure AIII-1 in Attachment III of this RFI report, encompasses PRS Nos. 35-003(d, e, f, g, l, m, o, and q). Corrective measures could include the following.

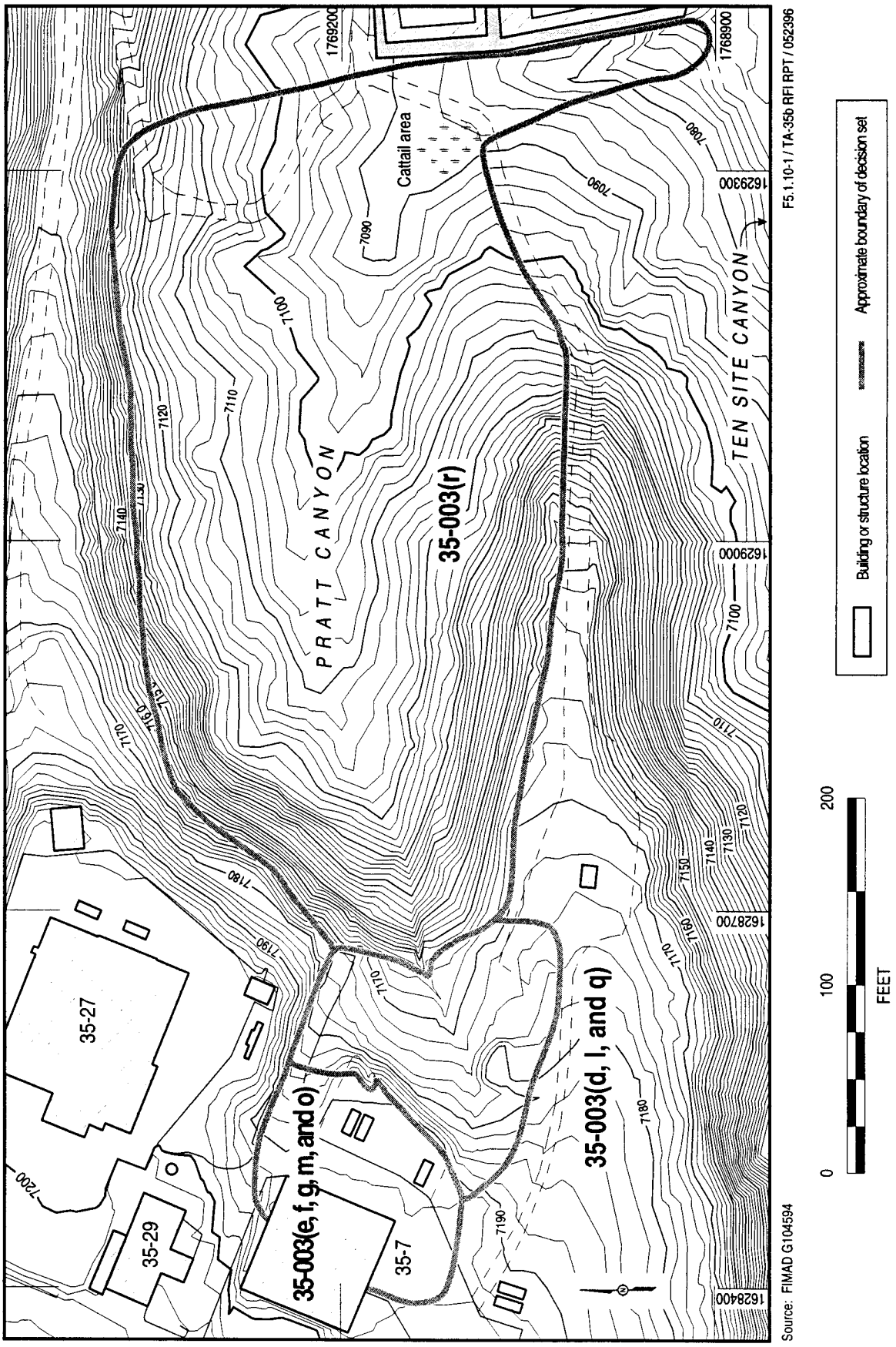


Figure 5.1.10-1. Approximate boundaries of decision sets.

- Engineering controls to prevent the further release of contamination to the accessible environment. This could be proposed if the remaining buried sources of contamination at the PRSs discussed in Sections 5.1 and 5.2 consist principally of radionuclides with half-lives measured in years or decades (for example, ^{90}Sr, ^{137}Cs).

- Removal of some buried material could be considered if the inventory of long-lived hazardous chemicals or radionuclides such as $^{239,240}Pu$ is large and their migration to the accessible environment cannot be prevented by natural barriers such as sorption onto tuff and very low migration rates in tuff.

No further action in this area could be considered if the remaining inventory of buried radionuclides and hazardous chemicals is sufficiently small that they would not present a serious risk to human health or the environment even if released at a maximum plausible rate into the accessible environment.

Further investigations in this area will address the following questions.

- What radionuclides and hazardous chemicals are present in the subsurface in quantities of potential concern if they should be released to the accessible environment? What are the spatial distributions of these contaminants? What is the approximate contaminant inventory still remaining on the mesa above Pratt Canyon?

Phase I data indicate the presence of strong beta emitters at many locations, probably ^{90}Sr (based on site history) as well as some gamma emitters. Elevated plutonium and uranium isotopes were noted at some locations, although they were not reported above SALs. Slightly elevated levels of lead and zinc were reported in a few locations, including one sample taken from backfill material that also contained some polycyclic aromatic hydrocarbons (PAHs).

In general, Phase I sampling showed the backfill material to be relatively clean except for one sample from Location ID. No. 35-2026. Most of the remaining contaminant inventory is expected to be localized at or within a few feet below the backfill/tuff interface. Phase I field screening for beta/gamma radioactivity indicate that radionuclides are concentrated near this interface in most locations (for example, at Location ID No. 35-2009) and have migrated a few feet into the underlying tuff only below a couple of PRSs (specifically, PRS Nos. 35-003[m] and 35-003[o]). However, Phase I boreholes were placed predominantly at locations of known or suspected releases; therefore, Phase I data do not indicate whether radionuclides or other released chemicals have migrated laterally from these original release points.

The investigations in the mesa-top PRSs may have to be extended westward after the FY96 decommissioning activities have been completed to estimate the total inventory of residual contamination. Some sampling is being coordinated with decommissioning and voluntary corrective actions associated with PRS Nos. 35-003(a, b, c, n, and misc.) (LANL 1996, 53733).

PRS Nos. 35-016(k) (an inactive outfall) and 35-016(l) (an active daylight discharge channel) also drain into Pratt Canyon. Extent of potential contamination associated with these PRSs will also be evaluated during this investigation.

- What are the hydrological, geochemical and biological factors controlling migration of radionuclides and other chemicals?

  Currently the western half of this area (i.e., the mesa-top surrounding PRSs Nos. 35-003(e, f, g, m, and o), Section 5.1) is paved, which controls erosion but may lead to the accumulation of moisture in the subsurface by preventing evapotranspiration. The eastern half (Section 5.2) is unpaved. Storm water is eroding a deep channel into the backfill material and creating a potential pathway for buried contaminants into Pratt Canyon. Deep-rooting plants like chamisa (*Chrysothamnus naseous*) grow in the area

and could bring buried contaminants to the surface. Some clay-filled fractures were observed in cores drilled at the site, and at least one of these produced very high field readings (borehole at Location ID No. 35-2018, see Table 5.1.4-2). Migration of contaminants in response to these physical factors is controlled by geochemical factors (such as the speciation and adsorption of the radionuclides) and by hydrological factors (such as surface water transport). Hydrological and geochemical factors also affect the biological uptake of contaminants by roots in soils and in tuff fractures.

5.1.10.1.2 Pratt Canyon

Pratt Canyon (discussed in Section 5.3) is shown in Figure AIII-2 in Attachment III of this RFI report. Further investigations are required to support baseline human health and ecological risk assessment as well as evaluation of the potential for further migration into Ten Site Canyon and possibly beyond the boundaries of the Laboratory. Potential remedial or interim actions to address past releases to this canyon include localized "hot spot" (elevated radioactivity) cleanup and the maintenance or establishment of barriers to erosion such as the sediment trap created by the road that leads to the TA-35 sewage lagoons and crosses the outflow from Pratt Canyon. The following questions need to be addressed during the execution of the SAP.

- What radionuclides and hazardous chemicals are present in Pratt Canyon at levels that could pose a risk to human health or the environment? What is their spatial distribution in sediments? What is the approximate contaminant inventory still remaining in Pratt Canyon? In what quantities and by what routes are they entering the biological food chain?

  The Phase I grid survey indicated elevated levels of beta/gamma radioactivity particularly (see Figure 5.1.4-1) in three areas: on the steep slope below the end of the daylight discharge channel (see Figure 5.1-1), on tuff boulders at the mouth of the erosion gully at the west end of the canyon, and in the small cattails area near the lagoon at the east end of TA-35. Elevated chromium was found in one of the floodplain samples near the east end of the canyon, and PAHs were found in one surface sample collected in the active channel. PAHs and petroleum hydrocarbons were also found on the north slope of the canyon below the storm drains that carry runoff from a large portion of TA-35 (Location ID No. 35-2214).

  Some of the contaminants released during the 1950s are known to have migrated out of Pratt Canyon into Ten Site Canyon and beyond. The cattails area probably dates only from the 1970s when the sewage lagoon was constructed. However, residual contamination may remain in sediments in the less active parts of the floodplain.

  Plants that are potential sources of food or fuel for human consumption and browse species for wildlife in the canyon include Gambel's oak (*Quercus gambelii*), mountain mahogany (*Cerocarpus montanus*), ponderosa pine (*Pinus ponderosa*), and cattails (*Typha latifolia*). Some of the vegetation in the canyon contains beta and/or gamma emitters at concentrations detectable by field instruments.

- What are the hydrological and geochemical factors controlling migration of radionuclides and other chemicals in Pratt Canyon and into Ten Site Canyon?

  Lateral flow from the PRSs discussed in Sections 5.1 and 5.2 of this RFI report would most likely emerge at the surface or in the shallow alluvium of Pratt Canyon. The presence of cattails in one small area indicates the presence of a small perched water zone, apparently created by the slightly elevated and compacted roadbed that crosses the canyon at this point. A second moist area in Ten Site Canyon is indicated by the presence of a stand of willows just east of the current confluence of Pratt Canyon and Ten

Site Canyon. However, the canyon is generally dry except during runoff events. For much of the length of Pratt Canyon, the active channel is narrow and well-defined, but the overhanging banks are flooded by large events and may store residual contamination.

The floor of Pratt Canyon is situated at the base of cooling unit 3 of the Tshirege Member (Qbt3) of the Bandelier Tuff and is bounded by relatively clay-rich colluvial deposits. The geochemical properties of these colluvial deposits have not been extensively characterized, and they may differ substantially from those of the sediments washed down from the mesa top east of TA-35-7.

Sampling will end at the confluence with Ten Site Canyon. Ten Site Canyon has received contamination from TA-50 as well as from the TA-35 PRSs (LANL 1995, 49925). Limited sampling above and below the confluence will permit a preliminary evaluation of the relative contribution from Pratt Canyon.

5.1.10.1.3 Regulatory Drivers

Sampling is primarily driven by the EPA RCRA Module VIII Hazardous and Solid Waste Amendments (HSWA) permit, which was issued on May 23, 1990, and modified on May 19, 1994. Other regulatory drivers may include the following.

- State of New Mexico's (NM) Water Quality Act and implementing regulations
- NM Solid Waste Act and implementing regulations
- NM Hazardous Waste Act and implementing regulations
- NM Radioactive and Hazardous Materials Act and implementing regulations

Federal regulatory drivers include the following.

- The Federal Facilities Compliance Act and implementing regulations
- The Toxic Substances Control Act and implementing regulations
- The Clean Water Act and implementing regulations
- RCRA/HSWA implementing regulations

5.1.10.2 Sampling and Analysis Plan Design

Sampling for PRS Nos. 35-003(d, e, f, g, m, o, q, and r) will comprise several types of investigations.

- Sampling and analysis of subsurface backfill material, soil, and tuff from boreholes in the mesa-top PRSs

  This information is needed to estimate the remaining inventory of buried contaminants and its distribution.

- Geomorphic and radiometric field surveys in Pratt Canyon to locate alluvial sediments that could store contaminants released during the 1950s (and more recently) and to identify locations of radioactively contaminated sediments and vegetation

  This information is needed to bias sediment and vegetation sampling, to identify potential areas for remediation, and as input for sediment transport modeling.

- Physical measurements of surface water flow and of geochemical and geotechnical properties in tuff, soil, sediments, and water

  Site-specific information on these types of parameters is needed to model the rate at which contaminants could be transported into and through Pratt Canyon. Core materials will be archived pending analytical results. After the necessary number of measurements has been established, the core will be submitted for the geotechnical measurements.

- Sediment and vegetation sampling of Pratt Canyon colluvial and alluvial floodplain samples

  This information is needed both to bound the total inventory of contaminants there for human health risk assessment under current use scenarios and to estimate concentration ratios defining the uptake of contaminants into biota, which is relevant for human health risk assessment under alternative scenarios and for ecological risk assessment.

- Background sediment and soil sampling to characterize the relatively clay-rich colluvial deposits that border Pratt Canyon

  These deposits, which are potentially rich in iron and associated trace elements, are one source of sedimentary material in the floodplain.

- Sediment sampling in the active channels of Pratt Canyon

  This information will be used to determine the extent of any petroleum hydrocarbon releases in storm water runoff and to evaluate the need for and feasibility of localized voluntary corrective action to address them. Surface runoff from other PRSs on the mesa top drain into the Pratt Canyon surface water. Transport issues associated with PRS Nos. 35-016(k and l) will also be addressed by the sediment sampling.

These activities are described in the following subsections. Samples and analyses are summarized in Table 5.1.10-1. Specific sampling and analytical methods to be used, including a list of analytes for each suite identified in Table 5.1.10-1, are described in Section 5.1.10.3.

5.1.10.2.1 Buried Contaminant Inventory

Phase I field observations demonstrated significant residual contamination at and below the backfill/tuff interface at Location ID Nos. 35-2016 and 35-2018 (see Figure AIII-1 in Attachment III of this RFI report). Clusters of three boreholes, within 20 ft of one another, will be drilled near these two locations to a depth of at least 30 ft. At each location one borehole will be drilled within 5 ft of the original Phase I sample location. Core material will be field screened for beta/gamma radiation, and the drilling will be continued beyond 30 ft if necessary, until at least 5 ft of core with background level screening is obtained.

In each borehole, one sample will be collected from the backfill material above the backfill/tuff interface. Its selection will be biased by field screening if radioactive contamination is detected above the interface. In the absence of such field indications, the backfill material sample will be collected immediately above the interface.

Three tuff samples will be collected from each borehole.

- The first sample will be collected at the backfill/tuff interface.

- The second sample will be collected from the interval below the interface with the highest field screening readings. If no elevated radiation measurements are made in a borehole, then this sample will be collected at about the 20-ft depth in the boreholes near Location ID No. 35-2016 and at about the 12-ft depth in the boreholes near Location ID No. 25-2018.

TABLE 5.1.10-1

SAMPLING SUMMARY FOR PRS Nos. 35-003(d, e, f, g, l, m, o, q, and r)

Sampling Area	Location ID No.	Matrix	Planned Depth (ft)	Analytical Suites						
				Moisture Content	Inorganic Constituents	Gross $-\alpha, -\beta, -\gamma$	Radionuclides	Organic Constituents	Particle Size Analysis	Geotechnical Properties
Ten Site Mesa, PRS No. 35-003(o), near Location ID No. 35-2016	35-2303-B1	Soil (backfill)	Biased	1	1	1	1	0	0	0
	35-2303-B2	Tuff	0–1*	1	1	1	1	0	0	1
	35-2303-B3	Tuff	Biased	1	1	1	1	0	0	0
	35-2303-B4	Tuff	Biased	1	1	1	1	0	0	0
	35-2303-B?	Soil (fracture fill)	Biased	1	1	1	1	0	0	0
	35-2304-B1	Soil (backfill)	Biased	1	1	1	1	0	0	0
	35-2304-B2	Tuff	0–1*	1	1	1	1	0	0	1
	35-2304-B3	Tuff	Biased	1	1	1	1	0	0	0
	35-2304-B4	Tuff	Biased	1	1	1	1	0	0	0
	35-2304-B?	Soil (fracture fill)	Biased	1	1	1	1	0	0	0
	35-2305-B1	Soil (backfill)	Biased	1	1	1	1	0	0	0
	35-2305-B2	Tuff	0–1*	1	1	1	1	0	0	1
	35-2305-B3	Tuff	Biased	1	1	1	1	0	0	0
	35-2305-B4	Tuff	Biased	1	1	1	1	0	0	0
	35-2305-B?	Soil (fracture fill)	Biased	1	1	1	1	0	0	0
Ten Site Mesa, PRS No. 35-003(m), near Location ID No. 35-2018	35-2306-B1	Soil (backfill)	Biased	1	1	1	1	0	0	0
	35-2306-B2	Tuff	0–1*	1	1	1	1	0	0	1
	35-2306-B3	Tuff	Biased	1	1	1	1	0	0	0
	35-2306-B4	Tuff	Biased	1	1	1	1	0	0	0
	35-2306-B?	Soil (fracture fill)	Biased	1	1	1	1	0	0	0
	35-2307-B1	Soil (backfill)	Biased	1	1	1	1	0	0	0
	35-2307-B2	Tuff	0–1*	1	1	1	1	0	0	1
	35-2307-B3	Tuff	Biased	1	1	1	1	0	0	0
	35-2307-B4	Tuff	Biased	1	1	1	1	0	0	0
	35-2307-B?	Soil (fracture fill)	Biased	1	1	1	1	0	0	0
	35-2308-B1	Soil (backfill)	Biased	1	1	1	1	0	0	0
	35-2308-B2	Tuff	0–1*	1	1	1	1	0	0	1
	35-2308-B3	Tuff	Biased	1	1	1	1	0	0	0
	35-2308-B4	Tuff	Biased	1	1	1	1	0	0	0
	35-2308-B?	Soil (fracture fill)	Biased	1	1	1	1	0	0	0

TABLE 5.1.10-1 (continued)

SAMPLING SUMMARY FOR PRS Nos. 35-003(d, e, f, g, l, m, o, q, and r)

Sampling Area	Location ID No.	Matrix	Planned Depth (ft)	Analytical Suites						
				Moisture Content	Inorganic Constituents	Gross $-\alpha$, $-\beta$, $-\gamma$	Radionuclides	Organic Constituents	Particle Size Analysis	Geotechnical Properties
Ten Site Mesa, PRS No. 35-003 (misc.), near Location ID No. 35-2026	35-2309-B1	Soil (backfill)	Biased	1	1	1	1	0	0	0
	35-2309-B2	Tuff	0–1*	1	1	1	1	0	0	1
	35-2309-B3	Tuff	Biased	1	1	1	1	0	0	0
	35-2309-B4	Tuff	Biased	1	1	1	1	0	0	0
	35-2309-B?	Soil (fracture fill)	Biased	1	1	1	1	0	0	0
Ten Site Mesa, PRS Nos. 35-003 (d, l, and q), near Location ID Nos. 35-2009, 35-2212, and 35-2011	35-2310-B1	Soil (backfill)	Biased	1	1	1	1	0	0	0
	35-2310-B2	Tuff	0–1*	1	1	1	1	0	0	1
	35-2310-B3	Tuff	Biased	1	1	1	1	0	0	0
	35-2310-B4	Tuff	Biased	1	1	1	1	0	0	0
	35-2310-B?	Soil (fracture fill)	Biased	1	1	1	1	0	0	0
	35-2311-B1	Soil (backfill)	Biased	1	1	1	1	0	0	0
	35-2311-B2	Tuff	0–1*	1	1	1	1	0	0	1
	35-2311-B3	Tuff	Biased	1	1	1	1	0	0	0
	35-2311-B4	Tuff	Biased	1	1	1	1	0	0	0
	35-2311-B?	Soil (fracture fill)	Biased	1	1	1	1	0	0	0
	35-2312-B1	Soil (backfill)	Biased	1	1	1	1	0	0	0
	35-2312-B2	Tuff	0–1*	1	1	1	1	0	0	1
	35-2312-B3	Tuff	Biased	1	1	1	1	0	0	0
	35-2312-B4	Tuff	Biased	1	1	1	1	0	0	0
	35-2312-B?	Soil (fracture fill)	Biased	1	1	1	1	0	0	0
West end of Pratt Canyon, PRS No. 35-003(r), near Location ID Nos. 35-2030 and 35-2249	35-2313-A1	Sediment	Biased	0	1	1	1	0	0	0
	35-2314-A1	Sediment	Biased	0	1	1	1	0	0	0
	35-2315-S1	Tuff	0-0.25	0	1	1	1	0	0	0
West end of Pratt Canyon, PRS No. 35-016(l), near Location ID No. 35-2214	35-2316-S1	Soil/Sediment	0-0.5	0	0	1	0	1	1	0
	35-2317-S1	Soil/Sediment	0-0.5	0	0	1	0	1	0	0
	35-2318-S1	Soil/Sediment	0-0.5	0	0	1	0	1	0	0
	35-2319-S1	Soil/Sediment	0-0.5	0	0	1	0	1	0	0

TABLE 5.1.10-1 (continued)

SAMPLING SUMMARY FOR PRS Nos. 35-003(d, e, f, g, l, m, o, q, and r)

Sampling Area	Location ID No.	Matrix	Planned Depth (ft)	Analytical Suites						
				Moisture Content	Inorganic Constituents	Gross $-\alpha, -\beta, -\gamma$	Radionuclides	Organic Constituents	Particle Size Analysis	Geotechnical Properties
Pratt Canyon, PRS No. 35-003(r), near Location ID No. 35-2028	35-2320-S1	Sediment	0-0.5	0	0	1	0	1	0	0
	35-2321-S1	Sediment	0-0.5	0	0	1	0	1	0	0
	35-2322-S1	Sediment	0-0.5	0	0	1	0	1	0	0
Pratt Canyon, PRS No. 35-003(r), paired vegetation/sediment samples	35-2323-A1	Sediment	Biased	0	1	1	1	0	0	0
	35-2324-G1	Vegetation (grass/forb)	N/A	0	1	1	1	0	0	0
	35-2325-A1	Sediment	Biased	0	1	1	1	0	0	0
	35-2326-G1	Vegetation (grass/forb)	N/A	0	1	1	1	0	0	0
	35-2327-A1	Sediment	Biased	0	1	1	1	0	0	0
	35-2328-G1	Vegetation (grass/forb)	N/A	0	1	1	1	0	0	0
	35-2329-A1	Sediment	Biased	0	1	1	1	0	0	0
	35-2330-G1	Vegetation (grass/forb)	N/A	0	1	1	1	0	0	0
	35-2331-A1	Sediment	Biased	0	1	1	1	0	0	0
	35-2332-G1	Vegetation (shrub)	N/A	0	1	1	1	0	0	0
	35-2333-A1	Sediment	Biased	0	1	1	1	0	0	0
	35-2334-G1	Vegetation (shrub)	N/A	0	1	1	1	0	0	0
	35-2335-A1	Sediment	Biased	0	1	1	1	0	0	0
	35-2336-G1	Vegetation (shrub)	N/A	0	1	1	1	0	0	0
	35-2337-A1	Sediment	Biased	0	1	1	1	0	0	0
	35-2338-G1	Vegetation (shrub)	N/A	0	1	1	1	0	0	0
	35-2339-A1	Sediment	Biased	0	1	1	1	0	0	0
	35-2340-G1	Vegetation (tree)	N/A	0	1	1	1	0	0	0
	35-2341-A1	Sediment	Biased	0	1	1	1	0	0	0
	35-2342-G1	Vegetation (tree)	N/A	0	1	1	1	0	0	0
	35-2343-A1	Sediment	Biased	0	1	1	1	0	0	0
	35-2344-G1	Vegetation (tree)	N/A	0	1	1	1	0	0	0
	35-2345-A1	Sediment	Biased	0	1	1	1	0	0	0
	35-2346-G1	Vegetation (tree)	N/A	0	1	1	1	0	0	0

TABLE 5.1.10-1 (continued)

SAMPLING SUMMARY FOR PRS Nos. 35-003(d, e, f, g, l, m, o, q, and r)

Sampling Area	Location ID No.	Matrix	Planned Depth (ft)	Analytical Suites						
				Moisture Content	Inorganic Constituents	Gross $-\alpha, -\beta, -\gamma$	Radionuclides	Organic Constituents	Particle Size analysis	Geotechnical Properties
Pratt Canyon, PRS No. 35-003(r), floodplain sediment samples	35-2347-A1	Sediment	0-3 (Biased)	0	1	1	1	1	1	0
	35-2348-A1	Sediment	0-3 (Biased)	0	1	1	1	1	1	0
	35-2349-A1	Sediment	0-3 (Biased)	0	1	1	1	1	1	0
	35-2350-A1	Sediment	0-3 (Biased)	0	1	1	1	1	1	0
Pratt Canyon cattails area, sediment and vegetation sampling	35-2351-A1	Sediment	0-1	0	1	1	1	1	1	0
	35-2351-A2	Sediment	1-2	0	1	1	1	0	0	0
	35-2351-A3	Sediment	2-3	0	1	1	1	0	0	0
	35-2352-A1	Sediment	0-1	0	1	1	1	0	0	0
	35-2352-A2	Sediment	1-2	0	1	1	1	0	0	0
	35-2352-A3	Sediment	2-3	0	1	1	1	0	0	0
	35-2365-A1	Sediment	0-1	0	1	1	1	0	0	0
	35-2365-A2	Sediment	1-2	0	1	1	1	0	0	0
	35-2365-A3	Sediment	2-3	0	1	1	1	0	0	0
	35-2366-G1	Vegetation (cattails)	N/A	0	1	1	1	0	0	0
	35-2367-G1	Vegetation (cattails)	N/A	0	1	1	1	0	0	0
	35-2368-G1	Vegetation (cattails)	N/A	0	1	1	1	0	0	0
	35-2369-G1	Vegetation (cattails)	N/A	0	1	1	1	0	0	0
Pratt Canyon cattails area, tuff and water sampling	35-2370-B1	Tuff	5-10 (est)	1	1	1	1	0	0	1
	35-2370-B2	Tuff	10-15 (est)	1	0	1	0	0	0	1
	35-2370-B3	Tuff	15-20 (est)	1	0	1	0	0	0	1
	35-2370-B4	Tuff	20-25 (est)	1	0	1	0	0	0	1
	35-2370-B5	Tuff	25-30 (est)	1	0	1	0	0	0	1
	35-2371-W1	Alluvial water (filtered)	N/A	0	1	1	1	0	0	0
	35-2371-W2	Alluvial water (unfiltered)	N/A	0	0	1	0	1	0	0
	35-2372-W1	Pore water (filtered)	N/A	0	1	1	1	0	0	0
	35-2372-W2	Pore water (unfiltered)	N/A	0	0	1	0	1	0	0

TABLE 5.1.10-1 (continued)

SAMPLING SUMMARY FOR PRS Nos. 35-003(d, e, f, g, l, m, o, q, and r)

Sampling Area	Location ID No.	Matrix	Planned Depth (ft)	Analytical Suites						
				Moisture Content	Inorganic Constituents	Gross $-\alpha, -\beta, -\gamma$	Radionuclides	Organic Constituents	Particle Size Analysis	Geotechnical Properties
Pratt Canyon cattails area, tuff and water sampling (continued)	35-2372-W3	Pore water (filtered)	N/A	0	1	1	1	0	0	0
	35-2372-W4	Pore water (unfiltered)	N/A	0	0	1	0	1	0	0
	35-2373-W1	Pore water (filtered)	N/A	0	1	1	1	0	0	0
	35-2373-W2	Pore water (unfiltered)	N/A	0	0	1	0	1	0	0
	35-2373-W3	Pore water (filtered)	N/A	0	1	1	1	0	0	0
	35-2373-W4	Pore water (unfiltered)	N/A	0	0	1	0	1	0	0
Pratt Canyon active channel weirs and surface water gauges	35-2374-W1	Surface water (filtered)	N/A	0	1	1	1	0	0	0
	35-2374-W2	Surface water (unfiltered)	N/A	0	0	1	0	1	0	0
	35-2375-W1	Surface water (filtered)	N/A	0	1	1	1	0	0	0
	35-2375-W2	Surface water (unfiltered)	N/A	0	0	1	0	1	0	0
	35-2376-W1	Surface water (filtered)	N/A	0	1	1	1	0	0	0
	35-2376-W2	Surface water (unfiltered)	N/A	0	0	1	0	1	0	0
	35-2377-W1	Surface water (filtered)	N/A	0	1	1	1	0	0	0
	35-2377-W2	Surface water (unfiltered)	N/A	0	0	1	0	1	0	0
	35-2378-W1	Surface water (filtered)	N/A	0	1	1	1	0	0	0
	35-2378-W2	Surface water (unfiltered)	N/A	0	0	1	0	1	0	0
	35-2379-W1	Surface water (filtered)	N/A	0	1	1	1	0	0	0
	35-2379-W2	Surface water (unfiltered)	N/A	0	0	1	0	1	0	0

TABLE 5.1.10-1 (continued)

SAMPLING SUMMARY FOR PRS Nos. 35-003(d, e, f, g, l, m, o, q, and r)

Sampling Area	Location ID No.	Matrix	Planned Depth (ft)	Analytical Suites						
				Moisture Content	Inorganic Constituents	Gross $-\alpha, -\beta, -\gamma$	Radionuclides	Organic Constituents	Particle Size Analysis	Geotechnical Properties
Pratt Canyon, background soil sampling	35-2380-A1	Soil (A horizon)	0–0.5 (est.)	0	1	1	1	0	0	0
	35-2381-A1	Soil (B horizon)	0.5–1 (est.)	0	1	1	1	0	0	0
	35-2382-A1	Soil (B horizon)	0.5–1 (est.)	0	1	1	1	0	0	0
	35-2383-A1	Soil (C horizon)	1–2 (est.)	0	1	1	1	0	0	0
Ten Site Canyon	35-2384-S1	Sediment	0.5–1	0	1	1	1	0	0	0
	35-2385-S1	Sediment	0.5–1	0	1	1	1	0	0	0

* Tuff sample will be collected in the first 1-ft interval below the sediment/tuff interface.

- The third sample will be collected from the first 5-ft interval at which background radiation levels are observed. If no elevated radiation measurements are encountered in a borehole, then this sample will be collected approximately 5 ft below the second sample.

One borehole will be drilled into the backfilled area beneath the former tank farm, and two boreholes will be drilled in the backfill material east of the tank farm (see Figure AIII-1 in Attachment III of this RFI report). One of the latter boreholes will be drilled within 5 ft of Location ID No. 35-2009. All boreholes will be drilled to a depth of at least 30 ft (or more if necessary) to obtain at least 5 ft of core with field-measured background beta/gamma radiation levels. In each borehole, one sample will be collected in the backfill material above the backfill/tuff interface (biased by field screening). Three samples will be collected in the tuff: at the backfill/tuff interface, below the interface at the point of highest radioactivity screening results, and approximately 5 ft below the deepest detected elevated field screening results. If no elevated field screening results are obtained in the tuff, the second sample will be collected 2 ft below the backfill/tuff interface, and the third sample will be collected at total depth.

One borehole will be drilled to a depth of 2 ft below the backfill/tuff interface at a location 10 to 15 ft east/southeast (along the path of the excavated lines) of Location ID No. 35-2026. A backfill material sample will be collected either at the point with the highest beta/gamma radiation measurements or (in the absence of above-background measurements) at a depth of 3 ft. A second sample will be collected from the first 1 ft of tuff below the interface.

If clay-filled fracture zones are encountered while drilling in the tuff, up to ten samples of fracture-fill material will be collected. If suitable, some of this material will be reserved for measurement of parameters needed for flow and transport modeling, as described in Section 5.1.10.2.3.

Geological logs will be provided for all boreholes. Beta/gamma radiation field screening results will be reported for each 5-ft interval (a range) and for each sampled interval (a point reading). Core from the tuff layer below the backfill material will be analyzed at 5-ft intervals in the mobile laboratory facility for gravimetric moisture content.

Up to three samples of core will be collected to measure parameters needed for flow and transport modeling. The required geotechnical, hydrologic, and geochemical analyses and use of these data are described in Section 5.1.10.2.3.

All backfill material, tuff, and fracture fill samples will be analyzed by standard laboratory methods for ^{90}Sr, tritium, gamma spectroscopy analytes, uranium and plutonium isotopes, and inorganic constituents. If fracture fill or tuff samples with gravimetric moisture content exceeding 50% H_2O (g/g) are collected, the pore water will be extracted and analyzed for ^{90}Sr and tritium.

The analytical results will be used to estimate the total inventory of radionuclides and other chemicals that remain buried to the east of TA-35-7. The results will also provide data to estimate the depth distribution of residual contamination and the lateral extent in three areas of known releases.

Assumptions and Data Quality Requirements

Because of the field biasing, inventory estimates based on these data are expected to be biased high for beta and gamma emitters. For other contaminants, which are not necessarily collocated with the beta and gamma emitters, the bias may be less significant.

5.1.10.2.2 Field Surveys

Geomorphic Survey

A geomorphic survey will be conducted in Pratt Canyon to identify sedimentary deposits most likely to contain Laboratory-derived contamination from the mesa-top PRSs. The course of storm water runoff below Location ID

No. 35-2214 must also be mapped to the point where it joins the main channel draining the mesa-top PRSs. This mapping will bias sample collection described in Section 5.1.10.2.6 to locations where contaminants are expected to have accumulated.

Geomorphic characterization activities focus on the identification, description, and mapping of surface deposits and land forms that provide evidence for processes that can potentially result in the exposure and/or transport of contaminants. In Pratt Canyon, the geomorphic characterization will focus on identifying young (post-1950), potentially contaminated sediment deposits by relying primarily on nonintrusive observational and measurement techniques. Boundaries of geomorphic units are commonly marked by distinct topographic breaks; although, in places such boundaries may be gradational and more difficult to delineate. Direct visual observation of partially buried objects and debris, especially those that can be linked to Laboratory activities, provide conclusive evidence of post-1950 deposition events and, therefore, the age of some geomorphic units. Further evidence for the age of geomorphic units can be obtained by observing the nature and age of vegetation in different areas of the reach, such as whether the bases of trees are buried by sediment. Flood debris, such as driftwood, may provide additional evidence of the extent of historic flooding and the distribution of historic overbank sediment deposition. Identification of the pre- and post-1950 floodplains is required to focus radiometric surveys and subsequent sampling within Pratt Canyon.

Sediment Transport

Site-specific input will be collected for several parameters needed to support sediment transport modeling. This input includes topography (slope and slope length), soil erosion potential (a function of texture, organic matter and soil structure), and vegetation characteristics.

Radiometric Survey

A field radiometric survey for gross-alpha, -beta, and -gamma radiation will be conducted on the floodplain using a 5-ft grid, where practical, from the west end of Pratt Canyon to the road below the area of cattail growth, excluding the cattails area itself (see Figure AIII-2 in Attachment III of this RFI report.) Discrete geomorphic features identified as potential deposition zones for contaminated sediments will be surveyed in more detail to provide information about contaminant distributions. Bank cuts where buried sediments are exposed along the active channel will also be examined. Potentially contaminated sedimentary deposits identified by the geomorphic survey will be surveyed in more detail, including bank cuts where buried sediments are exposed along the active channel. Vegetation with elevated readings will also be identified and mapped.

Ecological Survey

A vegetation survey will be coordinated with the field radiometric survey so that appropriate pairs of sediment and vegetation samples can be identified. Paired sediment and vegetation samples are needed to test whether ratios of plant COPC concentrations to sediment concentrations fall within published ratios. Key plant species for human health and/or ecological exposure scenarios include Gambel's oak and mountain mahogany (shrubs), ponderosa pine, cattails, and species in the grass/forb layer. The range of gross-beta and -gamma radiation in the root zones of at least 12 individuals from each of the grass/forb, shrub, and tree growth forms will be recorded during the vegetation survey so that pairs covering an appropriate range can be selected for sampling and analysis as described in Section 5.1.10.2.4. (Because ponderosa pines and shrubs may have laterally extensive root zones, individuals growing outside of the floodplain may be included. The range of gross-beta and -gamma radiation in the adjacent floodplain areas and the distance from plant stem to the adjacent floodplain should be recorded in these cases, as well as the range of radioactivity directly under the plant canopy.) Above-background radioactivity measured for vegetation will also be recorded.

The gross radioactivity in the cattails area will be measured at the sampling sites during sample collection (see Section 5.1.10.2.4).

Assumptions and Data Quality Requirements

The locations for vegetation sampling must include those with beta and gamma root-zone measurements from the full range of activity (including some with background measurements if available). This strategy may require that more than 12 pairs be recorded. If vegetation with elevated radioactivity readings is found where the surrounding surface sediments show only background radioactivity, this finding should be specifically recorded because it may indicate a potential subsurface "hot spot."

5.1.10.2.3 Geochemical Investigations and Modeling

Computational modeling of geochemical processes influencing the fate and transport of COPCs, including ^{90}Sr, ^{137}Cs, and uranium and plutonium isotopes, may be performed using surface water and pore-water data. Maximum concentrations of contaminants may be associated with pore water in the cattails area of Pratt Canyon. Investigations in the cattails area will also focus on determining the extent of the water-bearing zone(s) and the potential for recharge to the underlying Bandelier Tuff. The intermittent surface water in the stream channel of Pratt Canyon consists almost entirely of runoff water from TA-35. Surface water is closely linked to the pore-water system (both chemically and hydraulically over short time periods); therefore, information about contamination in the surface water is also important to gain a complete understanding of the connected systems. Erosion and sediment transport are also important aspects of the hydrological system in Pratt Canyon. The results of such calculations will be used to determine if countermeasures are required to slow or arrest the rate of contaminant transport into Ten Site Canyon.

Surface Water Sampling

Surface water flow will be measured at two automatic gauging stations in Pratt Canyon and will operate through at least one annual cycle (spring, summer, and fall). One water gauging station will be installed in the western third of the canyon. The other will be installed below the road crossing at the cattails area, as shown in Figure AIII-2 in Attachment III of this RFI report. The type of gauging station appropriate to the environmental setting of Pratt Canyon will be decided in consultation with the Laboratory Water Quality and Hydrology group (ESH-18).

The gauging stations will measure the total volume of each flow event and will automatically collect time-weighted grab samples for each event with sufficient flow. These samples will be analyzed for three events (approximately quarterly, in spring, and either summer and fall or early and late summer, as flow permits). A filtered sample and an unfiltered sample will be submitted for chemical and radiochemical analyses. Filtered samples will be analyzed for ^{90}Sr, mid-level tritium, gross radioactivity, trace metals, major and minor anions, silica, and dissolved organic carbon. Unfiltered samples will be analyzed for gross radioactivity, SVOCs, PCBs, and total petroleum hydrocarbons (TPH).

Saturated Zone Sampling

Pore-water samples will be collected from two drive points in the cattails area, one on the upgradient side and one on the downgradient side (see Figure AIII-2 in Attachment III of this RFI report). These drive points are expected to be less than 10 ft deep and have a 3- to 5-ft screen placed at the water table (top of the screen at the water table) to account for variations in saturated thickness in the cattails area. Pore-water samples will be collected two times, once during relatively high surface water flow and again at relatively low (or no) surface water flow.

Field-measured parameters consist of pH, temperature, specific conductance, and carbonate alkalinity. Filtered pore-water samples will be analyzed for ^{90}Sr, mid-level tritium, gross radioactivity, trace metals, major and minor anions, neutral species, and dissolved organic carbon. Unfiltered samples will be analyzed for gross radioactivity , SVOCs, PCBs, and TPH. These data are important for evaluating the significance of the cattails for retarding contaminant transport.

A borehole will be drilled at the eastern perimeter of the cattails area to the top of cooling unit 2 of the Tshirege Member of the Bandelier Tuff (Qbt2) (a total depth of approximately 30 ft.) If this borehole intercepts a perched alluvial zone, the water will be sampled and submitted for analyses as listed above.

A geological log will be recorded, and beta/gamma radioactivity will be measured by field screening methods for each 5-ft interval (a range) and for each sampled interval (a point reading). Measurements of moisture content will be made on 5-ft core intervals of tuff below the alluvial sediments.

One or two core samples will be collected from these intervals. Together with core collected from moist intervals in tuff as described in Section 5.1.10.2.1 (if any), these cores will be submitted for geotechnical and hydrologic property measurements.

Hydrological and geotechnical properties to be measured on Bandelier Tuff core samples include bulk density, porosity, particle size distribution, moisture content (gravimetric and volumetric), matric potential, distribution (adsorption) coefficients, and saturated hydraulic conductivity. This information will be used to model matrix transport in the tuff. However, unless significant levels of moisture are found in the tuff (above 50% saturation), matrix transport is not a significant pathway, and site-specific geotechnical measurements may not be obtained.

One tuff sample will be collected from the first 6 ft of tuff below the sediment/Bandelier Tuff contact in the cattails area borehole. This sample should be biased, if possible, by field beta/gamma radioactivity measurements and/ or moisture content. This sample will be analyzed by standard laboratory methods for ^{90}Sr, tritium, gamma spectroscopy analytes, uranium and plutonium isotopes, and inorganic constituents to determine whether contaminants are moving vertically below the cattails area. If the moisture content in this interval (the first 6 ft) is greater than 50% (g/g), one of the samples selected for pore-water analysis as described above should also come from this interval.

Geochemical Modeling

Radionuclide-metal adsorption, mineral precipitation, and solute (dissolved species) speciation will be evaluated using two geochemical computer codes, MINTEQA2 and PHREEQE, which have been developed by the EPA and the United States Geological Survey, respectively. Results obtained from the model simulations will be used to quantify geochemical processes relevant to risk analysis and risk decision. For example, it is important to know the speciated form(s) of ^{90}Sr (Sr^{2+}, $Sr\,HCO_3^-$, $Sr(OH)_2^o$), which influences the uptake of this radionuclide into plants growing within the cattails area. Adsorption reactions are also quantified using MINTEQA2. Cation exchange of strontium with other metals onto solid organic matter is an important process controlling the distribution of this element within Los Alamos Canyon (Longmire et al. 1996, 54168). Longmire et al. (1996, 54168) provide adsorption data (distribution coefficients) for ^{90}Sr for soils and creek channel sediments collected in Los Alamos Canyon, which can be used to supplement TA-35 data in evaluating ^{90}Sr transport at the mesa-top PRSs and within Pratt Canyon.

Sediment Transport Modeling

Erosion rates at the edge of Ten Site Mesa will be estimated using a physically based soil erosion model (Water Erosion Prediction Project [WEPP]) (Flanagan and Nearing 1995, 54166) that has recently been developed by the United States Department of Agriculture. A process-oriented model based on fundamentals of hydrology and on soil erosion mechanics, WEPP was developed to allow extrapolation to a broad range of conditions. It is a spatially distributed model capable of simulating erosion for small watersheds. Initial model tests for Pajarito Plateau conditions look promising, and efforts to calibrate and validate this model for local conditions is continuing (Wilcox and Simonton 1995, 54165; Wilcox et al. 1996, 54164).

The model will be parameterized using site characteristics that impact erosion, including topography, soil and vegetation characteristics, and climatic information.

Assumptions and Data Quality Requirements

The active channel in Pratt Canyon is dry except during seasonal runoff events; therefore, sediments and contaminants are likely to be mobilized only during such events.

No perched water zones were observed during Phase I drilling. Although no subsurface sampling was performed in the immediate vicinity of the cattails area where perched water is most likely to exist, plant species that do not thrive in saturated zones are growing within 20 ft of the cattails. Therefore, if any alluvial or perched water exists in that area, it is not laterally extensive.

It is assumed that the cattails area borehole will be located so that a shallow tuff sample can be collected downgradient with respect to a hydrologic head that might carry any contamination from the sediments downward into tuff. It is not practical or desirable to drill in the middle of the area, which should be disturbed as little as possible by sampling activities because it may be serving as a natural trap for any migrating contaminants. (Likewise, to minimize disturbance to this area, the drive points will be installed using a sledge hammer instead of a drill rig.) However, a borehole located close to the road on the eastern edge of the cattails area should serve this purpose.

5.1.10.2.4 Sediment and Vegetation Sampling in Pratt Canyon

Four sediment/vegetation pairs will be selected for each of the three growth forms: grass/forbs, shrubs, and trees. (Probable species are Gambel's oak, mountain mahogany, and ponderosa pine.) A method for making this selection from the 12 or more surveyed pairs for each species is described in Section 5.1.10.3.3. For each selected pair, one sediment sample from the root zone (in the intersection of the root zone with the flood plain) will be collected at a depth to be determined by the rooting depth of the species. A vegetation sample (leaves, stems, and fruit for Gambel's oak and mountain mahogany; a trunk core for ponderosa pine) will be collected from the associated individual.

The cattails are localized in a single compact area. Nine sediment samples from three depths and three locations and a total of four samples of the cattail tubers and the above-ground leaves and flower heads will be collected. The sediment samples should represent both the aerobic and anaerobic strata in the cattails area, if both are present. Samples will be field screened for beta/gamma radioactivity at the time of collection.

Four additional floodplain samples will be collected. These sample locations will be selected after the geomorphic and radiation surveys described in Section 5.1.10.3 are completed, and will correspond to either radioactive "hot spots" that may be found outside the cattails area or sediments identified during the geomorphic survey as possibly dating from the 1950s. These samples will be collected using a hand auger, and the depth with the highest radioactivity readings will be sampled (or, in the absence of above-background readings, a depth judged on geomorphic bases as possibly 30 to 50 years old.).

In addition, three Phase I "hot spots" will be sampled to obtain full-suite chemical and radiochemical analyses at these locations. Two of these samples will come from the split drainage on the slope below the end of the daylight diversion channel (approximately Location ID Nos. 35-2249 and 35-2030). The depth of these samples will be determined by field beta/gamma radiation screening within the 0 to 3-ft interval; the default depth in the absence of elevated radiation is 6 to 12 in. The third sample will be a tuff sample collected from the surface (0 to 2 in.) of one of the tuff boulders at the mouth of the erosion channel at the west end of Pratt Canyon, which exhibit elevated beta/gamma radioactivity.

Two near-surface sediment samples will be collected in Ten Site Canyon. One location will be selected above the modern confluence of Pratt Canyon and Ten Site Canyon. (The confluence may have been displaced slightly to the west when the sewage lagoon was constructed in the 1970s.) The second location will be selected to the east of the willows that are just east of the modern confluence. Geomorphically the two locations should be as similar as possible, and the sediments must be sufficiently deep that samples can be collected from below the mobile surface layer (approximately 6 to 12 in.).

The extent of soil development at all sampled locations will be described, including the presence of clay and organic matter in the sample. A subset of six samples will be selected for particle size measurements from locations extending the length of Pratt Canyon from the western boundary down to and including the cattails area. In addition, a subset of up to five samples with abundant clay, as determined by field observation, will be identified for clay fraction analyses. Five samples, including some with abundant clay, if possible, will be designated for SVOC, PCB, and TPH analysis.

Sediment samples will be sieved in the laboratory to remove gravel. Soil samples and the <2 mm fraction for all sediment samples will be analyzed by standard laboratory methods for ^{90}Sr, gamma spectroscopy analytes, uranium and plutonium isotopes, and inorganic constituents. Analysis of organic constituents in the gravel-free fraction will be requested for the designated sediment samples. The clay (<0.062 mm) fraction of the sediment samples in which clay was identified will be analyzed for the same analytical suites. Particle size analyses will be performed on the designated samples. The tuff sample will be analyzed for ^{90}Sr, gamma spectroscopy analytes, inorganic constituents, and uranium and plutonium isotopes.

Vegetation samples will be analyzed by autoradiography (ponderosa cores) and/or ground or ashed and analyzed by modified laboratory methods for ^{90}Sr, gamma spectroscopy analytes, uranium and plutonium isotopes, and inorganic constituents.

Sediment and vegetation data will be used directly in the human health risk assessment and to evaluate the need for interim measures or long-term corrective actions to limit exposure or control erosion in Pratt Canyon. Paired sediment/vegetation data will be used to characterize routes by which soil contamination enters the food chain and other biological pathways (for example, use of ponderosa pine for fuel) by providing preliminary estimates of concentration ratios. These data will be used eventually in ecological risk assessment and also for separate human health risk assessment under alternative scenarios (especially the American Indian scenario), which must incorporate data from other parts of Ten Site Canyon and Mortandad Canyon.

Assumptions and Data Quality Requirements

Sample locations in the cattails area must not consist solely of "convenience" samples that are biased toward the edge of the stand. Taken as a whole, the samples should be representative of the entire stand.

To obtain some measure of the contribution of sampling and analysis variability to the uncertainty in estimates of concentration ratios, sampling for one individual of each species will be duplicated (that is, a second sediment sample and a second vegetation sample will be collected). The duplicated individual should be associated with the highest radioactivity measurement (for sediment and/or vegetation) among the sampled pairs of that species.

5.1.10.2.5 Background Soils and Sediments

A total of four samples will be collected from the A, B (two samples), and C master horizons in the clay-rich soil that is found on the floor of Pratt Canyon. These samples will be collected from an area north of the sewage lagoon that has been unaffected by activities at TA-35. Samples will be analyzed for inorganic and radionuclide constituents, including "fallout" radionuclides such as ^{241}Am, ^{137}Cs, ^{238}Pu, ^{239,240}Pu, and ^{90}Sr.

These background soil samples will supplement the Laboratory-wide data set reported by Longmire et al. (1995, 48818; 1995, 52227). By comparison with the mesa-top soils and sediments that represent the other principal source of material for Pratt Canyon sediments, these reddish soils are expected to be enriched in iron and in trace elements with an affinity for iron (such as arsenic and manganese). Background sediments in Pratt Canyon may also be enriched in these elements by comparison with the limited existing background sediment data set provided by Longmire et al. (1995, 52227). Because it is difficult to find sediments unaffected by Laboratory activities in either Pratt Canyon or Ten Site Canyon, data from these background samples are needed to avoid misinterpreting inorganic and radionuclide data from Pratt Canyon floodplain sediments.

5.1.10.2.6 Petroleum Hydrocarbon Contamination

Location ID Nos. 35-2214 and 35-2028 will be resampled (0 to 6 in. surface samples). Three additional surface sediment samples will be collected: two approximately 5 ft and one approximately 15 ft downgradient from the former location and at the point where storm runoff from the culvert at Location ID No. 35-2214 enters the main Pratt Canyon channel. Two additional samples will be collected approximately 15 and 25 ft downgradient from Location ID No. 35-2028. All samples will be analyzed for SVOCs, PCBs, and TPH. These data will be used to determine whether voluntary corrective action is required to address any oil spills that may have migrated into the canyon from mesa-top PRSs (for example, PRS Nos. 35-016[k and l]).

5.1.10.2.7 Schedule Constraints

A complete inventory of residual buried contamination on the mesa top will require additional sampling in areas that are currently undergoing decommissioning. This sampling cannot be planned until decommissioning and associated data collection activities are completed; however, it will be coordinated with the sampling described in Section 5.1.10.2.1.

Some of the sampling described in Section 5.1.10.2.3 must be carried out at different seasons, beginning before the spring snowmelt if there is measurable snowpack on the slopes of upper Pratt Canyon.

Vegetation samples will be collected during periods of greatest biological activity and when receptors are likely to be exposed to COPCs in vegetation. Cattail tubers and sediment pore water will be collected concurrently during the growing season when there is surface flow in Pratt Canyon. Cattail flowers will be collected in late summer or early fall when they are mature. Other vegetative samples will be collected when fruits reach maturity (late summer) and at other times when foraging animals consume vegetation (that is, grasses and forbs in summer and shrub stems in summer and fall).

5.1.10.3 Sampling and Analysis Plan Implementation

The overall sample collection design for the investigation of PRS Nos. 35-003(d, e, f, g, l, m, o, q, and r) is summarized in Table 5.1.10-1. The field and measurement methods proposed for sample collection and analysis are discussed in the following sections. Field QA/QC samples, such as field blanks and collocated samples, will be collected according to the most recent Environmental Restoration (ER) Project guidance (LANL 1996, 53450). Quality control (QC) samples are not included in the number of samples in Table 5.1.10-1 except for some duplicate pairs explicitly called out at the end of Section 5.1.10.2.4.

5.1.10.3.1 Field Methods

Field Surveys

The geomorphic investigation of Pratt Canyon will be performed according to LANL-ER-SOP-03.08,R0, "Geomorphic Characterization." Field activities will be documented according to LANL-ER-SOP-03.12, "Field and Laboratory Notebook Documentation for ER Earth Sciences Studies." The results of the geomorphic survey will be mapped onto topographical coverages of Pratt Canyon with 2-ft contours and a resolution of at least 1 in:25 ft. The geomorphic maps will be digitized and transmitted to the Facility for Information Management, Analysis, and Display (FIMAD) for electronic display.

The radiometric survey will use nonintrusive surface measurements of gross-alpha, -beta, and -gamma radiation. The gross radiation survey techniques will provide information about radioactivity originating from the surface of the sediment layer. The proposed instrumentation and their applications are summarized in Table 5.1.10-2. Because of the shielding of particle emissions by fine particulate surface layers, litter, and ambient air, it may not be possible to obtain meaningful gross-alpha measurements at the surface. Meaningful gross-alpha

TABLE 5.1.10-2

DESCRIPTION OF RADIOLOGICAL SURVEY INSTRUMENTATION

Instrument/Detector	Emission Detected	Applications
Zinc sulfide (ZnS) scintillator	α	Gross-alpha radiation screening
Gas proportional counter	α/β	Gross-alpha/-beta radiation screening, field surveys, and point source detection
Geiger-Müller pancake	β/γ	Gross-beta/-gamma radiation screening, field surveys, and point source detection
Plastic scintillator	β	Gross-beta radiation screening
Sodium iodide (NaI[Tl]) scintillator	γ	Gamma radiation screening, field surveys, and point source detection

measurements may be obtained by first removing the top 2- to 5-cm surface layer (for example, the litter layer) and then using a zinc sulfide scintillator probe to detect alpha particles. Gross-beta or gross-beta/gamma measurements can be made using Geiger-Müller (GM) pancake probe or gas proportional counter detectors. Detection of gross-gamma emissions can be achieved using a sodium iodide scintillator detector. The minimum detectable activity of the detectors proposed to be used in a 60-second count of a 100 g sample is about 0.2 pCi/g for the gross radiation counters.

The initial walkover survey will take many short count-time (1 to 10 seconds) measurements. The short count-time measurements will provide low-resolution, qualitative data over a large area and allow rapid identification of specific point sources of near-surface radioactivity ("hot spots"). Longer count-time (60 seconds or longer) measurements will be made at locations where radiological anomalies are detected and at selected, representative locations within each geomorphic unit to achieve higher resolution data. Geodetic measurements will be made to provide locational data for mapping of the radiometric survey data. The radiological measurements will be mapped onto topographical coverages of Pratt Canyon with 2-ft contours and a resolution of at least 1 in:25 ft. The radiometric maps will be digitized and transmitted to FIMAD for electronic display.

To determine whether contaminants are present at subsurface depths and to evaluate possible variations in contaminant concentrations between sediment layers, the vertical faces of bank cuts along active and inactive channels will be surveyed for gamma radioactivity. To provide spatial definition of approximately 1 cm, either a thallium-doped sodium iodide scintillator or a high-purity germanium detector collimated with lead shielding is proposed for the vertical surface survey. Either detector is sensitive to gamma radiation, particularly to the 0.66 MeV emission of the ^{137m}Ba daughter of ^{137}Cs.

An important consideration in the design of the radiometric survey is an appropriate definition and measurement of the "background" radioactivity that will be used as the decision level for comparison to the field measurements. The decision level is usually defined as the mean background value plus twice the standard deviation of the mean. Major contributions to the background count rate are emissions from naturally occurring radioactive material, cosmic rays, and electronic noise. The background level of radioactivity is expected to depend on proximity to Laboratory emission sources and the geology of the reach. Background count rate for a detector is usually determined by counting an area known to be uncontaminated and located as close to the sampling area as possible. If a known uncontaminated area close to the actual environmental measurement site is not available, the site can be surveyed and a background count rate determined by developing a statistical trend among the lowest measurements.

All borehole core intervals (maximum 5-ft lengths) will be field screened for gross beta/gamma radioactivity using GM pancake probe meters. These measurements will be used to bias the collection of core samples.

Sample Collection Methods

Sediment samples will be collected using the methods and ER Project standard operating procedures (SOPs) listed in Table 5.1.10-3 (LANL 1991, 21556). The tools used to collect the sediment samples will depend on the cohesion of the sediment material, the collection depth, and the presence of flowing or standing surface water. A scoop or ring sampler will be used to collect surface sediment samples at depths of 0 to 0.5 ft. A spade or hand auger may be used to collect sediment samples at depths up to 1 ft. A hand auger will be used to collect samples at depths exceeding 1 ft. If undisturbed lithologic samples are required to examine sedimentary strata, an open tube (Trier) or thin-wall tube sampler will be employed. If surface water is present at the sampling location, a scoop, trowel, or hand corer will be used to collect grab sediment samples.

Drilling methods (hollow-stem augering and rotary drilling) are described in LANL-ER-SOP-04.01, "Drilling Methods and Drill Site Management." Other applicable SOPs for drilling operations and borehole sampling are listed in Table 5.1.10-4. Drive points in the cattails area are to be installed using a sledge hammer rather than a drill rig. The cattails borehole will likewise be sited to minimize impact on this cattails area.

Surface water grab samples will be collected according to LANL-ER-SOP-06.13, "Surface Water Sample Collection." Surface runoff water samples will be collected according to the operating procedures provided by the manufacturer of the gauging stations. Samples will be filtered (as required) and preserved at the time of collection.

All samples will be collected following the applicable ER Project SOPs (LANL 1991, 21556) for the collection, preservation, identification, storage, transport, and documentation of environmental samples, as described in *Quality Assurance Project Plan Requirements for Sampling and Analysis* (the ER Project QAPP) (LANL 1996, 53450). Decontamination of sampling equipment will be performed in accordance with LANL-ER-SOP-01.08,R0, "Field Decontamination of Drilling and Sampling Equipment." Wash water and other wastes generated during the sampling operation will be managed and disposed of in accordance with LANL-ER-AP-05.3, "Management of ER Program Wastes."

Each sample location will be marked or permanently monumented (where possible), photographed, and assigned a unique ER sample location identification number. All samples will be field-screened using hand-held instruments at the point of collection for gross radioactivity and organic vapors. When the samples are submitted to the Sample Management Office (SMO), gross-alpha, -beta, and -gamma radiation measurements will be taken on each sample before they are transported to a fixed-site analytical laboratory.

5.1.10.3.2 Measurement Methods

Sediment, soil, and borehole core samples collected according to criteria outlined in Section 5.1.10.2 will undergo full-suite analyses for organic, inorganic, and radionuclide constituents. All analyses will be performed at

TABLE 5.1.10-3

SUMMARY OF SEDIMENT SAMPLING METHODS REQUIREMENTS

Sampling Tools	Sample Types	Sampling Depth	LANL-ER-SOP No.
Spade and scoop	Surface grab	0–1 ft	06.09
Ring sampler	Surface grab	0–0.5 ft	06.11
Thin-wall tube	Surface grab; lithologic (undisturbed)	0–5 ft	06.10
Hand auger	Surface or subsurface grab; vertical composite	0–5 ft	06.10
Open tube (Trier)	Lithologic (undisturbed)	0–5 ft	06.17
Scoop and trowel	Grab (under surface water)	0–0.5 ft	06.14
Hand corer	Grab (under surface water)	0–0.5 ft	06.14

TABLE 5.1.10-4

BOREHOLE CORE SAMPLING METHODS REQUIREMENTS

Activity	LANL-ER-SOP No.
Drilling methods and drill-site management	04.01
General borehole logging	04.04
Core-barrel sampling for subsurface earth materials	06.26
Field logging, handling, and documentation of borehole samples	12.01

an ER Project-approved fixed-site laboratory. The analytical suites and methods for analysis of organic constituents are listed in Table 5.1.10-5. The analytical suites include SVOCs, PCBs, and TPH that will be analyzed in selected samples. Analysis for VOCs will be performed on any sample for which a significant organic vapor measurement is obtained by field screening using hand-held instruments. All analyses for organic constituents will be performed according to EPA SW-846 protocols (EPA 1986, 31733). The detailed analyte lists, EQLs, required QC procedures, and the acceptance criteria are found in the ER Project analytical services statement of work (LANL 1995, 49738).

The target analytes, estimated detection limits (EDLs), and analytical methods for inorganic constituents are listed in Table 5.1.10-6. All analyses for inorganic constituents will be performed according to EPA SW-846 protocols using mineral acid sample extraction procedures for the inductively coupled plasma emission spectroscopy (ICPES), graphite furnace atomic absorption (GFAA), and inductively coupled plasma mass spectrometry (ICPMS) techniques.

The target analytes and their half-lives, detected emission, EQLs, and analytical methods for radionuclide constituents are listed in Table 5.1.10-7. Before chemical separation and counting for alpha or beta emissions, samples will undergo a complete digestion or fusion procedure. All samples submitted for tritium analysis will also be analyzed for moisture content. The analyte list for the gamma spectroscopy analysis includes long-lived activation and fission products, as well as their shorter-lived daughter products. The shorter-lived daughter products are usually included in the analyte list to verify the presence of the longer-lived parents. The shorter-lived radionuclides (half-life less than 180 days) are not considered to be COPCs. Sediment samples will be prepared for gamma spectroscopy measurements by homogenization and drying; no sample extraction will be performed. The required QC procedures and acceptance criteria for both the inorganic and radiochemical analyses are found in the ER Project analytical services statement of work (LANL 1995, 49738).

Sediment samples in the floodplain will be collected to represent specific geomorphic strata, and it is important that the laboratory sample be representative of the sediment stratum that is collected in the field. To identify

TABLE 5.1.10-5

ANALYTE SUITES AND ANALYTICAL METHODS FOR ANALYSIS OF ORGANIC CONSTITUENTS IN SOIL, SEDIMENT, AND CORE SAMPLES

Analyte Suite	Analytical Method	Analytical Protocol
Polychlorinated biphenyl compounds	GC/ECD	SW-8081A or SW-8082
Semivolatile organic compounds	GC/MS	SW-8270
Total petroleum hydrocarbons (diesel range)	GC/FID	Modified SW-8100
Volatile organic compounds*	GC/MS	SW-8260

* Samples will be analyzed for volatile organic compounds only if field screening indicates their presence.

TABLE 5.1.10-6

ANALYTE LIST, ESTIMATED DETECTION LIMITS, AND ANALYTICAL METHODS FOR INORGANIC CONSTITUENTS IN SOIL, SEDIMENT, AND CORE SAMPLES

Analyte	EDL (mg/kg)	Analytical Method	Analytical Protocol
Metals			
Aluminum	40	ICPES	SW-6010B
Antimony	12	ICPES or ICPMS	SW-6010B or SW-6020
Arsenic	2	GFAA or ICPMS	SW-7060 or SW-6020
Barium	40	ICPES	SW-6010B
Beryllium	1	ICPES	SW-6010B
Boron	10	ICPES	SW-6010B
Cadmium	1	ICPES	SW-6010B
Calcium	500	ICPES	SW-6010B
Chromium	2	ICPES	SW-6010B
Cobalt	10	ICPES	SW-6010B
Copper	5	ICPES	SW-6010B
Iron	20	ICPES	SW-6010B
Lead	0.6	GFAA or ICPMS	SW-7421 or SW-6020
Magnesium	1000	ICPES	SW-6010B
Manganese	3	ICPES	SW-6010B
Mercury	0.1	CVAA	SW-7471A
Nickel	8	ICPES	SW-6010B
Potassium	500	ICPES	SW-6010B
Selenium	1	GFAA or ICPMS	SW-7741 or SW-6020
Silver	2	ICPES	SW-6010B
Sodium	500	ICPES	SW-6010B
Thallium	2	GFAA or ICPMS	SW-7841 or SW-6020
Titanium	1	ICPES	SW-6010B
Uranium (total)	0.5	ICPMS	SW-6020
Vanadium	10	ICPES	SW-6010B
Zinc	4	ICPES	SW-6010B
Anions*			
Bromide	0.1	IC	SW-9056
Chloride	0.1	IC	SW-9056
Fluoride	0.02	IC	SW-9056
Sulfate	0.1	IC	SW-9056
Other Inorganics			
Silica (dissolved)*	1000	Colorimetry	EPA Method 370.1

* Anions and dissolved silica analyses will be performed on the leachate formed from a deionized water slurry of the homogenized core sample.

patterns in the distribution of metals and radionuclides in the geomorphic strata, it is important that the sample preparation method for all analyses be consistent. To meet the objectives for representativeness and comparability, the sediment samples will be well mixed in the field using a stainless steel bowl and spoon before placing them in containers for shipment to the laboratory. Large stones, organic matter, and other debris will be removed from the sample by hand. Sediment samples submitted for inorganic and radiochemical analyses will be air-dried and sieved to obtain the gravel-free size fraction (< 2mm). A subset of the sediment samples submitted for analysis may also be sieved to obtain the clay fraction (<0.062 mm). The sediment sample preparation procedure is described in the attached Field Unit 4 requirement (see Attachment IV of this RFI report). The laboratory will be instructed to take representative aliquots from the gravel-free fraction for each analysis. Selected sediment samples will also undergo particle size analysis using American Society for Testing and Materials method D422-63 (dry sieve plus hydrometer).

TABLE 5.1.10-7

ANALYTE LIST, ESTIMATED QUANTITATION LIMITS, AND ANALYTICAL METHODS FOR RADIONUCLIDE CONSTITUENTS IN SOIL, SEDIMENT, AND CORE SAMPLES

Analyte	Half-Life (yr)	Detected Emission	EQL (pCi/g)	Analytical Method
^{3}H	12.3	β	300 pCi/L	LSC
^{238}Pu	87.7	α	0.1	α-Spectrometry
$^{239,240}Pu$[a]	2.410×10^{4}	α	0.1	α-Spectrometry
^{90}Sr	29.1	β	2.0	GPC
^{234}U	2.46×10^{5}	α	0.1	α-Spectrometry
^{235}U	7.04×10^{8}	α	0.1	α-Spectrometry
^{238}U	4.47×10^{9}	α	0.1	α-Spectrometry
Gamma spectroscopy analytes	–	γ	1[b]	γ-Spectroscopy
Gross-alpha	–	α	10.0	GPC or LSC
Gross-beta	–	β	10.0	GPC or LSC
Gross-gamma	–	γ	2.0	NaI(Tl) or HPGe detection

a. The ^{239}Pu and ^{240}Pu isotopes cannot be distinguished by alpha spectrometry. The half-life of ^{239}Pu is given.
b. The minimum detectable activity for ^{241}Am and ^{137}Cs is 1 pCi/g; the value for other analytes will vary.

Major anions in borehole core samples will be analyzed by ion chromatography of the deionized water leachate prepared according to the attached Field Unit 4 requirements (see Attachment IV of this RFI report). Before preparing the leachate solution, the sample is ground to a mesh size of 100 (<0.150 mm). The sample is extracted with deionized water for at least 16 hours. A preparation blank sample is also extracted and analyzed with each batch of core samples. The requirements for the ion chromatographic analysis are also given in Attachment IV of this RFI report.

The gravimetric moisture content of all borehole core samples will be determined using fast-turnaround analysis. If elevated moisture content is found, the borehole core sample may be submitted for further geotechnical and hydrologic property measurement at the discretion of the field geologist. The suite of geotechnical and hydrologic analyses are listed in Table 5.1.10-8.

Surface water samples will be measured for the field parameters listed in Table 5.1.10-9 at the time collection. Field measurements include alkalinity, dissolved oxygen, pH, specific conductance, temperature, and turbidity. Pore-water samples will be measured for alkalinity, pH, specific conductance, and temperature. Measurements will be performed according to LANL-ER-SOP-06.02, "Field Analytical Measurements of Groundwater Samples," or standard EPA methods.

Surface water samples collected according to the strategy outlined in Section 5.1.10.2 will undergo full-suite analyses for organic, inorganic, and radionuclide constituents at an ER Project-approved fixed-site laboratory. The organic analytical suite includes SVOCs and TPH in selected samples. All analyses for organic constituents will be performed on unfiltered samples according to EPA SW-846 protocols (EPA 1986, 31733) or EPA standard methods for water analysis. The detailed analyte lists, EQLs, required QC procedures, and the acceptance criteria for the SVOC analysis are found in the ER Project analytical services statement of work (LANL 1995, 49738). Selected water samples will also be analyzed for dissolved organic carbon as humic acids according to a modified EPA standard method 415.

Water samples will be analyzed for inorganic constituents to identify COPCs and to obtain a better understanding of the baseline geochemistry of surface water in Pratt Canyon. Inorganic analyses will be performed on

TABLE 5.1.10-8

GEOTECHNICAL AND HYDROLOGIC ANALYSES OF BOREHOLE CORE SAMPLES

Analysis	Analytical Method
Geotechnical analyses	
Bulk density, dry density	ASTM D-4531-86
Distribution coefficient (K_d)	Batch Method
Porosity (total and effective)	API Method 40, Section 3.58
Particle size analysis	ASTM D-422(dry sieve and hydrometer)
Hydrologic analyses	
Moisture content (gravimetric and volumetric)	ASTM D-4531-86
Matric potential	Chilled mirror psychrometer (and other)
Saturated hydraulic conductivity	ASTM D-2434-68

water samples that have been filtered to remove particulates larger than 0.45 mm at the time of collection. The target analytes, EDLs, and analytical methods for inorganic constituents are listed in Table 5.1.10-10. Measurements for inorganic constituents include analyses for 26 dissolved metals; major anions (bromide, chloride, fluoride, nitrate, and sulfate); minor anions (chlorate, nitrite, and phosphate); and dissolved silica. All analyses for inorganic constituents will be performed according to EPA SW-846 protocols (EPA 1986, 31732) or EPA standard methods for chemical analysis of water. The required QC procedures and acceptance criteria for the trace metals analyses are found in the ER Project analytical services statement of work (LANL 1995, 49738). Field Unit 4 requirements for ion chromatography analysis using SW-846 method 9056 are given in Attachment IV of this RFI report.

Water samples will be analyzed for the radionuclide constituents listed in Table 5.1.10-11. Radiochemical analyses will be performed on both filtered and unfiltered samples. The suite of radiochemical analyses includes gross-alpha, -beta, and -gamma radiation, ^{90}Sr, and mid-level tritium. If elevated levels of gross radioactivity are measured, analyses for specific radionuclides (gamma spectroscopy analytes and uranium and plutonium isotopes) will be performed for subsequent water samples collected.

TABLE 5.1.10-9

FIELD MEASUREMENTS FOR WATER SAMPLES

Measurement	Precision*	Method
Alkalinity	±1 mg/L $CaCO_3$	EPA Method 310.1
Dissolved oxygen	±0.1 mg/L	LANL-ER-SOP-06.02
pH	±0.02	LANL-ER-SOP-06.02
Specific conductance	±1 µmho/cm (25°C)	LANL-ER-SOP-06.02
Temperature	±1 °C	LANL-ER-SOP-06.02
Turbidity (nephelometric)	±1 NTU	EPA Method 180.1

* Precision with which measurement will be recorded.

TABLE 5.1.10-10

ANALYTE LIST, ESTIMATED DETECTION LIMITS, AND ANALYTICAL METHODS FOR INORGANIC CONSTITUENTS IN WATER SAMPLES*

Analyte	EDL (µg/L)	Analytical Method	Analytical Protocol
Metals (dissolved)			
Aluminum	200	ICPES	SW-6010B
Antimony	60	ICPES or ICPMS	SW-6010B or SW-6020
Arsenic	10	GFAA or ICPMS	SW-7060 or SW-6020
Barium	200	ICPES	SW-6010B
Beryllium	5	ICPES	SW-6010B
Boron	10	ICPES	SW-6010B
Cadmium	5	ICPES	SW-6010B
Calcium	50	ICPES	SW-6010B
Chromium	10	ICPES	SW-6010B
Cobalt	50	ICPES	SW-6010B
Copper	25	ICPES	SW-6010B
Iron	20	ICPES	SW-6010B
Lead	3	GFAA or ICPMS	SW-7421 or SW-6020
Magnesium	50	ICPES	SW-6010B
Manganese	15	ICPES	SW-6010B
Mercury	0.2	CVAA	SW-7470A
Nickel	40	ICPES	SW-6010B
Potassium	500	ICPES	SW-6010B
Selenium	5	GFAA or ICPMS	SW-7741 or SW-6020
Silver	10	ICPES	SW-6010B
Sodium	50	ICPES	SW-6010B
Thallium	10	GFAA or ICPMS	SW-7841 or SW-6020
Titanium	10	ICPES	SW-6010B
Uranium (total)	1	ICPMS	SW-6020
Vanadium	50	ICPES	SW-6010B
Zinc	20	ICPES	SW-6010B
Anions (dissolved)			
Bromide	100	IC	SW-9056
Chlorate	100	IC	SW-9056
Chloride	100	IC	SW-9056
Fluoride	20	IC	SW-9056
Nitrate	40	IC	SW-9056
Nitrite	40	IC	SW-9056
Phosphate	20	IC	SW-9056
Sulfate	100	IC	SW-9056
Other Inorganics			
Silica (dissolved)	1000	Colorimetry	EPA Method 370.1

* All water samples will be filtered to remove particles larger than 0.45 µm at the time of collection.

TABLE 5.1.10-11

ANALYTE LIST, ESTIMATED QUANTITATION LIMITS, AND ANALYTICAL METHODS FOR RADIONUCLIDE CONSTITUENTS IN WATER SAMPLES[a]

Analyte	Half-Life (yr)	Detected Emission	EQL (pCi/L)	Analytical Method
^{241}Am	432.2	α	0.1	α-Spectrometry
^{3}H (mid-level)	12.3	β	25	Electrolytic enrichment/GPC
^{238}Pu	87.7	α	0.1	α-Spectrometry
$^{239,240}Pu$[b]	2.410×10^4	α	0.1	α-Spectrometry
^{90}Sr	29.1	β	5.0	GPC
^{234}U	2.46×10^5	α	0.1	α-Spectrometry
^{235}U	7.04×10^8	α	0.1	α-Spectrometry
^{238}U	4.47×10^9	α	0.1	α-Spectrometry
Gamma spectroscopy analytes	-	γ	20[c]	γ-Spectroscopy
Gross-alpha	-	α	3.0	GPC or LSC
Gross-beta	-	β	3.0	GPC or LSC
Gross-gamma	-	γ	100	NaI(Tl) or HPGe detection

a. Analyses will be performed on both filtered and unfiltered samples.
b. The ^{239}Pu and ^{240}Pu isotopes cannot be distinguished by alpha spectrometry. The half-life of ^{239}Pu is given.
c. The EQL for ^{241}Am and ^{137}Cs is 20 pCi/L; the EQL for other analytes will vary.

Pore-water samples will be prepared by centrifugation of core samples obtained from saturated zones in the cattails area. Filtered pore-water samples will be analyzed for inorganic and radionuclide constituents and dissolved organic carbon (as humic acids). Unfiltered pore-water samples will be analyzed for gross radioactivity, SVOCs, PCBs, and TPH.

Vegetation samples will be analyzed for ^{90}Sr, tritium, gamma spectroscopy analytes, and uranium and plutonium isotopes. After removal of an aliquot for tritium analysis, samples will be prepared by drying and ashing in a muffle furnace, and an acid digest of the ash will be analyzed. Tritium will be analyzed in water distilled from the sample.

5.1.10.3.3 Field Decisions

The sampling design described in Section 5.1.10.2 requires that field decisions be made at several points. More details are provided in this section.

- Biased sampling from borehole cores based on geological criteria (Section 5.1.10.2.1)

  Backfill/Tuff Interface

  In most locations sampled during the Phase I RFI, the backfill material was described as sand and/or clay with tuff cobbles, whereas the top of the tuff was nonwelded and soft but usually consolidated and relatively homogeneous. The field geologist will identify the boundary. The first foot of tuff is to be sampled in all boreholes. Unless above-background beta/gamma radiation is observed in the backfill material above the tuff, the backfill sample required in Section 5.1.10.2.1 will also be collected from the 1.5 ft of backfill material immediately above the boundary.

Fracture Fill Material

Fill material lining fractures in the tuff, such as the red clay encountered at 10.8 ft at Location ID No. 35-2018, is of particular interest in modeling contaminant transport. The field geologist will examine all cores to identify discrete fractures or fracture zones from which sufficient fill material for analysis can be recovered. Separate samples of fracture fill material for chemical analyses, as described in Section 5.1.10.2.1, will be prepared in the field. However, intervals of core including filled fractures that are to be submitted for geotechnical measurements, as described in Section 5.1.10.2.3, should be shipped intact if possible.

- Biased sampling from borehole cores based on field beta/gamma radiation measurements (Sections 5.1.10.2.1 and 5.1.10.2.3)

  Background beta/gamma radiation levels may be slightly higher in tuff than in backfill material, but they are generally in the range of 200 to 400 cpm as measured with a GM pancake probe meter. Media-specific background levels will be established in the field. If above-background levels are measured in the core from a given borehole, the backfill material sample and/or the second tuff sample required by Section 5.1.10.2.1 will be collected within 1 ft of the point where the highest readings are observed. In addition, Section 5.1.10.2.1 requires a third, deeper sample to be collected approximately 5 ft below the point where field measurements return to background levels.

  Default sampling depths, to be used if no above-background beta/gamma radiation levels are reported, are provided in Sections 5.1.10.2.1 and 5.1.10.2.3.

- Biased sampling from cores based on fast-turnaround moisture measurements (Sections 5.1.10.2.1 and 5.1.10.2.3)

  Geotechnical measurements will be made on tuff if fast-turnaround moisture content results exceed 50% (g/g). (The field geologist may lower this criteria if field indications suggest that flow and transport in the tuff is occurring or has occurred.) In this case, samples for geotechnical measurements will be collected from relatively moist intervals. If possible, three samples from three different boreholes will be collected. No more than two samples may come from a single borehole, and if two samples are collected from one borehole, they must be separated by at least 5 ft in depth.

- Surface water sampling at gauging stations (Section 5.1.10.2.2)

  Samples will be collected automatically during every event that generates enough flow, but only two events are to be selected for laboratory analysis. The first of these should be the first event of the season, whether that is spring snowmelt or an early summer storm. The second should be selected well into the summer storm season. Samples will be collected in coordination with ESH-18.

- Pore water from the cattails (Section 5.1.10.2.2)

  One pair of samples will be collected when surface flow is present in Pratt Canyon. An appropriate sampling opportunity can be identified by monitoring the alarmed gauging stations in coordination with ESH-18.

- Selection of vegetation/sediment pairs to be sampled (Section 5.1.10.2.4)

  The survey described in Section 5.1.10.2.2 will provide at least 12 vegetation/sediment pairs that are candidates for sampling and analysis. Only four will actually be sampled.

Ranked set sampling (RSS) (PNL 1995, 54167) will be used to select these pairs to obtain both spatial coverage and coverage of the range of field radioactivity without sacrificing randomness. RSS will be implemented as follows.

- Divide 12 pairs identified for a given species during the field surveys into four groups of three, each of which is approximately homogeneous with respect to the field vegetation and sediment radioactivity measurements. For example, one group should contain only pairs for which little or no above-background radioactivity was observed in either sediment or vegetation and one group should contain all the above-background vegetation (if any). If more than 12 pairs have been surveyed, some groups may be larger.

- Number the four groups 1 through 4. These numbers should be assigned at random (for example, draw numbers out of a hat.)

- Select the westernmost individual from group number 1. Select a middle (west to east) individual from groups number 2 and number 3. Select the easternmost individual from group number 4.

If above-background vegetation radioactivity measurements have been observed in one or more individuals of a given species, at least one such individual must be included in the sample. This will be assured if one of the four groups contains only individuals with above-background radioactivity measurements. However, if this can not be arranged, withdraw the group containing at least one above-background individual from the RSS scheme, leaving three groups to be randomized and subsampled as above, and add an above-background pair from the fourth group as the fourth sample.

- Using radioactivity and geomorphic criteria to select additional floodplain sediment samples (Section 5.1.10.2.4)

  Expected results of the radiometric survey include identification of floodplain sediments with above-background surface radioactivity. Expected results of the geomorphic survey include identification of areas of the floodplain that could contain sediments dating from the 1950s. Four additional samples are to be selected from sediments meeting one or both of these criteria. To the extent possible within these constraints, these sample locations will also be selected to represent both the length and width of the floodplain above the cattails area. In particular, they will represent four distinct sedimentary deposits if possible.

  A geomorphologist will be consulted when the two Ten Site Canyon samples are collected to select appropriate depths. Field radioactivity measurements may be used to bias sample collection if they are above background.

- Using radiometric survey results to identify depth of samples below the daylight discharge channel (Section 5.1.10.2.4)

  An appropriate background level must be determined for these soils. Samples are to be taken in the depth interval 0 to 3 ft. Depth will be biased by gross radioactivity measurements (see first bullet above) if above-background measurements are obtained at the selected locations.

- Sampling from tuff boulder (Section 5.1.10.2.4)

  Very high beta/gamma radiation has been reported on the surface of at least one of the boulders at the base of the backfill material at the west end of Pratt Canyon. The field

team will attempt to replicate this result, and assuming that they are successful, the required sample will be collected from this above-background tuff.

- Selecting a subset of floodplain samples for analysis of the fine fraction analysis and for organic constituents (Section 5.1.10.2.4)

  Five floodplain samples are to be selected for particle size analysis, and chemical analyses of the clay fraction (<0.062 mm) will be performed. Appropriate samples for this purpose (relatively clay-rich) must be identified by an experienced soil scientist or geologist. To the extent possible, these sampling locations will also be selected to represent different locations, depths, and sedimentary deposits within Pratt Canyon.

  Some of the same samples may be submitted for organic constituent analyses. At least one of the samples selected will be collected in the cattails area.

5.1.10.3.4 Sample Handling

All samples will be identified in accordance with LANL-ER-SOP-01.04, R3, "Sample Control and Field Documentation." Chain-of-custody requirements described in LANL-ER-SOP-01.04, R3 will be implemented. The SMO will be consulted regarding the appropriate sample containers and preservation. Samples will be packaged and shipped according to LANL-ER-SOP-01.03, R1, "Handling, Packaging and Shipping of Samples." All samples will be shipped from the SMO to off-site laboratories for analysis except those samples that are submitted to the mobile radiological van for screening purposes.

5.1.10.3.5 Data Tracking

The data management scheme described in Sections A10 and B10 of the ER Project QAPP (LANL 1996, 53450) will be followed. Manually recorded data will be reviewed by the field team as required by LANL-ER-SOP-1.01, R0, "General Instructions for Field Investigations," LANL-ER-SOP-01.04, R3, and LANL-ER-SOP-03.12, R0, "Field and Laboratory Notebook Documentation for Environmental Restoration Earth Sciences Studies." Data generated by the analytical laboratories will be submitted to the SMO following the requirements of the ER Project analytical services statement of work (LANL 1995, 49738). The reporting requirements include electronic and hard copy deliverables for routine analyses. The SMO is responsible for data verification, validation, and transmittal to FIMAD. The results of radiological screening conducted in the mobile radiological van will be documented and sent to the SMO along with the samples.

5.1.10.4 Data Assessment

5.1.10.4.1 Verification and Routine Validation

Data generated by the analytical laboratories will undergo the verification and baseline validation procedures described in Sections D1 and D2 of the ER Project QAPP (LANL 1996, 53450). Field data will be reviewed for accuracy and completeness by the field team at the time of collection.

5.1.10.4.2 Data Quality Assessment

Reconciliation of the data with the investigation objectives will be accomplished using the qualitative data quality assessment methods described in Section D3 of the ER Project QAPP (LANL 1996, 53450). The assessment team will evaluate the sufficiency of the data set for the decision-making purposes described in Section 5.4.10.1 using their best professional judgment. The assessment team shall consist of a geologist, geochemist, hydrologist, human health risk assessor, ecological risk assessor, statistician, and chemist (at a minimum). The data quality assessment process outlined in Figure D-3 of the ER Project QAPP will be followed.

5.1.10.5 Administration

5.1.10.5.1 Project Task Organization

The Field Unit 4 project task organization for implementing the field activities described in this SAP is shown in Table 5.1.10-12.

5.1.10.5.2 Training

All ER Project personnel involved with the execution of this SAP will have fulfilled the required training for applicable roles in accordance with the ER worker positions matrix in administrative procedure LANL-ER-AP-05.2, R1, "Determination, Completion, and Documentation of Environmental Restoration Worker Training." ER Project personnel training records are located on-site during field activities and will be available for inspection. ER Project personnel will not perform tasks under site conditions that require special training beyond that documented in their training records.

TABLE 5.1.10-12

FIELD UNIT 4 KEY PERSONNEL

Functional Role	Name	Organization	Phone
	Field Project Management		
Field Project Leader (FPL)	Allyn Pratt	EES-13	667-4308
Technical Team Leader	Dave Broxton	EES-1	667-2492
Field Team Manager (FTM)	Deba Daymon	ERM/Golder	662-1327
Management Support Leader	Curt Thomson	LATA	662-1812
	Field Team		
Field Team Leader (FTL)	Leslie Sontag	SAIC	672-3666
Geologist	Leslie Sontag	SAIC	672-3666
Site Safety Officer (SSO)	Darril Stafford	SAIC	672-3666
Field Technician/Sampler	Carmella Romero	SAIC	672-3666
Field Technician/Sampler	Darril Stafford	SAIC	672-3666
	Technical/Assessment Team		
Assessment Team Leader	Gabriela Gainer	LATA	662-1817
Human Health Risk Assessor	Ralph Perona	ERM/Golder	662-1305
Eco-risk Assessor	Orrin Meyers	EES-15	665-3742
Statistician	Kathy Campbell	EES-5	667-2799
Statistician	Mary Mullen	ESH-20	665-8963
Geochemist	Patrick Longmire	CST-7	665-1264
Geomorphologist	Steven Reneau	EES-1	665-3151
Watershed Hydrologist	Brad Wilcox	EES-15	665-6044
Chemist	Catherine Smith	LATA	662-1873
	Alternate Personnel		
Alternate FTL / Geologist	Richard Koch	SAIC	672-3666
Alternate SSO / Sampler	John Hayes	ERM/Golder	662-1348
	Coordinator		
Field Project Coordinator	Robert Simeone	DOE/LAAO	667-0587

5.1.10.5.3 Records

Field records will document sample collection and tracking, H&S briefings and checks of monitoring equipment performance, and nonsampling activities such as site inspections and walkovers, which are documented as engineering surveys in Daily Activity Logs. Table 5.1.10-13 is a summary of required field documents, the appropriate requirement reference, and document recipients. All original documents will be transferred to the ER Project Records-Processing Facility (RPF) in accordance with administrative procedure LANL-ER-AP-02.1, R1, "Procedure for LANL ER Records Management."

Photographs and videotapes may be used to document observations and sample collection activities. Site visit photographic documentation will be referenced in a Daily Activity Log in accordance with ER-SOP-01.04, R3.

5.1.10.5.4 Oversight

Oversight, review, and approval of ER Project field activities are provided by the following Laboratory groups.

- ESH-1 for radiological control technician (RCT) support and oversight
- ESH-5 for review, approval, and oversight of the site-specific health and safety plan (SSHASP)

TABLE 5.1.10-13

FIELD ACTIVITY DOCUMENTATION

Document	Requirement Reference	Document Recipients
	Sample Collection and Tracking	
Daily Activity Log	LANL-ER-SOP-01.04, R3* Attachment E	FU4 file, RPF
Sample Collection Log	LANL-ER-SOP-01.04, R3* Attachment B	FU4 file, RPF
Core Sample Log	LANL-ER-SOP-12.01, R1* Attachment E	FU4 file, RPF
Daily Drilling Summary	LANL-ER-SOP-12.01, R1* Section 8 (form attached)	FU4 file, RPF
Daily Report Form	FU4 Guidance (form attached)	FU4 file, RPF
Chain of Custody / Request for Analysis Forms	LANL-ER-SOP-01.04, R3* Attachment C	FU4 file, RPF
Electronic Follower (COC / Request for Analysis)	LANL-ER-SOP-01.04, R3* Section 6.1.5	SMO
	Health and Safety	
Tailgate Safety Meeting / Attendee Signoff Sheet	FU4 Guidance (form attached)	FU4 file, RPF
Flame/Photo Ionization Detector Field Data Form	FU4 Guidance (form attached)	FU4 file, RPF
Direct Survey Results	ESH-1 Guidance (form attached)	FU4 file, RPF
Smear Survey Results	ESH-1 Guidance (form attached)	FU4 file, RPF
LAS Survey Results	ESH-1 Guidance (form attached)	FU4 file, RPF
Radiation Grid Survey Results	FU4 Guidance (form attached)	FU4 file, RPF
Daily Safety Inspection Checklist	FU4 Guidance (form attached)	FU4 file, RPF
Daily Drill Rig Inspection Checklist	FU4 Guidance (form attached)	FU4 file, RPF
PPE Inspection Checklist	FU4 Guidance (form attached)	FU4 file, RPF
Equipment and Item Removal Log	FU4 Guidance (form attached)	FU4 file, RPF
Site Access Log	FU4 Guidance (form attached)	FU4 file, RPF
	Engineering Surveys	
Daily Activity Log	ER-SOP-01.04, R3* Attachment E	FU4 file, RPF

* LANL 1991, 21556

- ESH-3 and ESH-5 for review, approval, and oversight of the ES&H Questionnaire
- ESH-19 for oversight of the waste management plan and/or the Waste Characterization Strategy Form
- CST-5 and CST-17 for review and approval of the waste management plan and/or the Waste Characterization Strategy Form

The ER Project Office may schedule an audit of sampling activities to ensure the quality of field performance. Such audits will conform to the ER Project quality procedures LANL-ER-QP-01.1, R0, "Audits," and LANL-ER-QP-01.2Q, R0, "Surveys" (LANL 1992, 11686). Laboratory group ESH-5 will evaluate the ER Project field operations to determine compliance with H&S requirements.

5.1.10.5.5 Inspection and Acceptance Policies

All activities associated with this SAP will follow Laboratory policies on inspections and acceptance. All sampling equipment, including sample containers, rinsate water, and sample preservation reagents, will be inspected by the field team leader upon receipt. The SMO provides the sample containers used for sample collection. The sample containers are certified by the manufacturer for prescribed cleanliness and quality. Sample preservation reagents are received from reputable chemical suppliers with reagent purity certification on the container label.

5.1.10.5.6 Reports to Management

The field team leader will submit daily activity reports to the field team manager during field activities.

5.1.10.5.7 Attachments

The following field forms (which are not included in the SOPs) used to execute the SAP are attached to this RFI report (see Attachment V).

- ESH-1 Direct Survey Form
- ESH-1 LAS Survey Form (LAS = large area swipe)
- ESH-1 Smear Survey Form
- ESH-1 Smear Continuation Form
- FU 04 Equipment and Item Removal Log
- FU 04 Survey Form
- FU 04 Site Access List
- FU 04 Tailgate Safety Meeting

5.2 PRS Nos. 35-003(d, l, and q)

The PRSs in this decision set include PRS No. 35-003(d), the site of the former liquid waste holding tanks (TA-35-10) and the associated daylight diversion channel; PRS No. 35-003(l), the site of the former pump pit (TA-35-8); and PRS No. 35-003(q), the site of the former pipe trench (TA-35-9). These PRSs are associated with the former TA-35 wastewater treatment plant. Figure 5.1-1 shows the locations of the PRSs and structures at the site. These PRSs were grouped into one decision set because they are located together and are associated with the same process source term.

COPCs identified as a result of the screening assessment include Aroclor 1254, Aroclor 1260, and benzo[a]pyrene. In addition, high levels of beta-emitting radiation were measured during screening activities.

Further investigations are proposed for PRS Nos. 35-003(d, l ,and q). The SAP for these PRSs is included in Section 5.1.10.

5.2.1 History

PRS Nos. 35-003(d, l, and q) are described in Section 3.3.2 of the work plan (LANL 1992, 7666).

The former structures associated with these PRSs were an integral part of the wastewater treatment plant and were collectively referred to as the "tank farm." These structures were used as part of the wastewater treatment plant until 1963 when a new wastewater treatment plant at TA-50 became operational. However, as late as 1974 the holding tanks at TA-35 were used to store low-level wastes (Kennedy 1968, 846; Emelity et al. 1975, 324).

Spills and accidental releases from the holding tanks and/or the associated piping were documented throughout the operational history of the wastewater treatment plant. The first documented release from the tank farm was in July 1951 when 5 mCi of contaminated liquid were reported to have been released from the holding tanks (Aeby 1954, 742). At least 11 instances of spills or nonoperational releases were documented between 1951 and 1956. Table 5.2.1-1 summarizes these releases.

From 1981 to 1985, D&D activities were conducted for much of the wastewater treatment plant and associated structures and pipelines. These D&D activities are described in Section 5.2.3.

The contaminants that were potentially present (and therefore investigated during this RFI) include gross-alpha, -beta, and -gamma radiation; ^{90}Sr; VOCs; SVOCs; metals; PCBs; and tritium.

TABLE 5.2.1-1

SUMMARY OF SPILLS AND NONOPERATIONAL RELEASES FROM THE TANK FARM

Date	Amount Released (gal.)	Amount Released (mCi)	Comments	Sources
7/21/51	nr	5	First recorded "dump"	Aeby 1954,742
7/26/52	nr	12		Aeby 1954, 742
8/6/52	2,000 to 3,000	1,800	Discharged at slow rate	Aeby 1955, 743
10/21/52	50,000	110	Laboratory-approved release	Aeby 1952, 741; Aeby 1954, 742
5/25/53	100,000	80	Released into canyon	Keenan 1975, 845
2/15/53	nr	7		Aeby 1954, 742
10/13/53	nr	80		Keenan 1975, 845
5/1/54	nr	160	Accidental release of "hot" water from T-4	Aeby and Garcia 1954, 745; Aeby 1954, 742
Late 1/55	5,00	20	3,000 gal. overflow and 2,000 gal. discharge	Aeby 1955, 743; Keenan 1975, 845
Early 9/55	a "few" gal. released	nr	Two storage tanks overflowed	Aeby 1955, 744
2/11/56 2/12/56	21,200	nr	"hot" concentrated sludge lost from T-6	LASL 1962, 859; Keenan 1975, 845
Total	179,200+	2,274	Total volume of liquid not known	

5.2.2 Description

These PRSs are located about 150 ft east of TA-35-7 near the end of Ten Site Mesa (see Figure 5.1-1). Collectively, the PRSs cover an area about 100 ft by 150 ft. After the structures were removed in 1985, the site was backfilled with up to 20 ft of clean fill material. At the time of the RFI, the site was an open field composed of backfill material (indigenous tuff) covered with weeds and grasses. The area slopes gently to the east, and surface runoff from the area flows eastward into Pratt Canyon. A storm water outlet pipe discharges to the southeast corner of the site, and the storm water discharge flows across the site into Pratt Canyon. The source of the storm water is a surface storm drain located at the southwest corner of TA-35-7. An arroyo has formed in the backfill material that transects the site from southwest to northeast. The arroyo is up to 10 ft deep at the eastern edge of the site.

PRS No. 35-003(d) is the site of TA-35-10, which was a large rectangular reinforced concrete structure (Figure 5.1-1) comprising four separate 50,000-gal. tanks (referred to as T-3 through T-6) with a total holding capacity of 200,000 gal. The holding tanks were 85 ft long and 35 ft wide. Each tank was situated mostly below ground level with just the top portion exposed. The tanks did not have a drain outlet; all liquids were pumped out through the pipe trench and the pump house to TA-35-7 for treatment and discharge from the wastewater treatment plant.

PRS No. 35-003(q) is the site of the former pipe trench that was adjacent to the holding tanks and connected the holding tanks to the pump pit and to TA-35-2, TA-35-3, and TA-35-7 (see Figure 5.1-1). The pipe trench was about 60 ft long and 10 ft wide at the west side of the holding tanks and contained at least five pipelines that connected the pump pit to each of the four holding tanks. The pipe trench was partially buried below the ground surface and contained floor drains that discharged to the daylight diversion channel.

PRS No. 35-003(l) is the site of the former pump pit that was adjacent to the pipe trench and the liquid waste holding tanks. The pump pit was about 10 ft wide by 14 ft long and housed two large capacity electric pumps and associated valves and piping for transfer the liquid in the holding tanks among the tanks and to TA-35-7 (see Figure 5.1-1). The pump pit also contained floor drains that discharged to the daylight diversion channel.

The daylight diversion channel was constructed around the west and south sides of the tank farm to collect all surface runoff and the discharge from the floor drains in the pump pit and pipe trench. The daylight diversion channel collected all routine discharges from the wastewater treatment plant; during plant operations 2,000 to 3,000 gal. of liquid per day were discharged. The daylight diversion channel discharged to the south rim of Pratt Canyon southeast of the tank farm.

The archival information indicated that all operational releases from the wastewater treatment plant were directed through Line 95 and into the daylight diversion channel. Additionally, any spills or leaks from the pump pit, pipe trench, and the piping connected to the holding tanks were collected into the daylight diversion channel. The holding tanks did not have a gravity drain line to the canyon; all contents were pumped through TA-35-7 for treatment and discharge through the daylight diversion channel (LASL 1959, 25250; LASL 1952, 25236). Several reports mention that the holding tanks accidentally over-filled and spilled contaminated liquids directly into Pratt Canyon (Table 5.2.1-1). These occasional spills were probably the only discharges that did not flow through the daylight diversion channel. Based on this information, additional site surveys were conducted at the discharge site of the daylight diversion channel where beta/gamma radiation measurements above background levels were obtained during field screening (see Section 5.2.4.1).

5.2.3 Previous Investigations

No previous RFI has been conducted at these sites. However, site investigations relating to the operation of the wastewater treatment plant were performed, and these previous investigations are discussed in Section 3.3.2.4 of the work plan (LANL 1992, 7666).

Removal of the four 50,000-gal. liquid waste holding tanks was completed in February 1985. Numerous spills and overflows of radioactive waste from these tanks occurred in the 1950s, and the soil around and beneath the

tanks was highly contaminated. Decommissioning of this structure required excavation to a depth of 18 to 20 ftbelow the ground surface and removal of 340 m^3 of soil. Field screening of the excavation site showed that up to 356 pCi/g gross-beta activity from ^{90}Sr and ^{90}Y was left in the soil at that depth, and the pit was backfilled with clean soil. The area was determined to be decontaminated, and an ALARA decision was made (Cox 1985, 783).

The pump pit and the pipe trench were also removed during D&D activities in 1984. The D&D report does not mention that contamination was left at the sites of the pump pit and the pipe trench after the structures were removed (Elder 1986, 3089).

5.2.4 Field Investigation

The objective of the Phase I RFI was to characterize the nature of potential contamination associated with the former wastewater treatment plant.

The conceptual model for the RFI took into account historic spills, leaks, and routine releases from the wastewater treatment plant. Subsequently, sampling activities were biased toward areas where residual contamination is most likely to be present. The conceptual model took into account the following factors.

- Previous D&D activities removed most contamination, but not all of it.
- Contaminated liquids and sludge leaked from some of the former structures into the surrounding soils and bedrock. D&D information provides some insight into the depths where contaminants may be found. The location of the remaining contamination is assumed to be near the backfill/bedrock interface.
- Leakage from underground tanks and waste lines into surrounding soils is assumed. The transport of contaminants is localized.

Field activities included an H&S radiation survey, engineering surveys, and environmental surveys including a radiation grid survey.

Field screening during site surveys and sample collection activities was performed using a Hazco 1256 OVA, a Ludlum Model 39 alpha meter, and an Eberline ESP-1 beta/gamma meter. Using this instrumentation, background radiation measurements at TA-35 range from 200 to 500 cpm beta/gamma radiation depending on the location and substrate rock type. Field screening measurements greater than 500 cpm beta/gamma radiation were generally considered to be above background levels. No beta/gamma radiation measurements above background levels were obtained during field screening at the surface of these PRSs; however, elevated beta/gamma radiation measurements were recorded at the discharge point from the daylight diversion channel and in a few samples from some of the boreholes, as described in the following section. No alpha radiation or organic vapors were detected during field screening of the samples. The significant field screening results of the borehole samples are summarized below; all results are shown on the geological logs in Attachment II of this RFI report.

5.2.4.1 Environmental and Engineering Surveys

The H&S radiation survey was performed on January 6, 1994. The beta/gamma radiation measurements ranged from 210 to 350 cpm, which are within background levels.

Engineering surveys were performed from January 6, 1994, through March 15, 1994. The surveys consisted of reviews of archival information, oblique photographs, aerial photographs, and engineering drawings of TA-35 as well as a field site inspection and a description of the PRSs. Each PRS was located, and the condition of the site was described. Registered professional surveyors located most of the former structures.

The radiation grid surveys were performed on January 13, 1994, and February 28, 1994. The initial survey area was located at the site of the former structures. Subsequently, additional grid locations were added to the southeastern side of the initial survey area to include the outfall area of the daylight diversion channel. A total of 69 radiation measurements were obtained from grid locations that were spaced at approximately 20-ft intervals. Beta/gamma radiation measurements ranged from 200 to 1,000 cpm, and the mean was 317 cpm. All measurements were within background levels except two locations in the discharge area of the daylight diversion channel, which measure 750 and 1,000 cpm beta/gamma radiation. An isopleth map created by gridding (using inverse distance) the survey data (and data from PRS Nos. 35-003[e, f, g, m, o, and r]) is shown in Figure 5.1.4-1.

5.2.4.2 Deviations from the Sampling and Analysis Plan

The original SAP is described in Section 7.8 of the work plan (LANL 1992, 7666). However, the SAP was modified based on information gathered during the engineering surveys. The changes to the SAP, which are summarized below, are documented in the March 28, 1994, memorandum to the Operable Unit 1129 file (Koch 1994, 46647).

- Two boreholes (Location ID Nos. 35-2006 and 35-2007) were relocated to sample potential contamination at the site of the daylight diversion channel because an engineering survey indicated that most discharges from the tanks were pumped through the wastewater treatment plant piping system to the daylight diversion channel.

- One borehole (Location ID No. 35-2015) was relocated and drilled to a depth of 30 ft because engineering surveys indicated that Line 95 drained into a corrugated metal pipe (CMP) that discharged into the daylight diversion channel. The SAP was changed to collect samples at the following depth intervals: 0 to 2 ft, 15 to 20 ft, and 25 to 30 ft.

- One borehole (Location ID No. 35-2022) was relocated to the outfall area of the daylight diversion channel because additional information indicated a history of large discharges (above normal daily flow) into the channel. The contaminated tank contents would have drained down the daylight diversion channel and into Pratt Canyon.

- Two surface samples (Location ID Nos. 35-2208 and 35-2212) were planned to assess possible contamination in the erosional channel that transects the former site of the holding tanks. Any surface contamination associated with the erosional channel would have been the result of relatively recent discharges from an outfall draining the surface area southwest of TA-35-7. Therefore, it was determined that five surface samples from the erosional channel were not necessary to adequately characterize the backfill material. One surface sample (Location ID No. 35-2209) was relocated to the outfall of the daylight diversion channel at PRS No. 35-003(r).

- Five samples were planned to be collected from each borehole (Location ID Nos. 35-2004, 35-2005, 35-2006, 35-2007, 35-2008, 35-2011, and 35-2013) at the following depths: the interval from 0 to 5 ft, the backfill/tuff interface, and three additional randomly generated depths. However, only four samples were collected from two of the boreholes (Location ID Nos. 35-2007 and 35-2009) because one of the planned sample collection intervals coincided with the backfill/tuff interface.

These changes to the SAP did not adversely impact the success of the field activities.

5.2.4.3 Sampling Activities

Phase I sampling was performed from April 6, 1994, through May 2, 1994, and supplemental sampling was performed on December 8, 1995. A total of 13 locations were sampled, and 49 soil samples were collected (not including duplicate QA/QC samples). Table 5.2.4-1 summarizes samples taken and target analytical suites for PRS Nos. 35-003(d, l, and q); Figure 5.2.4-1 shows the sample locations. The soil materials encountered in the

TABLE 5.2.4-1

SUMMARY OF SAMPLES TAKEN AT PRS Nos. 35-003(d, l, and q)

Location ID	Sample ID	Depth (ft)	Matrix	SVOC Mobile Lab	SVOC Fixed Lab	PCB Fixed Lab	INORG Mobile Lab	INORG Fixed Lab	Rad Van	Rad Fixed Lab
35-2004	AAB0993	1-2	mixed soil	17316	NR	17316	17328	NR	1	17373
35-2004	AAB1457	16-17	mixed soil	17316	NR	17316	17328	NR	NR	17373
35-2004	AAB0995	64-65	Qbt3	17316	NR	17316	17328	NR	1	17373
35-2004	AAB0994	9-10	mixed soil	17316	NR	17316	17328	NR	1	17373
35-2004	AAB0996	99-100	Qbt2	NR	NR	17316	17326	19619	1	19560
35-2005	AAB0989	1-2	mixed soil	17288	17307	17307	17409	NR	1	19582
35-2005	AAB1458	15-16	mixed soil	17288	NR	17288	17409	NR	1	19582
35-2005	AAB0991	34-35	Qbt3	17288	NR	17288	17409	NR	1	19582
35-2005	AAB0990	49-50	Qbt3	17288	NR	17288	17409	NR	1	19582
35-2005	AAB0992	99-100	Qbt2	17288	NR	17288	17409	NR	1	19582
35-2006	AAB1459	2-3	mixed soil	17347	NR	17347	19683	NR	1	19577
35-2006	AAB0997	24-25	Qbt3	17347	NR	17347	19683	19606	1	19577
35-2006	AAB0998	54-55	Qbt3	17347	NR	17347	19683	NR	1	19577
35-2006	AAB0999	69-70	Qbt3	17347	NR	17347	19683	NR	1	19577
35-2006	AAB1000	99-100	Qbt2	17352	NR	17352	19614	NR	20918	19575
35-2007	AAB1037	0.5-1.5	mixed soil	17146	NR	17146	17151	17153	1	17155
35-2007	AAB1038	39-40	Qbt3	17146	NR	17146	17151	NR	1	17155
35-2007	AAB1039	64-65	Qbt3	17146	NR	17146	17151	NR	1	17155
35-2007	AAB1040	91-92	Qbt3	17146	17148	17146, 17148	17151	NR	1	17155
35-2008	AAB1033	1-2	mixed soil	17204	17205	17204, 17205	17223	NR	17387	17372
35-2008	AAB1460	13.5-14.5	mixed soil	17204	NR	17204	17223	NR	17387	17372
35-2008	AAB1034	63.5-64.5	Qbt3	17204	NR	17204	17223	NR	17387	17372
35-2008	AAB1035	74-75	Qbt3	17204	NR	17204	17223	NR	17387	17372
35-2008	AAB1036	99-100	Qbt2	17204	NR	17204	17223	NR	17387	17372
35-2009	AAB0977	1-2	mixed soil	17194	NR	17194	17225	NR	1	17295
35-2009	AAB0978	11-12	Qbt3	17194	17196	17196	17225	NR	1	17295
35-2009	AAB0979	80-81	Qbt2	17194	NR	17194	17225	NR	1	17295
35-2009	AAB0980	99-100	Qbt2	17194	NR	17194	17225	NR	1	17295
35-2011	AAB1001	1-2	mixed soil	NR	NR	17319	17326	NR	1	19560
35-2011	AAB1002	10-11	mixed soil	17319	17314	17314	17326	NR	1	19560
35-2011	AAB1003	24-25	Qbt3	NR	NR	17319	17326	NR	1	19560
35-2011	AAB1004	64-65	Qbt3	17347	NR	17347	19683	NR	1	19577
35-2011	AAB1005	99-100	Qbt2	17347	NR	17347	19683	NR	1	19577
35-2013	AAB0981	1-2	mixed soil	17320	NR	17320	17327	NR	1	17333
35-2013	AAB0982	15-16	mixed soil	17320	NR	17320	17327	NR	1	17333
35-2013	AAB0984	34-35	Qbt3	17320	NR	17320	17327	17437	1	17333
35-2013	AAB0985	64-65	Qbt3	17320	NR	17320	17327	NR	1	17333
35-2013	AAB0986	99-100	Qbt2	17320	NR	17320	17327	NR	1	17333
35-2015	AAB0949	1-2	mixed soil	17318	17315	17318, 17315	17325	NR	17943	17943
35-2015	AAB0950	10-11	mixed soil	17318	NR	17318	17325	NR	17943	17943
35-2015	AAB0951	19-20	Qbt3	17318	NR	17318	17325	NR	17943	17943
35-2015	AAB0952	29-30	Qbt3	17318	NR	17318	17325	NR	17943	17943
35-2022	AAA6637	1.5-2.5	mixed soil	17167	NR	17167	17169	NR	1	17170
35-2022	AAA6638	19-20	Qbt3	17167	NR	17167	17169	NR	1	17170
35-2022	AAA6639	21-22	Qbt3	17168	1	17168, 17167	17169	NR	1	17170
35-2022	AAA6640	29-30	Qbt3	17167	NR	17167	17169	NR	1	17170
35-2208	AAB1024	0-0.5	mixed soil	17376	NR	17376	19611	NR	21851	19975
35-2212	AAB1044	0-0.5	mixed soil	17376	NR	17376	19611	NR	21851	19975
35-2212	AAB0987	0-0.5	mixed soil	17376	NR	17376	19611	NR	21851	19975
35-2281	0435-95-0196	1-2	mixed soil	NR	1678	NR	NR	NR	NR	NR

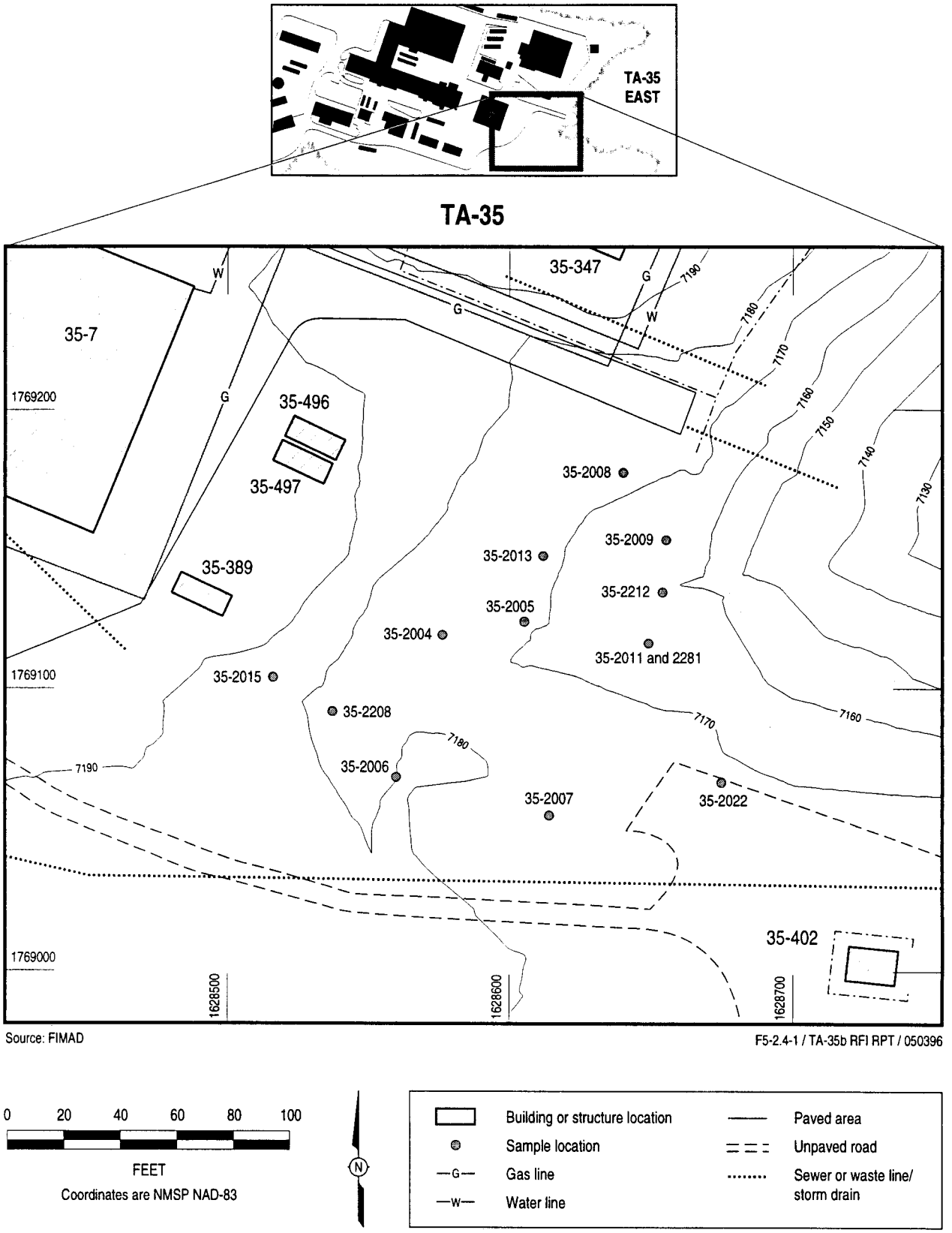


Figure 5.2.4-1. Locations of samples at PRS Nos. 35-003(d, l, and q).

boreholes and the field screening results are described on the geological logs for each borehole in Attachment II of this RFI report.

Seven boreholes (Location ID Nos. 35-2004, 35-2005, 35-2006, 35-2007, 35-2008, 35-2011, and 35-2013) were drilled to a depth of 100 ft. One borehole (Location ID No. 35-2007) was drilled to only 92 ft because of drill rig refusal at that depth. Two boreholes (Location ID Nos. 35-2015 and 35-2022) were drilled to a depth of 30 ft. Two surface samples were collected at Location ID Nos. 35-2208 and 35-2212 in the erosional channel.

Sampling information including depth to the tuff interface and a summary of beta/gamma screening results is presented in Table 5.2.4-2. Detailed screening results are presented in the geological logs in Attachment II of this RFI report.

TABLE 5.2.4-2

SUMMARY OF SAMPLING ACTIVITIES INFORMATION

				Beta/Gamma Screening	
Location ID	Total Depth of Hole (ft)	Depth to Tuff Interface (ft)	Number of Readings	Results (cpm)	Depth of Reading (ft)
35-2004	100	16.3	34	200 (max)	all
35-2005	100	15.5	32	200 (max)	all
35-2006	100	2.2	43	300(max)	25, 70
35-2007	92	0.5	19	280 (max)	1
35-2008	100	14.2	42	1000	14
35-2009	100	10	39	1000	11
				800	12
				700	13
				450	14
35-2011	100	10.5	39	300 (max)	14
35-2012	100	21	31	550	25
				500	28
35-2013	100	15.8	37	200 (max)	all
35-2015	30	10.5	8	200 (max)	all
35-2022	30	2	11	280 (max)	2

5.2.5 Background Comparisons

Background comparisons were performed for inorganic chemicals and radionuclides for which UTL values are available, as discussed in Section 3.2 in Chapter 3.0 of this RFI report. For inorganic chemicals analyzed by XRF in the mobile laboratory facility, the UTL values have been corrected for some analytes to account for method differences that generally result in higher measured background concentrations by XRF. Derivation of corrected UTL values for XRF data is discussed in Section 3.1.3 in Chapter 3.0 of this RFI report. If data are available by both methods, the data reported by the fixed-site laboratory will be given precedence because more confidence is placed in fixed-site laboratory data than in the XRF analyses.

Forty-eight samples from twelve locations were analyzed by alpha spectrometry in a fixed-site laboratory for plutonium and uranium isotopes. Nine samples from eight locations were analyzed by gamma spectroscopy in a fixed-site laboratory for an analyte suite that included ^{241}Am, ^{140}Ba, ^{144}Ce, ^{60}Co, ^{137}Cs, ^{152}Eu, ^{22}Na, ^{237}Np, and ^{106}Ru. In addition, sixteen samples from five locations were analyzed for tritium by liquid scintillation. Radionuclide data from samples submitted to the mobile laboratory facility are not available, as discussed in Section 4.3 in Chapter 4.0 of this RFI report.

Forty-eight samples from twelve locations were analyzed by XRF in the mobile laboratory facility for an analyte suite that included antimony, arsenic, barium, cadmium, calcium, chromium, copper, iron, lead, manganese, mercury, nickel, potassium, selenium, thorium, titanium, uranium, and zinc. As discussed in Section 4.1.3 in Chapter 4.0 of this RFI report, XRF data for antimony, cadmium, mercury, selenium, and uranium should be regarded as estimated, and nickel data may have a low bias. Four soil samples from four locations were also analyzed in a fixed-site laboratory for an inorganic chemical analyte suite that included aluminum, antimony, arsenic, barium, beryllium, cadmium, calcium, chromium, cobalt, copper, iron, lead, lithium, magnesium, manganese, molybdenum, nickel, potassium, selenium, silver, sodium, strontium, thallium, vanadium, and zinc using the EPA methods described in Section 3.1.1 in Chapter 3.0 of this RFI report. For certain analytes, fewer than four results were reported.

Samples from several locations were collected at depths of up to 100 ft below the ground surface. These deeper samples were collected to provide information about the potential vertical migration of contaminants released at these PRSs. Background comparisons are performed only for samples collected at depths of 30 ft or less below the ground surface. This depth was selected as the maximum likely depth at which human activities could result in contact with contaminated soil based on the depth of footings and buried tanks associated with TA-35-7. Eliminating data below 30 ft is intended to provide a reasonable data set for the human health screening assessment, which is based on exposure to surface soils, and does not imply that these data are irrelevant for evaluating contaminant transport.

The mixed-soil UTL values were used for background comparison for the sample intervals that contained any matrix other than, or in addition to, tuff. The UTL for the geologic tuff unit (either Qbt3 or Qbt2) was used for background comparison when the sample matrix was tuff alone. As discussed in Section 3.2 of Chapter 3.0 of this RFI report, UTL values for tritium, ^{137}Cs, and plutonium isotopes are not applied to the data set for these PRSs. In Tables 5.2.5-1 and 5.2.5-2, the values in the boxes indicate inorganic chemicals and radionuclides (respectively) that were detected in soil at concentrations greater than or equal to their respective UTL values, or for which UTL values are unavailable. Sample locations where inorganic chemicals or radionuclides exceeded UTL values are shown in Figure 5.2.5-1. The highest observed concentrations above a UTL value at each location are summarized below.

- Antimony was detected in one sample at a concentration of 5 mg/kg, which is above the XRF UTL of 1.45 mg/kg.
- Chromium was detected in one sample at a concentration of 3.6 mg/kg, which is above the Qbt2 UTL of 1.6 mg/kg.
- Lead was detected in eight samples at seven locations at a maximum concentration of 49.7 mg/kg, which is above the XRF UTL of 28.4 mg/kg.
- Potassium was detected in one sample at a concentration of 39,100 mg/kg, which is above the XRF UTL of 38,700 mg/kg.
- Thallium was detected in one sample at a concentration of 17.9 mg/kg, which is above the Qbt3 UTL of 1.7 mg/kg.
- Thorium was detected in five samples at four locations at a maximum concentration of 29 mg/kg, which is above the XRF UTL of 22.1 mg/kg.
- Uranium was detected in eleven samples at six locations at a maximum concentration of 14 mg/kg, which is above the XRF UTL of 5.33 mg/kg.
- Uranium-235 was detected in one sample at an activity of 0.101 pCi/g, which is above the Qbt3 UTL of 0.067 pCi/g.
- Zinc was detected in two samples at two locations at concentrations of 78 and 76.6 mg/kg, which are at or above the XRF UTL of 76.6 mg/kg.

TABLE 5.2.5-1

INORGANIC CHEMICALS WITH CONCENTRATIONS*
GREATER THAN BACKGROUND UTLs FOR PRS Nos. 35-003(d, l, and g)

Location ID	Sample ID	Depth (ft)	Ag	As	Cd	Cr	Hg	K	Li	Mo	Ni
SAL	N/A	N/A	383	N.A.	38	210	23	N.A.	1500	380	1500
Mixed soil UTL	N/A	N/A	N.A.	7.82	2.7	19.3	0.1	3410	N.A.	N.A.	15.2
Qbt2 UTL	N/A	N/A	N.A.	2	N.A.	1.6	N.A.	2730	N.A.	N.A.	N.A.
Qbt3 UTL	N/A	N/A	1.9	5	N.A.	2.1	N.A.	735	N.A.	N.A.	2.6
XRF UTL	N/A	N/A	N/A	18.1	N.A.	45.1	N.A.	38700	N/A	N/A	22.5
35-2004	AAB0993	1-2	NA	<4	<3	27	<5	27400	NA	NA	<13
35-2004	AAB0994	9-10	NA	5	<3	21	<5	27900	NA	NA	<13
35-2004	AAB1457	16-17	NA	<4	6	<12	<5	34100	NA	NA	<13
35-2004	AAB0995	64-65	NA	<4	5	<12	<5	35100	NA	NA	<13
35-2004	AAB0996	99-100	<.74	<3	<.34	3.6	<5	<921	5	<.9	<1.2
35-2005	AAB0989	1-2	NA	<4	<3	14	<5	28300	NA	NA	<13
35-2005	AAB1458	15-16	NA	<4	<3	<12	<5	35100	NA	NA	<13
35-2005	AAB0991	34-35	NA	<4	<3	<12	<5	34900	NA	NA	<13
35-2005	AAB0990	49-50	NA	<4	<3	14	<5	36500	NA	NA	<13
35-2005	AAB0992	99-100	NA	<4	<3	<12	<5	32100	NA	NA	<13
35-2006	AAB1459	2-3	NA	<4	<3	<12	<5	33000	NA	NA	<13
35-2006	AAB0997	24-25	<.74	<3	<.34	<1.8	<5	<339	<1.5	<.66	<1.2
35-2006	AAB0999	69-70	NA	<4	<3	<12	<5	38100	NA	NA	<13
35-2006	AAB1000	99-100	NA	<4	<3	<12	<5	34300	NA	NA	<13
35-2007	AAB1037	0.5-1.5	<1 UJ	1.6	<.4 UJ	2 J-	<5	420 J-	3.4 J-	<.9 UJ	<2 UJ
35-2007	AAB1038	39-40	NA	<4	<3	<12	<5	35600	NA	NA	<13
35-2007	AAB1039	64-65	NA	<4	<3	<12	<5	35600	NA	NA	<13
35-2007	AAB1040	91-92	NA	<4	<3	<12	<5	34700	NA	NA	<13
35-2008	AAB1033	1-2	NA	<4	<3	<12	<5	30000	NA	NA	<13
35-2008	AAB1460	13.5-14.5	NA	<4	<3	<12	<5	34000	NA	NA	<13
35-2008	AAB1034	63.5-64.5	NA	<4	<3	<12	<5	35500	NA	NA	<13
35-2008	AAB1035	74-75	NA	<4	<3	<12	<5	37200	NA	NA	<13
35-2008	AAB1036	99-100	NA	<4	<3	<12	<5	34200	NA	NA	<13
35-2009	AAB0977	1-2	NA	5	<3	<12	<5	30300	NA	NA	<13
35-2009	AAB0978	11-12	NA	<4	<3	<12	<5	34600	NA	NA	<13
35-2009	AAB0979	80-81	NA	<4	<3	<12	<5	35500	NA	NA	<13
35-2009	AAB0980	99-100	NA	<4	<3	<12	<5	34100	NA	NA	<13
35-2011	AAB1001	1-2	NA	<4	<3	<12	<5	29000	NA	NA	<13
35-2011	AAB1002	10-11	NA	<4	<3	<12	<5	32700	NA	NA	<13
35-2011	AAB1003	24-25	NA	<4	<3	<12	<5	39100	NA	NA	<13
35-2011	AAB1004	64-65	NA	<4	<3	<12	<5	38100	NA	NA	<13
35-2011	AAB1005	99-100	NA	<4	<3	<12	<5	36600	NA	NA	<13
35-2013	AAB0981	1-2	NA	<4	<3	<12	<5	27900	NA	NA	<13
35-2013	AAB0982	15-16	NA	<4	<3	<12	<5	38300	NA	NA	<13
35-2013	AAB0984	34-35	<.21	<1.6	<.21	0.72	<5	173	NA	NA	<.42
35-2013	AAB0985	64-65	NA	<4	<3	<12	<5	35100	NA	NA	<13
35-2013	AAB0986	99-100	NA	<4	<3	17	<5	34000	NA	NA	15
35-2015	AAB0949	1-2	NA	<4	<3	27	<5	28800	NA	NA	17
35-2015	AAB0950	10-11	NA	<4	<3	18	<5	34600	NA	NA	<13
35-2015	AAB0951	19-20	NA	<4	4	<12	<5	34200	NA	NA	<13
35-2015	AAB0952	29-30	NA	<4	<3	<12	<5	35100	NA	NA	<13
35-2022	AAA6637	1.5-2.5	NA	<4	<3	<12	<5	31200	NA	NA	<13
35-2022	AAA6638	19-20	NA	<4	<3	<12	<5	35600	NA	NA	<13
35-2022	AAA6639	21-22	NA	<4	<3	<12	<5	33100	NA	NA	<13
35-2022	AAA6640	29-30	NA	<4	<3	<12	<5	36300	NA	NA	<13
35-2208	AAB1024	0-0.5	NA	<4	<3	30.7	<5	27000	NA	NA	<13
35-2212	AAB1044	0-0.5	NA	<4	<3	32.3	<5	28500	NA	NA	18.3

* mg/kg

TABLE 5.2.5-1 (continued)

INORGANIC CHEMICALS WITH CONCENTRATIONS*
GREATER THAN BACKGROUND UTLs FOR PRS Nos. 35-003(d, l, and g)

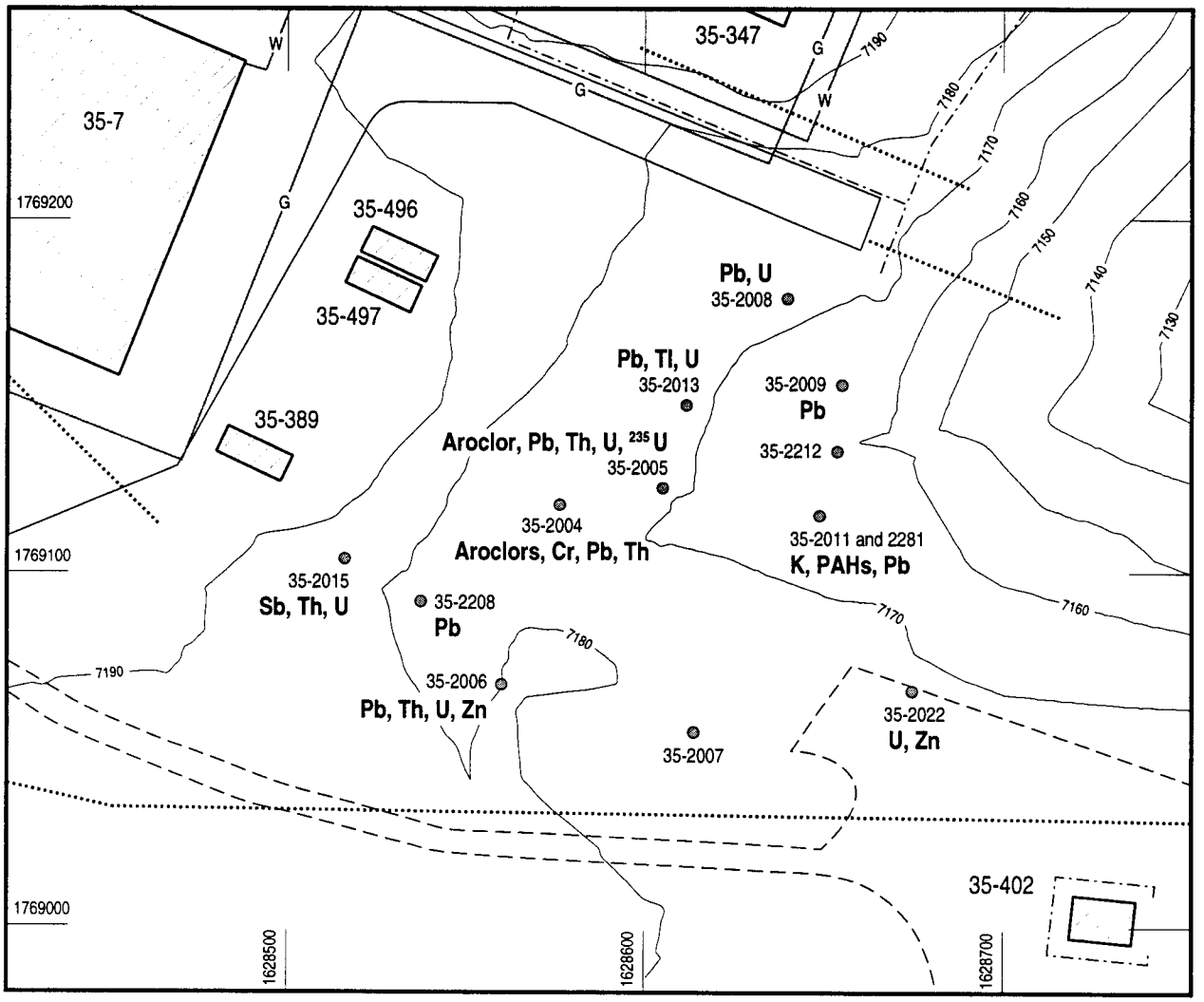
Location ID	Sample ID	Depth (ft)	Pb	Sb	Se	Sr	Th	Ti	Tl	U	Zn
SAL	N/A	N/A	400	31	380	46000	N.A.	N.A.	N.A.	230	23000
Mixed soil UTL	N/A	N/A	23.3	1	1.7	N.A.	14.6	N.A.	1	1.87	50.8
Qbt2 UTL	N/A	N/A	16.2	0.3	N.A.	N.A.	11.5	N.A.	1.3	2.48	55.5
Qbt3 UTL	N/A	N/A	16.2	0.4	N.A.	N.A.	9.29	N.A.	1.7	1.64	55.5
XRF UTL	N/A	N/A	28.4	1.45	N.A.	N/A	22.1	N.A.	N/A	5.33	76.6
35-2004	AAB0993	1-2	39	<4	<4	NA	23	2530	NA	<8	54
35-2004	AAB0994	9-10	26	<4	<4	NA	11	2370	NA	<8	53
35-2004	AAB1457	16-17	16	<4	<4	NA	10	623	NA	<8	46
35-2004	AAB0995	64-65	28	<4	<4	NA	29	487	NA	<8	51
35-2004	AAB0996	99-100	8	<4.2	<6.6	<1.7	<8	448	<23.4	<8	52
35-2005	AAB0989	1-2	35	<4	<4	NA	14	2300	NA	<8	43
35-2005	AAB1458	15-16	17	<4	<4	NA	26	591	NA	12	46
35-2005	AAB0991	34-35	19	<4	<4	NA	21	486	NA	<8	43
35-2005	AAB0990	49-50	26	<4	<4	NA	21	568	NA	<8	65
35-2005	AAB0992	99-100	16	<4	<4	NA	20	435	NA	11	60
35-2006	AAB1459	2-3	26.2	<4	<4	NA	16.1	1022	NA	<8	42.3
35-2006	AAB0997	24-25	12.8	<4.2	<6.6	<1.2	25.1	624	<23.4	8.43	35.9
35-2006	AAB0999	69-70	49.7	<4	<4	NA	21.3	419	NA	<8	76.6
35-2006	AAB1000	99-100	26.5	<4	<4	NA	18.7	370	NA	9.68	57.2
35-2007	AAB1037	0.5-1.5	<4 UJ	<.25 R	<.3	8.6 J-	16	965	<.25	<8	21 J-
35-2007	AAB1038	39-40	15	<4	<4	NA	15	501	NA	<8	47
35-2007	AAB1039	64-65	18	<4	<4	NA	19	455	NA	<8	46
35-2007	AAB1040	91-92	21	<4	<4	NA	20	445	NA	<8	53
35-2008	AAB1033	1-2	37	<4	<4	NA	18	2290	NA	<8	57
35-2008	AAB1460	13.5-14.5	18	<4	<4	NA	21	977	NA	11	53
35-2008	AAB1034	63.5-64.5	23	<4	<4	NA	15	410	NA	<8	49
35-2008	AAB1035	74-75	22	<4	<4	NA	18	463	NA	<8	48
35-2008	AAB1036	99-100	16	<4	<4	NA	13	474	NA	<8	49
35-2009	AAB0977	1-2	34	<4	<4	NA	<8	2360	NA	<8	48
35-2009	AAB0978	11-12	13	<4	<4	NA	10	446	NA	<8	27
35-2009	AAB0979	80-81	12	<4	<4	NA	18	385	NA	<8	40
35-2009	AAB0980	99-100	21	<4	<4	NA	18	515	NA	<8	59
35-2011	AAB1001	1-2	34	<4	<4	NA	12	2280	NA	<8	54
35-2011	AAB1002	10-11	16	<4	<4	NA	19	1260	NA	<8	46
35-2011	AAB1003	24-25	23	<4	<4	NA	21	601	NA	<8	54
35-2011	AAB1004	64-65	20.5	<4	<4	NA	18.4	478	NA	<8	42.5
35-2011	AAB1005	99-100	16.6	<4	<4	NA	19	446	NA	<8	56.5
35-2013	AAB0981	1-2	37	<4	<4	NA	18	2450	NA	<8	45
35-2013	AAB0982	15-16	26	<4	<4	NA	20	822	NA	<8	62
35-2013	AAB0984	34-35	4.5	<2.1	<3.6	NA	22	553	17.9	<8	22.3
35-2013	AAB0985	64-65	21	<4	<4	NA	18	508	NA	13	54
35-2013	AAB0986	99-100	22	<4	<4	NA	20	437	NA	13	44
35-2015	AAB0949	1-2	25	<4	<4	NA	29	2000	NA	<8	61
35-2015	AAB0950	10-11	19	5	<4	NA	19	606	NA	10	51
35-2015	AAB0951	19-20	16	<4	<4	NA	14	566	NA	14	50
35-2015	AAB0952	29-30	17	<4	<4	NA	18	574	NA	<8	45
35-2022	AAA6637	1.5-2.5	20	<4	<4	NA	22	1490	NA	12	64
35-2022	AAA6638	19-20	17	<4	<4	NA	16	524	NA	<8	63
35-2022	AAA6639	21-22	21	<4	<4	NA	21	800	NA	10	61
35-2022	AAA6640	29-30	24	<4	<4	NA	22	522	NA	<8	78
35-2208	AAB1024	0-0.5	28.9	<4	<4	NA	15	2439	NA	<8	40.6
35-2212	AAB1044	0-0.5	24.4	<4	<4	NA	16	1763	NA	<8	46.5

* mg/kg

TABLE 5.2.5-2

RADIONUCLIDES WITH ACTIVITIES GREATER THAN BACKGROUND ACTIVITIES FOR PRS Nos. 35-003(d, l, and q)

Location ID	Sample ID	Depth (ft)	Am-241	Ba-140	Ce-144	Co-60	Cs-137	Eu-152	H-3	Na-22	Np-237	Pu-238	Pu-239,240	Ru-106	U-235
SAL	N/A	N/A	22	N.A.	56	1.1	5.1	2.6	260	1.3	1.9	27	24	13	10
Mixed soil UTL	N/A	N/A	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	0.084
Qbt2 UTL	N/A	N/A	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	0.109
Qbt3 UTL	N/A	N/A	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	0.067
35-2004	AAB0993	1-2	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.002	0.007	NA	0.034
35-2004	AAB0994	9-10	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.034	0.02	NA	0.036
35-2004	AAB1457	16-17	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.011	0.001	NA	0.032
35-2004	AAB0995	64-65	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.059	0.029	NA	0.029
35-2004	AAB0996	99-100	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.002	0.014	NA	0.059
35-2005	AAB0989	1-2	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.011	0.007	NA	0.027
35-2005	AAB1458	15-16	NA	NA	NA	NA	NA	NA	NA	NA	NA	-0.007	0.014	NA	0.041
35-2005	AAB0991	34-35	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.009	0.004	NA	0.101
35-2005	AAB0990	49-50	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.002	0.002	NA	0.043
35-2005	AAB0992	99-100	0.006	49.7 J	-0.043	-0.02	-0.036	0.456	NA	0.004	-0.004	0.023	0.011	0	0.018
35-2006	AAB1459	2-3	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.002	0.023	NA	0.036
35-2006	AAB0997	24-25	-0.027	-23.5 J	-0.222	0.195	-0.022	0.124	NA	-0.008	-0.005	0.002	0.011	-0.063	0.036 J-
35-2006	AAB0998	54-55	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.018	0.002	NA	0.027 J-
35-2006	AAB0999	69-70	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.009	-0.002	NA	0.036 J-
35-2006	AAB1000	99-100	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.011	0.248	NA	0.059
35-2007	AAB1037	0.5-1.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.014	0.001	NA	0.05
35-2007	AAB1038	39-40	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.007	0.007	NA	0.009
35-2007	AAB1039	64-65	-0.025	-0.043	-0.015	0.025	-0.025 J	0.024	NA	-0.033	0.029	0.011	0.002	0.036	0.054
35-2007	AAB1040	91-92	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.002	0.005	NA	0.045
35-2008	AAB1033	1-2	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.007	0.011	NA	0.032
35-2008	AAB1460	13.5-14.5	0.116 J-	0.871	-0.192	0.071	0.837	0.166	NA	-0.039	-0.004	0.005	0.056	0.114	0.027
35-2008	AAB1034	63.5-64.5	0.008 J-	0.51	0.05	0.023	-0.009	0.135	NA	0.005	0.012	0.016	0.002	0.066	0.038
35-2008	AAB1035	74-75	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.011	0.001	NA	0.025
35-2008	AAB1036	99-100	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.001	0.072	NA	0.047
35-2009	AAB0977	1-2	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.016 J+	0.016	NA	0.036 J+
35-2009	AAB0978	11-12	0.053	0.232	-0.083	0.053	0.001	-0.005	NA	0.031	0.009	0.009 J+	0.007	-0.2	0.061 J+
35-2009	AAB0979	80-81	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.002 J+	0.001	NA	0.029 J+
35-2009	AAB0980	99-100	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.011 J+	0.009	NA	0.059 J+
35-2011	AAB1001	1-2	NA	NA	NA	NA	NA	NA	0.12685	NA	NA	0.004	0.004	NA	0.02
35-2011	AAB1002	10-11	NA	NA	NA	NA	NA	NA	0.19315	NA	NA	0.004	0.004	NA	0.038
35-2011	AAB1003	24-25	NA	NA	NA	NA	NA	NA	0.07704	NA	NA	0.029	0.004	NA	0.041
35-2011	AAB1004	64-65	NA	NA	NA	NA	NA	NA	NA	NA	NA	-0.002	0	NA	0.034 J-
35-2011	AAB1005	99-100	0.096	25.7 J	-0.105	0.004	0.009	0.334	0.26114 J	-0.058	-0.025	0.059 J-	0.009 J-	-0.415	0.052
35-2013	AAB0981	1-2	NA	NA	NA	NA	NA	NA	0.18601	NA	NA	0.001	0.007	NA	0.02
35-2013	AAB0982	15-16	NA	NA	NA	NA	NA	NA	0.195	NA	NA	0.023	0.036	NA	0.045
35-2013	AAB0984	34-35	0.028	0.075	-0.033	0.028	0.001	0.163	4.414	0.051	0.031	0.001	0.009	-0.295	0.038
35-2013	AAB0985	64-65	NA	NA	NA	NA	NA	NA	1.509	NA	NA	0.106	0.007	NA	0.032
35-2013	AAB0986	99-100	NA	NA	NA	NA	NA	NA	0.405	NA	NA	0.001	0.001	NA	0.05
35-2015	AAB0949	1-2	NA	NA	NA	NA	NA	NA	0.04383	NA	NA	0	0.05	NA	0.05
35-2015	AAB0950	10-11	NA	NA	NA	NA	NA	NA	0.07874	NA	NA	0	0.37	NA	0.07
35-2015	AAB0951	19-20	NA	NA	NA	NA	NA	NA	0.07498	NA	NA	0	0.01	NA	0
35-2015	AAB0952	29-30	0.006	38.5 J	0.051	0.052	-0.004	0.097	0.11333	0.003	0.039	0.02	0	0.048	0.06
35-2022	AAA6637	1.5-2.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.001	0.034	NA	0.045
35-2022	AAA6638	19-20	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.009	0.004	NA	0.036
35-2022	AAA6639	21-22	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.001	0.001	NA	0.027
35-2022	AAA6640	29-30	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.005	0.001	NA	0.027
35-2208	AAB1024	0-0.5	NA	NA	NA	NA	NA	NA	0.16826	NA	NA	0	0	NA	0.06
35-2212	AAB1044	0-0.5	NA	NA	NA	NA	NA	NA	0.13946	NA	NA	0	0.03	NA	0.04



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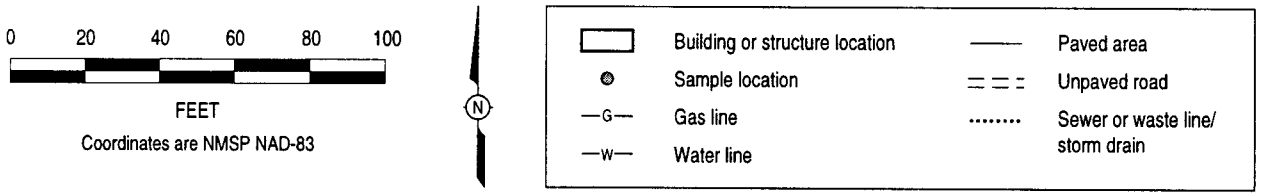


Figure 5.2.5-1. Locations of detected organic chemicals and analytes that exceed UTLs at PRS Nos. 35-003(d, l, and q).

5.2.6 Evaluation of Organic Constituents

The organic chemicals analyzed for at these PRSs include SVOCs and PCBs. Forty-five soil samples from twelve locations were analyzed for SVOCs in the mobile laboratory facility. Seven soil samples from seven locations were also analyzed for SVOCs in a fixed-site laboratory. The SVOC sample at Location ID No. 35-2281 that was analyzed in a fixed-site laboratory is a replacement for a missing 1- t o 2-ft SVOC sample at Location ID No. 35-2011; it is not considered to be a separate sample location. Forty-eight soil samples from twelve locations were analyzed for PCBs in a fixed-site laboratory.

As discussed in Section 4.2 in Chapter 4.0 of this RFI report, the sample results from the mobile laboratory facility are qualified with an "S" flag and may be biased low because of less effective extraction methods.

For reasons described in Section 5.2.5, only samples collected at depths of 30 ft or less below the ground surface are included in this summary of detected organic constituents.

Organic chemicals detected in soil are shown in Table 5.2.6-1 and are summarized below. The locations of these organic chemicals are shown in Figure 5.2.5-1.

- Aroclor 1254 was detected in one sample that was analyzed at a fixed-site laboratory.
- Aroclor 1260 (evaluated as mixed aroclor) was detected (at a concentration of 0.62 mg/kg) in one sample that was analyzed at a fixed-site laboratory.
- Benzo[a]anthracene was detected in one sample that was analyzed at a fixed-site laboratory.

TABLE 5.2.6-1

PRS Nos. 35-003(d, l, and q) SOIL CONCENTRATIONS* FOR DETECTED ORGANIC CHEMICALS

Location ID	Sample ID	Depth (ft)	Aroclor 1254	Mixed Aroclors	Benzo[a] anthracene	Benzo[a] pyrene	Benzo[b] fluoranthene
SAL	N/A	N/A	1.4	1	0.61	0.061	0.61
CRQL	N/A	N/A	0.033	0.033	0.33	0.33	0.33
35-2004	AAB0993	1-2	0.41	0.41	ND	ND	ND
35-2005	AAB0989	1-2	ND	0.62	ND	ND	ND
35-2281	0435-95-0196	1-2	NA	NA	0.035 J	0.044 J	0.032 J

* mg/kg

TABLE 5.2.6-1 (continued)

PRS Nos. 35-003(d, l, and q) SOIL CONCENTRATIONS* FOR DETECTED ORGANIC CHEMICALS

Location ID	Sample ID	Depth (ft)	Benzo[k] fluoranthene	Chrysene	Fluoranthene	Phenanthrene	Pyrene
SAL	N/A	N/A	6.1	24	2600	N.A.	2000
CRQL	N/A	N/A	0.33	0.33	0.33	0.33	0.33
35-2004	AAB0993	1-2	ND	ND	ND	ND	ND
35-2005	AAB0989	1-2	ND	ND	ND	ND	ND
35-2281	0435-95-0196	1-2	0.038 J	0.037 J	0.11 J	0.11 J	0.1 J

* mg/kg

- Benzo[a]pyrene was detected in one sample that was analyzed at a fixed-site laboratory.
- Benzo[b]fluoranthene was detected in one sample that was analyzed at a fixed-site laboratory.
- Benzo[k]fluoranthene was detected in one sample that was analyzed at a fixed-site laboratory.
- Chrysene was detected in one sample that was analyzed at a fixed-site laboratory.
- Fluoranthene was detected in one sample that was analyzed at a fixed-site laboratory.
- Phenanthrene was detected in one sample that was analyzed at a fixed-site laboratory.
- Pyrene was detected in one sample that was analyzed at a fixed-site laboratory.

5.2.7 Human Health Assessment

5.2.7.1 Screening Assessment

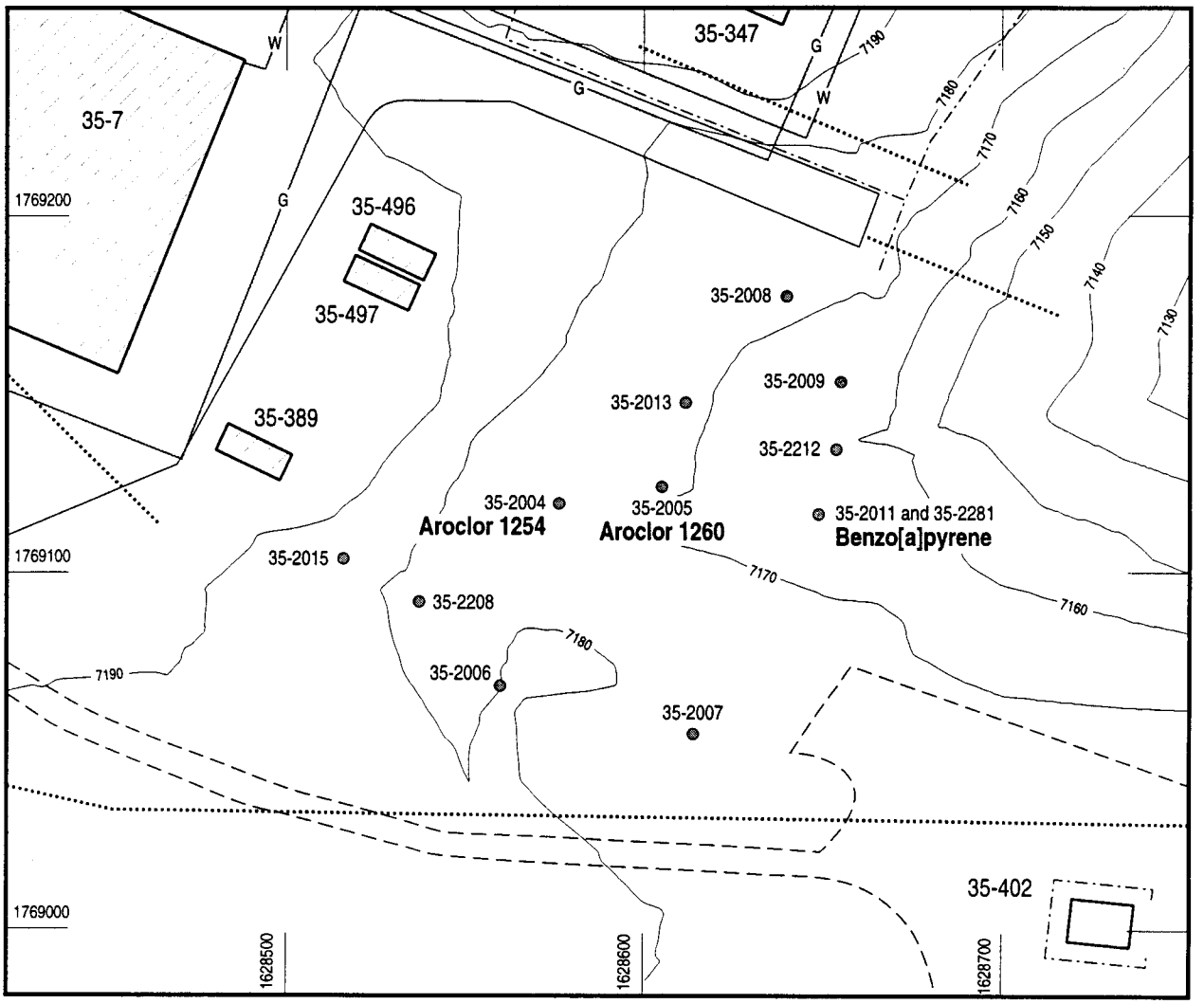
Eight inorganic chemicals, one radionuclide, and ten organic chemicals were carried forward from the background and EQL comparisons, in addition to inorganic chemicals and radionuclides for which UTL values are unavailable. As described in Section 3.4.1 in Chapter 3.0 of this RFI report, analytes are divided into three classes for the screening assessment, depending on whether a reference dose (noncarcinogens), slope factor (chemical carcinogens), or dose conversion factor (radionuclides) is used to calculate their SAL, to evaluate possible additive effects within each class of chemical.

No sample results for any chemical exceeded SAL values at these PRSs. The MCE result for chemical carcinogens is 1.5. Mixed aroclors and benzo[a]pyrene are identified as COPCs among the chemical carcinogens because their maximum concentrations exceed 10% of their SAL values. Chemical carcinogens that were identified as COPCs are shown in Figure 5.2.7-1. The MCE results for noncarcinogens and radionuclides are 0.78 and 0.48, respectively. The MCE values for noncarcinogens and radionuclides are less than unity; therefore, a potential human health risk based on additive effects is not identified for these classes of chemicals. The screening assessment for chemical carcinogens is presented in Table 5.2.7-1. Sample results that exceeded 10% of their SAL value and contributed to MCE exceedance are highlighted with a box in Table 5.2.7-1.

All the COPCs identified in Sections 5.2.5 and 5.2.6 have soil SALs for comparison except thorium, potassium, and phenanthrene. Thorium was measured above its XRF UTL value in only 5 of 47 samples, and at a maximum concentration that was only 30% higher than the UTL. The distribution of thorium at the PRSs in this decision set do not differ significantly from background levels, as shown in Figure AI-14 in Attachment I of this RFI report. Potassium is among those essential elements that may be eliminated from further evaluation in a risk assessment based on professional judgment (EPA 1989, 8021). Potassium is an essential element and was detected above background level in only 1 of 47 samples. Phenanthrene is structurally similar to pyrene and, like pyrene, is not suspected to be a carcinogen. Phenanthrene was detected in only 1 sample at an estimated concentration of 0.11 mg/kg, which is well below the SAL for pyrene of 2,000 mg/kg.

The only inorganic chemical for which neither a UTL nor a SAL value is available is titanium. Titanium is widely used as a food and cosmetics additive to whiten a product. It is generally considered to be physiologically inert in its common form as titanium dioxide (Amdur et al. 1991, 53961).

Barium-140 is the only radionuclide analyzed that has no UTL or SAL value. Activities as high as 49.7 pCi/g



Source: FIMAD

F 5-2.7-1 / TA-35b RFI RPT / 052196

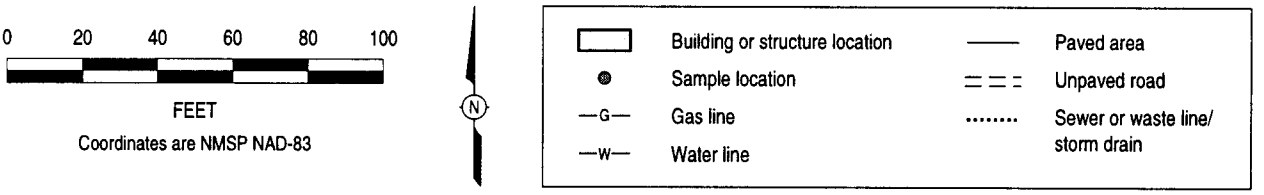


Figure 5.2.7-1. Locations of chemical carcinogens that exceed MCE at PRS Nos. 35-003(d, l, and q).

TABLE 5.2.7-1

PRS Nos. 35-003(d, l, and q) CHEMICAL CARCINOGENS WITH CONCENTRATIONS* THAT EXCEED MCE

Location ID	Sample ID	Depth (ft)	Aroclor (Mixed)	Benzo[a]pyrene
SAL	N/A	N/A	1	0.061
35-2004	AAB0993	1–2	0.41	ND
35-2005	AAB0989	1–2	0.62	ND
35-2281	0435-95-0196	1–2	NA	0.044 J

* mg/kg
MCE =1.46

were measured in samples collected at depths of up to 100 ft below the ground surface. However, these data are suspect because the half-life of ^{140}Ba is only 12.75 days, and any historical release of this isotope at these PRSs would have decayed and would not be detectable.

5.2.7.2 Risk Assessment

A quantitative human health risk assessment was not performed for these PRSs because additional data are required to define the nature and extent of contamination. However, the COPCs identified in the screening assessment are not the basis of any additional data required to reach a risk-based decision for these PRSs. An evaluation of the existing data gathered at these PRSs is provided in Section 5.2.7.2.1.

5.2.7.2.1 Review of Chemicals of Potential Concern and Extent of Contamination

Mixed aroclors and benzo[a]pyrene were identified as COPCs in the screening assessment. These samples were collected in surface intervals (1 to 2 ft) in the backfill material put in place during D&D activities in 1985. With the exception of di-n-butyl phthalate at trace concentrations, no SVOCs or PCBs were detected in any other samples at these PRSs. PAHs, such as benzo[a]pyrene, and PCBs are ubiquitous at low concentrations in industrial areas. Because no other samples revealed these chemicals, it is likely that these measurements reflect sporadic contamination in the backfill used at this site and do not indicate any particular or widespread release. An MCE value 50% above unity was calculated in the screening assessment based on a residential land use scenario and conservative exposure parameters. The low levels of contamination measured in these samples and the limited area where contamination was observed do not indicate a potential human health risk for industrial or commercial uses that are feasible in this area. Therefore, additional surface samples in the area of this decision set are not proposed in the SAP in Section 5.1.10.

As described in Sections 5.2.1 through 5.2.4, activities associated with these PRSs are known to have resulted in releases of radionuclides to the environment. These releases have been documented in previous investigations and in the Phase I RFI. In particular, soil containing up to approximately 360 pCi/g of gross-beta activity was left in place following D&D that was completed in 1985. Gross-beta/gamma activity was measured above background levels at the tuff/backfill interface at Location ID Nos. 35-2008 and 35-2009 during field screening for the Phase activities. The areal extent, volume, and soil concentrations associated with this residual contamination have not yet been determined. Laboratory analyses of soil samples from these PRSs did not include ^{90}Sr, which is the likely source of the elevated gross radioactivity observed during field screening.

Elevated levels of gross-beta/gamma radiation observed at the tuff/backfill interface at Location ID Nos. 35-2008 and 35-2009 are likely associated with residual contamination left in place following D&D. Additional data are required to quantify the nature and extent of this contamination and to evaluate the possibility that subsurface contamination at the tuff/backfill interface may migrate to Pratt Canyon.

5.2.8 Preliminary Ecological Assessment

The general landscape condition around this PRS is moderately developed and disturbed, but a high potential exists for receptors to come in contact with chemicals above background levels associated with the site (lead, thorium, and uranium) (see Table 2.4-1 in Chapter 2.0 of this RFI report). Therefore, this PRS will be included as a potential contaminant source in the ecological risk assessment. An ecological risk assessment will be conducted when that approach has been approved by the regulators. Threatened and endangered species and/or sensitive habitat listed in Chapter 2.0 of this RFI report will be evaluated in the ecological risk assessment.

5.2.9 Conclusions and Recommendations

The objective of the Phase I RFI for PRS Nos. 35-003(d, l, and q) was to determine the presence or absence of contamination associated with the former TA-35 wastewater treatment plant. Mixed aroclors and benzo[a]pyrene were identified as COPCs in the screening assessment, but additional samples addressing these particular contaminants is not proposed.

Field measurements of gross radioactivity and organic vapors, as well as samples for specific analytes, were collected from 10 boreholes at or adjacent to the holding tanks described in Section 5.2.1. Gross-beta/gamma activity was measured above background levels at sample Location ID Nos. 35-2008 and 35-2009.

Further sampling is recommended to determine the nature and extent of contamination identified in field measurements associated with the Phase I RFI.

5.2.10 Sampling and Analysis Plan for PRS Nos. 35-003(d, l, and q)

Because areas of contaminant accumulation for PRS Nos. 35-003(d, l, and q) overlap with PRS Nos. 35-003(e, f, g, m, o, and r) and because of their geographical proximity, the sampling activities for these PRSs are to be conducted as a combined event. Therefore, one SAP has been written for PRS Nos. 35-003(d, e, f, g, l, m, o, q, and r). The objectives of the sampling plan, including specific sample locations and analytical suites, are identified in the SAP in Section 5.1.10.

5.3 PRS No. 35-003(r)

PRS No. 35-003(r) is the site of the canyon disposal area for liquid and sludge effluent from the former wastewater treatment plant that was located at the east end of TA-35.

COPCs identified as a result of the screening assessment include benzo[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, dibenzo[a,h]anthracene, and indeno[1,2,3-cd]pyrene. In addition, high levels of beta radiation were measured during screening activities.

Further investigations are proposed for PRS No. 35-003(r). The SAP for this PRS is included in Section 5.1.10 of this RFI Report.

5.3.1 History

PRS No. 35-003(r) is described in Sections 3.3.2 and 7.8 of the work plan (LANL 1992, 7666).

The PRS is associated with the former wastewater treatment plant. A summary of the history of the operation of the wastewater treatment plant is presented in Section 5.1.1. From 1951 until 1963, radioactively contaminated liquids and sludge were released from the wastewater treatment plant into Pratt Canyon.

The contaminated liquids originated in the operation of hot cells used to prepare kilocurie sources of radioactive lanthanum (^{140}La) and barium (^{140}Ba), experimental reactors (LAPRE I, LAPRE II, and LAMPRE), plutonium research facilities, and a tritium facility. It is not believed that there were any releases before September 1951 (Aeby 1954, 742). From 1951 to 1955, the wastewater was stored in the concrete holding tanks for approximately 6 months to allow the ^{140}La to decay. The water was allowed to evaporate or was used to wash air cleaning filters (Emelity 1958, 794). If the incoming waste volumes were greater than losses through evaporation, the stored water would be released to the canyon. In 1953, assays of the storage tanks indicated that there were waste components with effective half-lives greater than those for ^{140}La and ^{140}Ba (Buckland 1953, 770). These components were primarily ^{89}Sr and ^{90}Sr that were present in the ^{140}La and ^{140}Ba materials. Additional treatment of the wastes was required to ensure that the activity released to the canyon did not exceed allowable limits (Meyer 1954, 874).

In 1955, an experimental treatment system, consisting of a cation exchange column, was installed to remove the radioactive strontium. The pilot plant was operated between January 24, 1956, and March 13, 1957. During this period, more wastewater was recirculated than was released to the canyon. Results were promising enough that the system was eventually expanded to include two ion exchange columns as well as chemical treatment of the wastewater. The new wastewater treatment plant went into operation on June 13, 1960. Between 1957 and 1963 different treatment options were tested. On July 26, 1963, wastewater operations were transferred to the new treatment plant at TA-50. During the operation of the facility, 119 separate batches of wastewater were processed. Approximately 2.7 million gal. of water were released to the canyon. The total activity was about 20 Ci gross-beta activity and 1.4 Ci of ^{89}Sr and ^{90}Sr. Table 5.3.1-1 summarizes the releases from the wastewater treatment plant to Pratt Canyon. It was estimated that 25%, by weight, of the total strontium was ^{90}Sr.

TABLE 5.3.1-1

TOTAL ANNUAL RELEASES FROM THE WASTEWATER TREATMENT PLANT TO PRATT CANYON BETWEEN 1951 AND 1963[a]

Year	No. of Runs	Volume of Wastewater Treated (gal.)			Gross-Beta Activity[b]	Total Sr Activity[b]	^{90}Sr Activity[b]	^{89}Sr Activity[b]
		Treated	Discharged	Recirculated	(Ci)	(Ci)	(Ci)	(Ci)
1951	1				0.00500	0.00020	0.00003	0.00017
1952	3		52,500		1.92200	0.07680	0.01160	0.06540
1953	3				0.16700	0.00670	0.00100	0.00570
1954	1				0.16000	0.00640	0.00097	0.00542
1955	10	52,890	46,850	9,040	0.15142	0.04902	0.00738	0.04164
1956	59	410,900	193,970	238,130	7.36369	0.83700	0.15400	0.68300
1957	16	480,550	446,380	34,440	1.76401	0.22487	0.03373	0.19114
1958	9	370,755	367,485	3,270	1.39311	0.11383	0.01707	0.09675
1959	10	560,234	560,234	0	3.64135	0.02803	0.00420	0.02383
1960	11	572,220	308,635	263,585	1.72937	0.03729	0.00559	0.03170
1961	3	342,497	342,497	0	1.39997	0.01097	0.00165	0.00932
1962	3	318,582	318,582	0	0.90934	0.01643	0.00246	0.01397
1963	1	105,532	105,532	0	0.10802	0.00227	0.00034	0.00193
Total	130	3,214,160	2,690,165	548,465	20.71428	1.40981	0.24002	1.16997

a. Release data was obtained from the Ten Site treatment plant daily operation logs, from Aeby 1954, 742 and from Christenson 1956, 775.
b. Activities are not corrected for radioactive decay.

Effluent from the wastewater treatment plant was routinely released through Line 95 into the daylight diversion channel (PRS No. 35-003[d]) to the south rim of Pratt Canyon. In addition to routine discharges, several radioactive liquid and sludge spills from the former holding tanks have been reported (see Table 5.1.1-1). The routine discharges and accidental spills from the wastewater treatment plant converged in the Pratt Canyon disposal area.

Records from the operation of the wastewater treatment plant indicate that two individual releases occurred in which the gross-beta activity exceeded 1 Ci. The first release occurred on September 6, 1952, when 1.8 Ci was released because of a malfunctioning solenoid valve (Aeby 1952, 741; Aeby 1954, 742); approximately 70 mCi of $^{89+90}$Sr was released. On the weekend of February 11 and 12, 1956, a leaking pipe caused 21,200 gal. of water and a quantity of sludge to be pumped into the canyon (Christenson 1956, 775); approximately 7 Ci of gross-beta activity and 0.6 Ci of $^{89+90}$Sr were released.

The contaminants that were potentially present (and therefore investigated during this RFI) include gross-alpha, -beta, and -gamma radiation; VOCs; SVOCs; metals; PCBs; and tritium.

5.3.2 Description

The PRS is located in Pratt Canyon at the east end of Ten Site Mesa. The PRS extends from the eastern edge of Ten Site Mesa (the headwall of the canyon) to the confluence of Pratt Canyon and Ten Site Canyon. The topography of the site varies from the steep headwall of the canyon to the gently sloping canyon floor. Surface water flow at the PRS drains down Pratt Canyon into Ten Site Canyon, which then flows towards Mortandad Canyon about one mile east of the PRS. The upper and middle part of the canyon is not developed or industrialized. The lower part of the canyon contains a small cattails area that was formed in 1975 by road-building around the TA-35 sewage lagoons (12 years after releases to the canyon ceased). The path of the drainage in the lower reach of the canyon was moved to the west about 30 ft when the sewage lagoons were constructed, thereby relocating the confluence of Pratt Canyon with Ten Site Canyon upstream about 30 ft.

The west end of the canyon ends abruptly at a headwall that is about 40 to 50 ft high. An erosional channel has cut into the western headwall by surface storm water flow across soft backfill materials that were placed on the mesa top west of the canyon during D&D activities at the former concrete holding tanks (PRS No. 35-003[d]). A colluvial fan composed of boulders and cobbles of tuff backfill material is present below the erosional channel at the west headwall and extends about 75 ft into the upper part of the canyon. Most of the colluvial fan appears to have been deposited as a result of erosion of backfill material on the mesa top. The storm water drainage that flows down the headwall is broken into several braided channels across the colluvial fan.

The central part of the canyon extends from the western headwall about 500 ft to the east and contains a gently sloping canyon floor that is about 40 to 50 ft wide. A small amount of alluvial valley-fill is present in the floor of the canyon. At one borehole (Location ID No. 35-2028) the valley-fill is about 5 ft thick. A small braided stream channel extends the length of the canyon and flows intermittently during periods of precipitation. The channel varies in width from 3 to 5 ft and is ordinarily incised about 6 in. to 1 ft into the alluvial sediments.

5.3.3 Previous Investigations

No previous RFI has been conducted at this site. However, site investigations relating to the operation of the wastewater treatment plant were performed, and these previous investigations are discussed in detail in Sections 3.3.2.3 and 3.3.2.4 of the work plan (LANL 1992, 7666).

Previous investigations have been documented as far back as 1952 and have included surveys for radioactivity in the soil and sediment. After highly contaminated water releases in the 1950s, whether inadvertent or intentional, soil and sediment samples were collected downstream from the releases (LASL 1962, 859; Abrahams and Purtymun 1966, 8141; Purtymun 1966, 11778). These samples were usually analyzed for gross-beta,

-gamma, and -radiostrontium activity at five sites in the canyon below the tank farm. The soil monitoring locations included the following sites.

Site 1 Near the Ten Site security fence at the rear of the tank farm

Site 2 In Pratt Canyon, at the bottom cf the steep slope, about 50 ft downstream from Site 1

Site 3 In Pratt Canyon, about 360 ft downstream from Site 1

Site 4 In Pratt Canyon, about 600 ft downstream from Site 1

Site 5 In Ten Site Canyon, about 930 ft from Site 1 and about 60 ft downstream from the confluence of Pratt Canyon and Ten Site Canyon.

Tables 5.3.3-1, 5.3.3-2, and 5.3.3-3 contain the results of the historical soil sampling and analyses in the canyon below the wastewater treatment plant. Samples were collected after major spills in 1956 and 1958, after which the analytical data show a decrease in radioactivity over time that is due to radioactive decay. Residual radioactive contamination in Pratt Canyon is primarily caused by the presence of long-lived radionuclides present in the liquid and sludge released from the wastewater treatment plant (LANL 1992, 7666). At Site 3, samples were collected at depths up to 36 in. from the surface and were analyzed for gross-beta activity (Table 5.3.3-2). Gross-gamma activity measurements (Table 5.3.3-3) were obtained during investigations conducted from 1956 through 1959.

TABLE 5.3.3-1

GROSS-BETA ACTIVITY IN CANYON SURFACE SEDIMENTS DURING OPERATION OF THE WASTEWATER TREATMENT PLANT[a,b]

	Sample Location				
Date	Site 1	Site 2	Site 3	Site 4	Site 5
2/20/56[c]	824,000	885,000	29,600	2,000	1,200
8/7/56	345,370	101,970	1,520	490	40
8/26/57	23,480	3,270	2,510	750	20
2/5/58	87,420	1,910	2,440	130	N.A.
5/25/59	562	991	446	141	25
7/16/59	1,119	557	832	327	78
9/11/59	4,990	1,510	440	50	b
11/19/59	2,801	237	294	33	<1
7/25/60	830	370	1,470	260	<1
4/4/61	2,130	590	1,530	1,440	850
9/6/61	870	2,390	710	360	140
4/12/62	450	470	100	590	30

a. LASL 1962, 859; Purtymun 1966, 11778
b. Counts per minute per dry gram of soil
c. Samples collected following accidental spill of wastewater and sludge (February 11 and 12, 1956)

TABLE 5.3.3-2

GROSS-BETA ACTIVITY AT DEPTH IN CANYON SEDIMENTS AT SITE 3 DURING OPERATION OF THE WASTEWATER TREATMENT PLANT[a,b]

	Sample Depth						
Date	Surface	6 in.	12 in.	18 in.	24 in.	30 in	36 in
5/25/59	446	1,685	1,090	83	30	23	2
7/16/59	832	2,120	1,447	410	284	N.A.	N.A.
9/11/59	440	1,680	510	50	1	30	N.A.
11/19/59	294	1,313	34	22	14	1	8
7/25/60	1,470	840	550	60	1	N.A.	N.A.
4/4/61	1,530	2,170	740	510	440	1,240	330
9/6/61	710	640	660	1,040	850	470	320
4/12/62	100	160	140	550	460	170	N.A.

a. LASL 1962, 859; Purtymun 1966, 11778
b. Counts per minute per dry gram of soil

TABLE 5.3.3-3

GROSS-GAMMA ACTIVITY IN CANYON SURFACE SEDIMENTS DURING OPERATION OF THE WASTEWATER TREATMENT PLANT[a,b]

	Sample Location				
Date	Site 1	Site 2	Site 3	Site 4	Site 5
2/20/56	171,510	207,810	1,840	290	90
8/7/56	11,670	1,350	19	7	6
8/26/57	4,416	314	48	30	1
2/5/58	61,198	2,002	852	1	N.A.
5/25/59	833	1,000	1	1	11

a. LASL 1962, 859; Purtymun 1966, 11778
b. Counts per minute per dry gram of soil

5.3.4 Field Investigation

The objective of the Phase I RFI was to characterize the nature of potential contamination associated with the wastewater treatment plant.FI took into account historic spills, leaks, and routine releases from the wastewater treatment plant. Subsequently, sampling activities were biased toward areas where residual contamination is most likely to be present. The conceptual model for this PRS took into account the following factors.

- Contaminated liquids and sludge leaked and were discharged into the canyon from the wastewater treatment plant.
- Discharges to the canyon were from two sources: the wastewater treatment plant diversion channel and spills from the wastewater holding tanks.
- Contaminants may have infiltrated the canyon soils and may be present at depth in the canyon sediments.

Field activities included an H&S radiation survey, engineering surveys, and environmental surveys including a radiation grid survey.

Field screening during site surveys and sample collection activities was performed using a Hazco 1256 OVA, a Ludlum Model 39 alpha meter, and an Eberline ESP-1 beta/gamma meter. Using this instrumentation, background radiation measurements at TA-35 range from 200 to 500 cpm beta/gamma radiation depending on the location and substrate rock type. Field screening measurements greater than 500 cpm beta/gamma radiation were generally considered to be above background levels. Beta/gamma radiation measurements significantly above background levels were obtained during field screening at the surface of this PRS and during field screening of borehole samples, as described below. No alpha radiation or organic vapors were detected during field screening of the samples. The significant field screening results of the borehole samples are summarized below; all results are shown on the geological logs in Attachment II of this RFI report.

5.3.4.1 Environmental and Engineering Surveys

The H&S radiation surveys were performed on May 19, 1994, and May 23, 1994. Because of high beta/gamma radiation measurements (> 2,000 cpm) at the head of the canyon during the initial survey, the site safety officer contacted RCTs from the Laboratory group ESH-1 to assist in performing the survey. The supplemental H&S radiation survey was performed in the company of ESH-1 RCTs. During the survey, beta/gamma radiation measurements up to 23,400 cpm were obtained on the southern slope of the canyon wall near the head of the canyon. Thereafter, Laboratory H&S personnel required that ESH-1 personnel be contacted before performing any work in the area.

Engineering surveys were performed from January 6, 1994, through May 23, 1994. The surveys consisted of reviews of archival information, oblique photographs, aerial photographs, and engineering drawings of TA-35 as well as a field site inspection. The site inspection was conducted on May 23, 1994, during which a detailed sketch map of the PRS was prepared that shows the significant features of the canyon.

The radiation grid survey was performed on June, 6, 1994, through June 13, 1994. The radiation grid locations included Location ID Nos. 35-6942 through 35-7171, for a total of 230 points, which were spaced at approximately 20-ft intervals. Beta/gamma radiation measurements ranged from 128 to 10,130 cpm, and the average was 617 cpm. The grid locations with elevated measurements were considered "hot spots," and some "hot spots" were selected for subsequent sample collection locations. The "hot spots" are located in an area approximately 200 ft long by 100 ft wide along the upper part of the canyon and on the western and southwestern headwall slopes of the canyon. The highest beta/gamma measurement (10,130 cpm) was obtained in an area covered with leaves on the southwest headwall of the canyon near the outfall from the former diversion channel (PRS No. 35-003[d]). Other measurements obtained near the outfall of the diversion channel ranged from 2,000 to 6,500 cpm. An isopleth map created by gridding (using inverse distance) the survey data (and data from PRS Nos. 35-003[d, e, f, g, l, m, o, and q]) is shown in Figure 5.1.4-1.

5.3.4.2 Deviations from the Sampling and Analysis Plan

The original SAP is described in Section 7.8 of the work plan (LANL 1992, 7666). However, the SAP was modified based on information gathered during the engineering and environmental surveys. The changes to the SAP, which are summarized below, are documented in the June 8, 1994, memorandum to the Operable Unit 1129 File (Pratt 1994, 52012).

- Surface samples were not collected on a 100 ft by 100 ft grid as specified in the original SAP. Instead, two hand-auger holes (Location ID Nos. 35-2030 and 35-2031) were relocated to sample "hot spots," and one surface sample (Location ID No. 35-2249) was located to collect from a "hot spot" on the canyon headwall below the discharge point of the wastewater treatment plant diversion channel. The hand-auger holes were drilled to a depth of 3 ft.

- Trenching and sample collection in the canyon was planned. The original SAP specified that 10-ft-long trenches be excavated across the drainage channels. However, these trenches would unnecessarily disturb contaminated areas and potentially cause migration of contamination, which would needlessly expose workers to radioactive contamination. Therefore, trenching was replaced by two transects consisting of three hand-auger holes each (Location ID Nos. 35-2243, 35-2244, 35-2245, 35-2246, 35-2247, and 35-2248). The hand-auger holes were drilled to a depth of 3 ft.

- One borehole (Location ID No. 35-2028) was drilled to a depth of 299 ft rather than 650 ft, and one borehole (Location ID No. 35-2029) was not drilled. The original SAP included two boreholes to be drilled to the depth of 650 ft. Because of the potential to contaminate subsurface units, only one borehole was drilled. At 299 ft it was possible to collect samples from the Tsankawi and Cerro Toledo Members of the Bandelier Tuff to assess the potential for contaminants at depth.

- In addition to the analyte suite specified in the original SAP, samples from each 10-ft interval at Location ID No. 35-2028 were collected to be analyzed for tritium and moisture content.

These changes to the SAP did not adversely impact the success of the field activities.

5.3.4.3 Sampling Activities

Phase I sampling was performed on May 3, 1994, June 15, 1994, June 16, 1994, October 31 through November 7, 1994, and February 27, 1995, and supplemental sampling was performed on December 8, 1995. A total of 13 locations were sampled, and 62 samples were collected: 10 surface samples and 52 subsurface samples (not including duplicate QA/QC samples). Table 5.3.4-1 summarizes samples taken for PRS No. 35-003(r); Figure 5.3.4-1 shows the sample locations. The soil materials encountered in the boreholes and the field screening results are shown on the geological logs for each borehole in Attachment II of this RFI report.

One borehole (Location ID No. 35-2028) was drilled to a depth of 229 ft. Three surface samples were collected at Location ID Nos. 35-2014, 35-2214, and 35-2249. Eight hand-auger holes (Location ID Nos. 35-2030, 35-2031, 35-2243, 35-2244, 35-2245, 35-2246, 35-2247, and 35-2248) were drilled to a depth of 3 ft.

Sampling information including depth to tuff interface and summary of beta/gamma screening results is presented in Table 5.3.4-2. Detailed screening results are presented in the geological logs in Attachment II of this RFI report.

One surface sample (Location ID No. 35-2209) was collected below the discharge area of the diversion channel where a radiological "hot spot" had been identified by beta/gamma radiation measurements obtained during field screening of the surface soil. One hand-auger hole (Location ID No. 35-2030) was drilled near the erosion channel on the western headwall of the canyon. One hand-auger hole (Location ID No. 35-2031) was drilled to a depth of 3 ft at a radiological "hot spot" near the base of the southwestern headwall to the canyon. One hand-auger hole (Location ID No. 35-2014) was drilled on the northwest side of the canyon headwall, below the discharge area of former outfalls associated with the wastewater treatment plant. One hand-auger (Location ID No. 35-2214) was drilled near the base of the northwest canyon headwall, below the discharge area from storm water drains at the east end of TA-35. This sample was collected to chararacterize potential contamination from PRS No. 35-016(k and l). Figure 5.3.4-1 shows the sample locations.

Two transect lines consisting of three hand-auger holes each were drilled across the canyon floor in the upper and central sections of the canyon. One hand-auger hole was drilled in or near the canyon drainage channel, and two auger holes were drilled on each side of the drainage channel about 15 ft from the center hole at each transect line. Each hand-auger hole was drilled to a depth of 3 ft and sampled alluvial valley-fill sediments.

TABLE 5.3.4-1

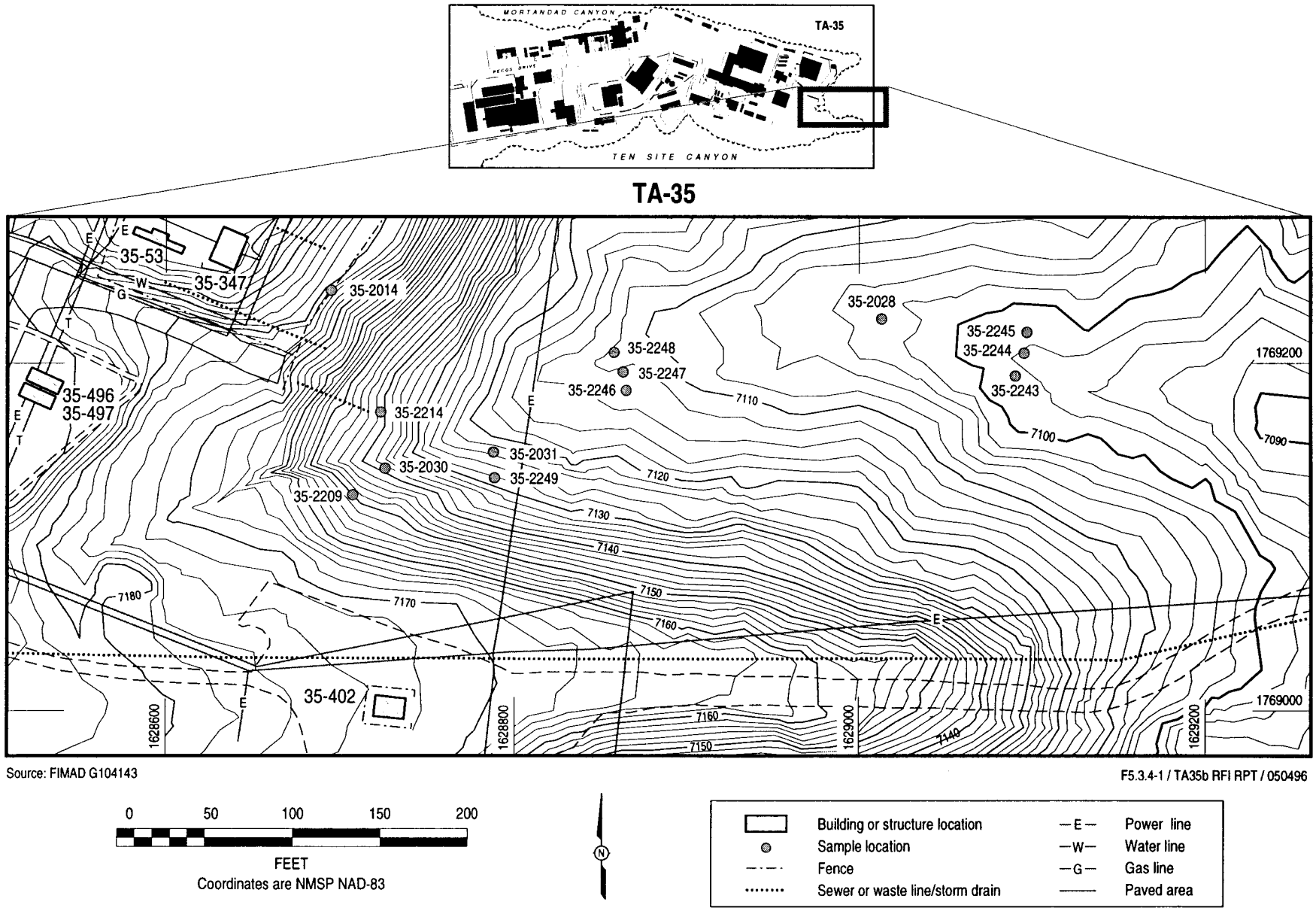
SUMMARY OF SAMPLES TAKEN AT PRS No. 35-003(r)

Location ID	Sample ID	Depth (ft)	Matrix	VOC Mobile Lab	SVOC Mobile Lab	SVOC Fixed Lab	PCB Mobile Lab	PCB Fixed Lab	INORG Mobile Lab	INORG Fixed Lab	Rad Van	Rad Fixed Lab
35-2014	AAB1020	0-2	mixed soil	NR	17376	NR	17376	NR	19611	NR	21851	19975
35-2028	AAB4282	0-0.5	mixed soil	NR	NR	19836	NR	19836	20051	NR	20740	20163
35-2028	AAB4283	6.5-7.5	Qbt3	NR	NR	19836	NR	19836	20051	NR	20740	20163
35-2028	0435-95-0208	13.3-13.5	Qbt3	NR	NR	NR	NR	NR	NR	1676	NR	NR
35-2028	AAB4284	14-15	Qbt3	NR	NR	19836	NR	19836	NR	NR	20740	20163
35-2028	AAB4285	24-25	Qbt3	NR	NR	19836	NR	19836	20051	NR	20740	20163
35-2028	AAB4286	35-36	Qbt2	NR	NR	NR	NR	NR	NR	NR	20615	NR
35-2028	AAB4287	44.5-45	Qbt2	NR	NR	NR	NR	NR	NR	NR	20615	NR
35-2028	0435-95-0209	52.5-52.7	Qbt2	NR	NR	NR	NR	NR	NR	1676	NR	NR
35-2028	XAAB4219	54-55	Qbt2	NR	NR	19902	NR	19902	NR	20046	20615	20160
35-2028	XAAB4220	68.8-69.3	Qbt2	NR	NR	NR	NR	NR	NR	NR	21080	NR
35-2028	XAAB4221	79.5-80	Qbt2	NR	NR	NR	NR	NR	NR	NR	21080	NR
35-2028	XAAB4222	89.5-90	Qbt2	NR	NR	NR	NR	NR	NR	NR	21080	NR
35-2028	XAAB4223	99.5-100	Qbt1v	NR	NR	NR	NR	NR	NR	NR	21080	NR
35-2028	XAAB4226	109.5-110	Qbt1v	NR	NR	NR	NR	NR	NR	NR	21080	NR
35-2028	XAAB4227	119.5-120	Qbt1v	NR	NR	NR	21080	NR	NR	NR	21080	NR
35-2028	XAAB4228	129.5-130	Qbt1v	NR	NR	NR	21080	NR	NR	NR	21080	NR
35-2028	0435-95-0206	133.3-133.5	Qbt1v	NR	NR	NR	NR	NR	NR	1676	NR	NR
35-2028	0435-95-0207	133.3-133.5	Qbt1v	NR	NR	NR	NR	NR	NR	1676	NR	NR
35-2028	XAAB4229	133.5-134.5	Qbt1v	NR	NR	19901	NR	19901	NR	20048	20617	20159
35-2028	AAB4231	149-149.5	Qbt1g	NR	NR	NR	NR	NR	NR	NR	20617	NR
35-2028	XAAB4235	159.5-160	Qbt1g	NR	NR	NR	NR	NR	NR	NR	21080	NR
35-2028	XAAB4236	169.5-170	Qbt1g	NR	NR	NR	NR	NR	NR	NR	21080	NR
35-2028	XAAB4237	179.5-180	Qbt1g	NR	NR	NR	NR	NR	NR	NR	21080	NR
35-2028	XAAB4238	189.5-190	Qbt1g	NR	NR	NR	NR	NR	NR	NR	1	NR
35-2028	XAAB4239	199-200	Qbt1g	NR	NR	19926	NR	19926	NR	20050	1	20158
35-2028	AAC1109	209.5-210	Qbt1g	NR	NR	NR	NR	NR	NR	NR	21706	NR
35-2028	AAC1110	219.5-220	Qbt1g	NR	NR	NR	NR	NR	NR	NR	21706	NR
35-2028	AAC1111	229.5-230	Qct	NR	NR	NR	NR	NR	NR	NR	21706	NR
35-2028	AAC1112	239.5-240	Qct	NR	NR	NR	NR	NR	NR	NR	21705	NR
35-2028	AAC1113	249.5-250	Qct	NR	NR	NR	NR	NR	NR	NR	21705	NR
35-2028	AAC1114	258-259	Qct	NR	NR	NR	NR	NR	NR	NR	21705	NR
35-2028	AAC1115	269.7-270	Qct	NR	NR	NR	NR	NR	NR	NR	21705	NR
35-2028	AAC1116	279.7-280	Qct	NR	NR	NR	NR	NR	NR	NR	21705	NR
35-2028	AAC1117	289.7-290	Qct	NR	NR	NR	NR	NR	NR	NR	21705	NR
35-2028	XAAB4273	298-299	Qbo	NR	NR	NR	NR	NR	NR	20051	NR	20155
35-2030	AAB4240	0-0.5	mixed soil	NR	17848	NR	17848	NR	19538	NR	18156	19594
35-2030	XAAB4241	1-2	mixed soil	NR	17848	NR	17848	NR	19538	NR	NR	19594
35-2030	XAAB4242	2-3	mixed soil	NR	17848	NR	17848	NR	19538	NR	NR	19594
35-2031	XAAB4243	0-0.5	mixed soil	NR	17848	NR	17848	NR	19538	NR	NR	19594
35-2031	XAAB4244	1-2	mixed soil	NR	17848	NR	17848	NR	19538	NR	NR	19594

TABLE 5.3.4-1 (continued)

SUMMARY OF SAMPLES TAKEN AT PRS No. 35-003(r)

Location ID	Sample ID	Depth (ft)	Matrix	VOC Mobile Lab	SVOC Mobile Lab	SVOC Fixed Lab	PCB Mobile Lab	PCB Fixed Lab	INORG Mobile Lab	INORG Fixed Lab	Rad Van	Rad Fixed Lab
35-2031	XAAB4245	2-3	mixed soil	NR	17848	NR	17848	NR	19538	NR	18156	19594
35-2209	AAB1028	0-0.5	mixed soil	NR	17376	NR	NR	17376	19611	NR	21851	19975
35-2214	AAC1140	0-1	mixed soil	21434	21434	21434	NR	NR	21450	NR	21450	NR
35-2243	AAB4217	0-0.5	mixed soil	NR	17767	17765	17767	17765	19543	NR	18157	19529
35-2243	AAB4218	1-2	mixed soil	NR	17767	NR	17767	NR	19543	NR	18157	19529
35-2243	AAB4219	2-3	mixed soil	NR	NR	NR	17767	NR	NR	NR	18157	19529
35-2244	AAB4220	0-0.5	mixed soil	NR	17767	NR	17767	NR	19543	NR	18157	19529
35-2244	AAB4221	1-2	mixed soil	NR	17767	NR	17767	NR	19543	19623	18157	19529
35-2244	AAB4222	2-3	mixed soil	NR	17767	NR	17767	NR	19543	NR	18157	19529
35-2245	AAB4223	0-0.5	mixed soil	NR	17767	17765	17767	17765	19543	NR	18157	19529
35-2245	AAB4226	1-2	mixed soil	NR	17767	NR	17767	NR	19543	NR	18157	19529
35-2245	AAB4225	2-3	mixed soil	NR	17767	NR	17767	NR	19543	NR	18157	19529
35-2246	AAB4227	0-0.5	mixed soil	NR	17767	NR	17767	NR	19543	NR	18157	19529
35-2246	AAB4228	1-2	mixed soil	NR	17767	NR	17767	NR	19543	NR	18157	19529
35-2246	AAB4229	2-3	mixed soil	NR	17767	NR	17767	NR	19543	NR	18157	19529
35-2247	AAB4233	0-0.5	mixed soil	NR	17848	NR	17848	NR	19538	NR	18156	19594
35-2247	AAB4234	1-2	mixed soil	NR	17848	NR	17848	NR	19538	NR	18156	19594
35-2247	AAB4235	2-3	mixed soil	NR	17848	NR	17848	NR	19538	19649	18156	19594
35-2248	AAB4236	0-0.5	mixed soil	NR	17848	NR	17848	NR	19538	NR	18156	19594
35-2248	AAB4238	1-2	mixed soil	NR	17848	NR	17848	NR	19538	NR	18156	19594
35-2248	AAB4239	2-3	mixed soil	NR	17848	NR	17848	NR	19538	NR	18156	19594
35-2249	XAAB4246	0-0.5	mixed soil	NR	17848	NR	17848	NR	19538	NR	18156	19594



Source: FIMAD G104143

F5.3.4-1 / TA35b RFI RPT / 050496

0 50 100 150 200
FEET
Coordinates are NMSP NAD-83

N

▭	Building or structure location	—E—	Power line
●	Sample location	—W—	Water line
—·—·—	Fence	—G—	Gas line
·····	Sewer or waste line/storm drain	——	Paved area

Figure 5.3.4-1. Locations of samples at PRS No. 35-003(r).

TABLE 5.3.4-2

SUMMARY OF SAMPLING ACTIVITIES INFORMATION

Location ID	Total Depth of Hole (ft)	Depth to Tuff Interface (ft)	Beta/Gamma Screening No. of Readings	Results (cpm)	Depth of Reading (ft)
35-2014	2	N/A	1	200	2
35-2028	299	5	112	500	0
				1000	2.5
				1000	5
				600	7.5
35-2030	3	N/A	4	900	0.5
				1200	1
				900	2
				1200	3
35-2031	3	N/A	4	850	0.5
				1300	1
				400	2
35-2209	0.5	N/A	1	500	0.5
35-2214	1	N/A	1	220	1
35-2243	3	N/A	4	250 (max)	all
35-2244	3	N/A	4	750	3
35-2245	3	N/A	4	700	2
				800	3
35-2246	3	N/A	4	800	0.5
				800	1
				800	2
35-2247	3	N/A	4	1200	0.5
				750	1
35-2248	3	N/A	4	450 (max)	0.5
35-2249	0.5	N/A	1	900	0.5

The core samples from one borehole (Location ID No. 35-2028) were archived at the SMO. Alluvial valley-fill sediments were encountered to a depth of 4.5 ft, weathered and altered tuff bedrock extended to a depth of 9.5 ft, and nonweathered tuff bedrock units were encountered below 9.5 ft. The geological log of this borehole is located in Attachment II of this RFI report. Supplemental soil samples were collected from the archived core at the SMO because the analytical laboratory(s) were unable to provide a result for a particular analyte in some samples. Supplemental samples were collected from the following intervals: 13.3 to 13.5 ft, 52.5 to 52.7 ft, and 133.2 to 133.5 ft.

5.3.5 Background Comparisons

Background comparisons were performed for inorganic chemicals and radionuclides for which UTL values are available, as discussed in Section 3.2 in Chapter 3.0 of this RFI report. For inorganic chemicals analyzed by XRF in the mobile laboratory facility, the UTL values have been corrected for some analytes to account for method differences that generally result in higher measured background concentrations by XRF. Derivation of corrected UTL values for XRF data is discussed in Section 3.1.3 in Chapter 3.0 of this RFI report. If data are available by both methods, the data reported by the fixed-site laboratory will be given precedence because more confidence is placed in fixed-site laboratory data than in the XRF analyses.

Thirty-five samples from twelve locations were analyzed by alpha spectrometry in a fixed-site laboratory for plutonium and uranium isotopes. Between one and three additional samples were analyzed by gamma spectroscopy in a fixed-site laboratory for an analyte suite that included ^{241}Am, ^{140}Ba, ^{214}Bi, ^{144}Ce, ^{60}Co, ^{137}Cs, ^{152}Eu, ^{40}K, ^{22}Na, ^{237}Np, ^{210}Pb, ^{212}Pb, ^{214}Pb, ^{223}Ra, ^{224}Ra, ^{226}Ra, ^{228}Ra, ^{106}Ru, ^{228}Th, ^{234}Th, and ^{208}Tl. In addition, four samples from three locations were analyzed for tritium by liquid scintillation. Radionuclide data from samples submitted to the mobile laboratory facility are not available, as discussed in Section 4.3 in Chapter 4.0 of this RFI report.

Thirty samples from twelve locations were analyzed by XRF in the mobile laboratory facility for an analyte suite that included antimony, arsenic, barium, cadmium, calcium, chromium, copper, iron, lead, manganese, mercury, nickel, potassium, selenium, thorium, titanium, uranium, and zinc. As discussed in Section 4.1.3 in Chapter 4.0 of this RFI report, XRF data for antimony, cadmium, mercury, selenium, and uranium should be regarded as estimated, and nickel data may have a low bias. In addition, XRF data from Location ID No. 35-2214 is included in this data set because of geographic proximity. Six soil samples from three locations were also analyzed in a fixed-site laboratory for an inorganic chemical analyte suite that included aluminum, antimony, arsenic, barium, beryllium, cadmium, calcium, chromium, cobalt, copper, iron, lead, lithium, magnesium, manganese, molybdenum, nickel, potassium, selenium, silver, sodium, strontium, thallium, vanadium, and zinc using the EPA methods described in Section 3.1.1 in Chapter 3.0 of this RFI report.

Samples from Location ID No. 35-2028 were collected at depths of up to 299 ft below the ground surface. These deeper samples were collected to provide information about the potential vertical migration of contaminants released at this PRS. Background comparisons are performed only for the first sample interval, 0 to 0.5 ft, because deeper intervals are located in tuff. Surface redistribution of subsurface contaminants in tuff is considered unlikely at this PRS because the canyon walls and floor are unsuitable for intrusive activities such as building construction. All sample data from other locations are obtained from surface soils. Eliminating data in subsurface tuff is intended to provide a reasonable data set for the human health screening assessment, which is based on exposure to surface soils, and does not imply that these data are irrelevant for evaluating contaminant transport.

The mixed-soil UTL values were used for background comparison for the sample intervals that contained any matrix other than, or in addition to, tuff. The UTL for the geologic tuff unit was used for background comparison when the sample matrix was tuff alone. As discussed in Section 3.2 of Chapter 3.0 of this RFI report, UTL values for tritium, ^{137}Cs, and plutonium isotopes are applied to the data set for this PRS because surface soils appear to be undisturbed. In Tables 5.3.5-1 and 5.3.5-2, the values in the boxes indicate inorganic chemicals and radionuclides (respectively) that were detected in soil at concentrations greater than or equal to their respective UTL values, or for which UTL values are unavailable. Sample locations where inorganic chemicals or radionuclides exceeded UTL values are shown in Figure 5.3.5-1. The highest observed concentrations above a UTL value at each location are summarized below.

- Aluminum was detected in one sample at a concentration of 3,630 mg/kg, which is above the Qbo UTL of 1,800 mg/kg.
- Chromium was detected in two samples: one at a concentration of 82.4 mg/kg, which is above the XRF UTL of 45.1 mg/kg, and the other at a concentration of 2.2 (J-), which is above the Qbt3 UTL of 2.1 mg/kg.
- Copper was detected in one sample at a concentration of 18.3 mg/kg, which is above the XRF UTL of 16.7 mg/kg.
- Lead was detected in three samples at three locations at a maximum concentration of 40.3 mg/kg, which is above the XRF UTL of 28.4 mg/kg.
- Manganese was detected in one sample at a concentration of 818 mg/kg, which is above the XRF UTL of 681 mg/kg.

TABLE 5.3.5-1

INORGANIC CHEMICALS WITH CONCENTRATIONS* GREATER THAN BACKGROUND UTL FOR PRS No. 35-003(r)

Location ID	Sample ID	Depth (ft)	Ag	Al	As	Cd	Cr	Cu	Hg	Li	Mn	Mo	Ni
SAL	N/A	N/A	383	77000	N. A.	38	210	2800	23	1500	N.A.	380	1500
Mixed soil UTL	N/A	N/A	N.A.	38700	7.82	2.7	19.3	15.5	0.1	N.A.	714	N.A.	15.2
Qbt1g UTL	N/A	N/A	N.A.	3700	0.7	N.A.	0.94	2.4	N.A.	N.A.	273	N.A.	N.A.
Qbt1v UTL	N/A	N/A	N.A.	8170	2	N.A.	1.7	2.6	N.A.	N.A.	533	N.A.	N.A.
Qbt2 UTL	N/A	N/A	N.A.	3700	2	N.A.	1.6	2	N.A.	N.A.	533	N.A.	N.A.
Qbt3 UTL	N/A	N/A	1.9	3700	5	N.A.	2.1	2	N.A.	N.A.	426	N.A.	2.6
Qbo UTL	N/A	N/A	N.A.	1800	N. A.	N.A.	2.3	2.6	N.A.	N.A.	170	N.A.	2.8
XRF UTL	N/A	N/A	N/A	N/A	18.1	N.A.	45.1	16.7	N.A.	N/A	681	N/A	22.5
35-2014	AAB1020	0-2	NA	NA	<4	<3	<12	<8	<5	NA	401	NA	17.3
35-2028	AAB4282	0-0.5	NA	NA	<4	<3	20.8	10.1	<5	NA	323	NA	<13
35-2028	AAB4283	6.5-7.5	NA	NA	<4	<3	40.9	13.8	<5	NA	454	NA	<13
35-2028	0435-95-0208	13.3-13.5	<0.88	598	<0.28	<0.68	2.2 J-	1.9 J	<0.05	NA	217	NA	<3.0
35-2028	AAB4285	24-25	NA	NA	<4	<3	31.9	<8	<5	NA	446	NA	<13
35-2028	0435-95-0209	52.5-52.7	<0.88	2970	<.43	<.26 UJ	<1.5 UJ	0.82	<.11	NA	176	NA	<3.0
35-2028	0435-95-0206	133.3-133.5	<0.91	1720	<.8	<0.7	<2.0 UJ	1.8 J	<.11	NA	318	NA	<3.1
35-2028	XAAB4239	199-200	<.22	1420	<.44	<.07	<.09 UJ	<.77	<.11	NA	58.5	NA	<.13
35-2028	XAAB4273	298-299	<.22 UJ	3630	<.43	<.07	<.48 UJ	<.74	<.1	NA	125	NA	<.16
35-2030	AAB4240	0-0.5	NA	NA	<4	<3	15.1	<8	<5	NA	379	NA	<13
35-2030	XAAB4241	1-2	NA	NA	5.32	<3	23.1	<8	<5	NA	389	NA	<13
35-2030	XAAB4242	2-3	NA	NA	5.24	<3	26.8	<8	<5	NA	416	NA	<13
35-2031	XAAB4243	0-0.5	NA	NA	<4	<3	20.7	<8	<5	NA	370	NA	<13
35-2031	XAAB4244	1-2	NA	NA	<4	<3	<12	10.4	<5	NA	382	NA	<13
35-2031	XAAB4245	2-3	NA	NA	<4	<3	<12	<8	<5	NA	361	NA	<13
35-2209	AAB1028	0-0.5	NA	NA	<4	<3	<12	<8	<5	NA	637	NA	13.9
35-2214	AAC1140	0-1	NA	NA	<4	<3	<12	18.3	5.43	NA	480	NA	14.3
35-2243	AAB4217	0-0.5	NA	NA	<4	<3	32.7	<8	<5	NA	401	NA	<13
35-2243	AAB4218	1-2	NA	NA	<4	<3	36.4	<8	<5	NA	378	NA	<13
35-2243	AAB4219	2-3	NA	NA	<4	<3	82.4	<8	<5	NA	407	NA	<13
35-2244	AAB4220	0-0.5	NA	NA	<4	<3	29.2	<8	<5	NA	399	NA	<13
35-2244	AAB4221	1-2	<.63 UJ	3170 J	<3.7 UJ	<.42 UJ	4.8 J	<3.9 UJ	<5	4.3 J	344 J	<.74 UJ	<3.9 UJ
35-2244	AAB4222	2-3	NA	NA	<4	<3	34.8	<8	<5	NA	516	NA	<13
35-2245	AAB4223	0-0.5	NA	NA	<4	<3	23.5	<8	<5	NA	360	NA	<13
35-2245	AAB4226	1-2	NA	NA	<4	<3	22.9	11.5	<5	NA	818	NA	<13
35-2245	AAB4225	2-3	NA	NA	<4	<3	19.9	16.4	<5	NA	607	NA	<13
35-2246	AAB4228	1-2	NA	NA	<4	<3	22.3	<8	<5	NA	427	NA	<13
35-2246	AAB4229	2-3	NA	NA	<4	<3	33.3	9.6	<5	NA	370	NA	<13
35-2247	AAB4233	0-0.5	NA	NA	<4	<3	25.5	13.4	<5	NA	350	NA	<13
35-2247	AAB4234	1-2	NA	NA	<4	<3	13.7	9.1	<5	NA	366	NA	<13
35-2247	AAB4235	2-3	<.8	2343	<3.2	2.1	5.5	11.5	<5	4.9	144	<.71	<3.2
35-2248	AAB4236	0-0.5	NA	NA	<4	<3	<12	<8	<5	NA	349	NA	<13
35-2248	AAB4238	1-2	NA	NA	<4	<3	28.2	<8	<5	NA	378	NA	<13
35-2248	AAB4239	2-3	NA	NA	<33	<2	<11	<13	<10	NA	563	NA	<28
35-2249	XAAB4246	0-0.5	NA	NA	<4	<3	26.4	9.06	<5	NA	671	NA	<13

*mg/kg

TABLE 5.3.5-1 (continued)

INORGANIC CHEMICALS WITH CONCENTRATIONS* GREATER THAN BACKGROUND UTL FOR PRS No. 35-003(r)

Location ID	Sample ID	Depth (ft)	Pb	Sb	Se	Sr	Th	Ti	Tl	U	Zn
SAL	N/A	N/A	400	31	380	46000	N.A.	N.A.	N.A.	230	23000
Mixed soil UTL	N/A	N/A	23.3	1	1.7	N.A.	14.6	N.A.	1	1.87	50.8
Qbt1g UTL	N/A	N/A	16.2	N.A.	N.A.	N.A.	7.69	N.A.	0.7	1.39	55.5
Qbt1v UTL	N/A	N/A	21.9	0.3	N.A.	N.A.	22.1	N.A.	1.7	5.93	84.6
Qbt2 UTL	N/A	N/A	16.2	0.3	N.A.	N.A.	11.5	N.A.	1.3	2.48	55.5
Qbt3 UTL	N/A	N/A	16.2	0.4	N.A.	N.A.	9.29	N.A.	1.7	1.64	55.5
Qbo UTL	N/A	N/A	5	N.A.	N.A.	N.A.	1.4	N.A.	0.9	0.2	21
XRF UTL	N/A	N/A	28.4	1.45	N.A.	N/A	22.1	N.A.	N/A	5.33	76.6
35-2014	AAB1020	0-2	17.3	<4	<4	NA	16	876	NA	<8	41.9
35-2028	AAB4282	0-0.5	24.7	<4	<4	NA	12.1	1606	NA	<8	47.6
35-2028	AAB4283	6.5-7.5	22.4	<4	<4	NA	12.9	2239	NA	<8	69.2
35-2028	0435-95-0208	13.3-13.5	3.6	<8.7	<0.28 UJ	NA	NA	NA	<0.30	NA	28
35-2028	AAB4285	24-25	14.8	<4	<4	NA	23.9	507	NA	<8	56.2
35-2028	0435-95-0209	52.5-52.7	8.2	<8.7	<.92	NA	NA	NA	<.87	NA	19.8
35-2028	0435-95-0206	133.3-133.5	8.2	<9.0	<1	NA	NA	NA	<1	NA	51.4
35-2028	XAAB4239	199-200	3.8	<.28	<.94	NA	28	282	<1.4	<8	5.7
35-2028	XAAB4273	298-299	2.8	<.28	<.93	NA	12	639	<.89	<8	10.7
35-2030	AAB4240	0-0.5	16.2	<4	<4	NA	12.4	1190	NA	8.36	44.5
35-2030	XAAB4241	1-2	15.9	<4	<4	NA	14.2	1090	NA	<8	43.2
35-2030	XAAB4242	2-3	13.3	<4	<4	NA	12.9	945	NA	<8	48.9
35-2031	XAAB4243	0-0.5	18.7	<4	<4	NA	9.02	1114	NA	<8	40.9
35-2031	XAAB4244	1-2	21.8	<4	<4	NA	18.3	730	NA	10.3	44.4
35-2031	XAAB4245	2-3	21.8	<4	<4	NA	22.7	611	NA	<8	45.2
35-2209	AAB1028	0-0.5	20.9	<4	<4	NA	9.02	976	NA	9.09	56.7
35-2214	AAC1140	0-1	40.3	<4	<4	NA	27.5	1660	NA	14.5	117
35-2243	AAB4217	0-0.5	19	<4	<4	NA	14.4	2339	NA	9.27	39.9
35-2243	AAB4218	1-2	21.7	<4	<4	NA	10.4	2118	NA	11.8	60
35-2243	AAB4219	2-3	23.3	<4	<4	NA	15.7	2521	NA	<8	71.4
35-2244	AAB4220	0-0.5	17.9	<4	<4	NA	11.8	1975	NA	<8	66.4
35-2244	AAB4221	1-2	7.9 J	<3.3	<7.12	7.9 J	16.4	1314	<18.5	8.22	48.4
35-2244	AAB4222	2-3	23.8	<4	<4	NA	18.5	1316	NA	<8	45
35-2245	AAB4223	0-0.5	21.9	<4	<4	NA	12.9	1467	NA	<8	52
35-2245	AAB4226	1-2	27.6	<4	<4	NA	10.7	1480	NA	<8	47.5
35-2245	AAB4225	2-3	26.4	<4	<4	NA	20.7	1457	NA	8.05	41.2
35-2246	AAB4228	1-2	23.4	<4	<4	NA	10.3	1442	NA	<8	56.2
35-2246	AAB4229	2-3	17.6	<4	<4	NA	15.8	1675	NA	8.74	28.9
35-2247	AAB4233	0-0.5	23.2	<4	<4	NA	11.9	1618	NA	<8	67.7
35-2247	AAB4234	1-2	29.4	<4	<4	NA	15.1	1200	NA	<8	67.4
35-2247	AAB4235	2-3	12	<4.5	<7.1	5.8	15.1	1272	<25.2	8.37	49.8
35-2248	AAB4236	0-0.5	23.8	<4	<4	NA	17.5	1122	NA	<8	49.9
35-2248	AAB4238	1-2	17.6	<4	<4	NA	<8	1180	NA	<8	39
35-2248	AAB4239	2-3	37	<3	<5	NA	28	282	NA	<8	96
35-2249	XAAB4246	0-0.5	27.6	<4	<4	NA	11.5	1964	NA	17.7	52.5

*mg/kg

TABLE 5.3.5-2

RADIONUCLIDES WITH ACTIVITIES GREATER THAN BACKGROUND ACTIVITIES* FOR PRS No. 35-003(r)

Location ID	Sample ID	Depth (ft)	Am-241	Ba-104	Bi-214	Ce-144	Co-60	Eu-152	H-3	Na-22	Np-237	Pb-210	Pb-212	Pb-214
SAL	N/A	N/A	22	N.A.	N.A.	56	1.1	2.6	260	1.3	1.9	N.A.	N.A.	N.A.
Mixed soil UTL	N/A	N/A	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	4.08	N.A.	N.A.	N.A.	N.A.	N.A.
Qbt1g UTL	N/A	N/A	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Qbt1v UTL	N/A	N/A	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Qbt2 UTL	N/A	N/A	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Qbt3 UTL	N/A	N/A	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Qbo UTL	N/A	N/A	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
35-2014	AAB1020	0-0.5	NA	NA	NA	NA	NA	NA	0.00998	NA	NA	NA	NA	NA
35-2028	AAB4282	0-0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
35-2028	AAB4283	6.5-7.5	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	1.244	0.818
35-2028	AAB4284	14-15	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
35-2028	AAB4285	24-25	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
35-2028	XAAB4219	54-55	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	2.023	1.533
35-2028	XAAB4229	133.5-134.5	ND	ND	1.937	ND	ND	ND	0.01827	ND	ND	ND	2.68	2.156
35-2028	XAAB4239	199-200	ND	ND	ND	ND	ND	ND	NA	ND	0.3904	3.46	3.026	2.844
35-2028	XAAB4273	298-299	NA	NA	NA	NA	NA	NA	0.012	NA	NA	NA	NA	NA
35-2030	AAB4240	0-0.5	0.087	-62.7 J	ND	0.174	0.108	0.099	NA	0.005	-0.03	ND	ND	ND
35-2030	XAAB4241	1-2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
35-2030	XAAB4242	2-3	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
35-2031	XAAB4243	0-0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
35-2031	XAAB4244	1-2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
35-2031	XAAB4245	2-3	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
35-2209	AAB1028	0-0.5	NA	NA	NA	NA	NA	NA	0.19716	NA	NA	NA	NA	NA
35-2243	AAB4217	0-0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
35-2243	AAB4218	1-2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
35-2243	AAB4219	2-3	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
35-2244	AAB4220	0-0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
35-2244	AAB4221	1-2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
35-2244	AAB4222	2-3	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
35-2245	AAB4223	0-0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
35-2245	AAB4226	1-2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
35-2245	AAB4225	2-3	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
35-2246	AAB4227	0-0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
35-2246	AAB4228	1-2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
35-2246	AAB4229	2-3	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
35-2247	AAB4233	0-0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
35-2247	AAB4234	1-2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
35-2247	AAB4235	2-3	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
35-2248	AAB4236	0-0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
35-2248	AAB4238	1-2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
35-2248	AAB4239	2-3	-0.034	49.5 J	ND	0.072	0.05	0.212	NA	-0.007	0.024	ND	ND	ND
35-2249	XAAB4246	0-0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

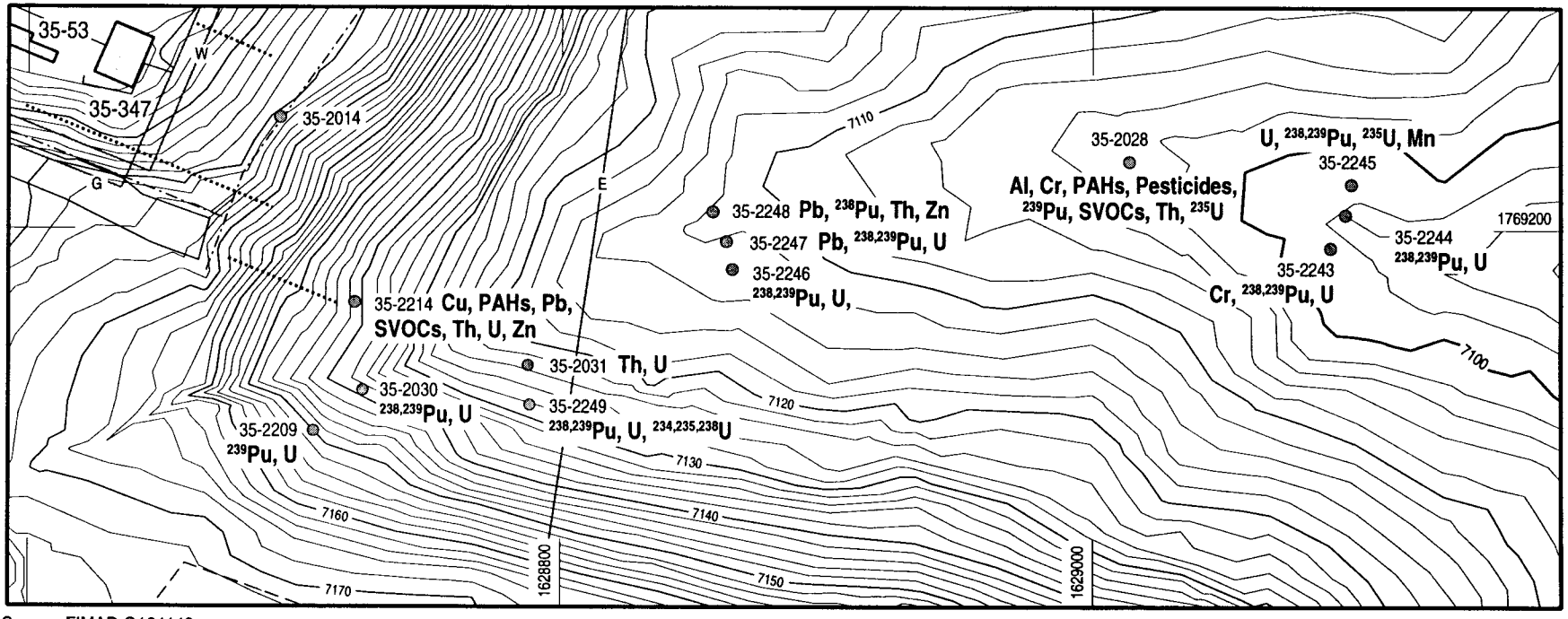
* pCi/g

TABLE 5.3.5-2 (continued)

RADIONUCLIDES WITH ACTIVITIES GREATER THAN BACKGROUND ACTIVITIES* FOR PRS No. 35-003(r)

Location ID	Sample ID	Depth (ft)	Pu-238	Pu-239, 240	Ra-223	Ra-224	Ra-228	Ru-106	Th-228	Th-234	Tl-208	U-234	U-235	U-238
SAL	N/A	N/A	27	24	N.A.	N.A.	1.3	13	1.7	N.A.	N.A.	13	10	67
Mixed soil UTL	N/A	N/A	0.014	0.052	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	1.94	0.084	1.82
Qbt1g UTL	N/A	N/A	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	3.59	0.155	3.37
Qbt1v UTL	N/A	N/A	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	2.7	0.116	2.53
Qbt2 UTL	N/A	N/A	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	2.53	0.109	2.37
Qbt3 UTL	N/A	N/A	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	1.55	0.067	1.46
Qbo UTL	N/A	N/A	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	1.99	0.086	1.87
35-2014	AAB1020	0-0.5	0.01	0.01	NA	NA	NA	NA	NA	NA	NA	0.65	0.05	0.59
35-2028	AAB4282	0-0.5	0.0035	0.0902	NA	NA	NA	NA	NA	NA	NA	0.5888 J+	0.0443 J+	0.5714 J+
35-2028	AAB4283	6.5-7.5	0.0006	0.0103	ND	ND	ND	ND	ND	1.648	ND	0.5168 J+	0.0488 J+	0.4625 J+
35-2028	AAB4284	14-15	0.0025	0.013	NA	NA	NA	NA	NA	NA	NA	0.6606 J+	0.0471 J+	0.6123 J+
35-2028	AAB4285	24-25	0.0013	0.0069	NA	NA	NA	NA	NA	NA	NA	0.6698 J+	0.0433 J+	0.6837 J+
35-2028	XAAB4219	54-55	0.0073	-0.0002	NA	NA	NA	NA	NA	NA	NA	0.5805 J+	0.03 J+	0.6502 J+
35-2028	XAAB4229	133.5-134.5	-0.0009	0.0069	18.83	ND	ND	ND	ND	3.907	0.7028	1.762 J+	0.3433 J+	1.839 J+
35-2028	XAAB4239	199-200	-0.0006	-0.0005	ND	8.211	2.642	ND	8.986	2.624	0.9663	1.239 J	0.0571 J	1.266 J
35-2028	XAAB4273	298-299	0.0104	-0.0005	NA	NA	NA	NA	NA	NA	NA	0.6237 J	0.044 2 J	0.6759 J
35-2030	AAB4240	0-0.5	-0.005	0.065 J	ND	ND	ND	0.241	ND	ND	ND	0.743	0.054	0.716
35-2030	XAAB4241	1-2	0.023	0.059 J	NA	NA	NA	NA	NA	NA	NA	0.705	0.047	0.691
35-2030	XAAB4242	2-3	0.007	0.029 J	NA	NA	NA	NA	NA	NA	NA	0.854	0.047	0.865
35-2031	XAAB4243	0-0.5	0.005	0.032 J	NA	NA	NA	NA	NA	NA	NA	0.759	0.034	0.721
35-2031	XAAB4244	1-2	0.007	0.045 J	NA	NA	NA	NA	NA	NA	NA	0.932	0.041	0.921
35-2031	XAAB4245	2-3	0.004	0.023 J	NA	NA	NA	NA	NA	NA	NA	0.901	0.038	0.786
35-2209	AAB1028	0-0.5	-0.02	0.100	NA	NA	NA	NA	NA	NA	NA	1.03	0.05	1.22
35-2243	AAB4217	0-0.5	0.014 J+	0.162 J	NA	NA	NA	NA	NA	NA	NA	0.813 J	0.072	0.845 J
35-2243	AAB4218	1-2	0.007 J+	0.036 J	NA	NA	NA	NA	NA	NA	NA	0.901 J	0.045	0.928 J
35-2243	AAB4219	2-3	-0.004 J+	0.018 J	NA	NA	NA	NA	NA	NA	NA	0.592 J+	0.011 J+	0.646 J+
35-2244	AAB4220	0-0.5	0.014 J+	0.043 J	NA	NA	NA	NA	NA	NA	NA	0.432 J	0.02	0.534 J
35-2244	AAB4221	1-2	0.122 J+	0.349 J	NA	NA	NA	NA	NA	NA	NA	0.905 J	0.05	0.77 J
35-2244	AAB4222	2-3	0.002 J+	0.07 J	NA	NA	NA	NA	NA	NA	NA	0.822 J	0.025	0.658 J
35-2245	AAB4223	0-0.5	0.027 J+	0.673 J	NA	NA	NA	NA	NA	NA	NA	0.514 J	0.034	0.601 J
35-2245	AAB4226	1-2	0.023 J+	1.002 J	NA	NA	NA	NA	NA	NA	NA	1.545 J	0.077	1.149 J
35-2245	AAB4225	2-3	0	0.16 J	NA	NA	NA	NA	NA	NA	NA	1.032 J	0.092	0.784 J
35-2246	AAB4227	0-0.5	0.023 J+	0.545 J	NA	NA	NA	NA	NA	NA	NA	1.223 J	0.063	1.07 J
35-2246	AAB4228	1-2	0.014 J+	0.18 J	NA	NA	NA	NA	NA	NA	NA	0.822 J	0.045	0.919 J
35-2246	AAB4229	2-3	0.02 J+	0.11 J	NA	NA	NA	NA	NA	NA	NA	0.779 J+	0.034 J+	0.743 J+
35-2247	AAB4233	0-0.5	0.018	1.73 J	NA	NA	NA	NA	NA	NA	NA	1.023	0.05	0.959
35-2247	AAB4234	1-2	0.009	0.189 J	NA	NA	NA	NA	NA	NA	NA	0.874 J	0.07 J	0.939 J
35-2247	AAB4235	2-3	0.016	0.124 J	NA	NA	NA	NA	NA	NA	NA	0.795	0.041	0.811
35-2248	AAB4236	0-0.5	0.045 J-	0.018 J-	NA	NA	NA	NA	NA	NA	NA	0.453	0.016	0.475
35-2248	AAB4238	1-2	0.02	0.011 J	NA	NA	NA	NA	NA	NA	NA	0.421	0.027	0.48
35-2248	AAB4239	2-3	0.002	0.009 J	ND	ND	ND	0.039	ND	ND	ND	0.595 J+	0.029 J+	0.541 J+
35-2249	XAAB4246	0-0.5	0.014	0.245 J	NA	NA	NA	NA	NA	NA	NA	2.761	0.133	3.64

* pCi/g



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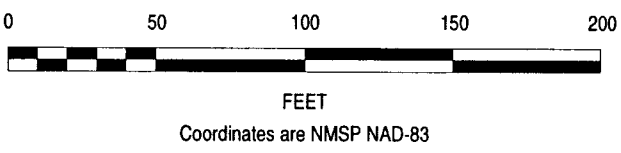


▭	Building or structure location	—E—	Power line
●	Sample location	—W—	Water line
—·—·	Fence	—G—	Gas line
·····	Sewer or waste line/storm drain	——	Paved area

Figure 5.3.5-1. Location of detected organic chemicals and analytes that exceed UTLs at PRS No. 35-003(r).

- Plutonium-238 was detected in 14 samples at eight locations at a maximum activity of 0.122 (J+) pCi/g, which is above the mixed-soil UTL of 0.014 pCi/g.
- Plutonium-239 was detected in 17 samples at nine locations at a maximum activity of 1.73 (J) pCi/g, which is above the mixed-soil UTL of 0.052 pCi/g.
- Thorium was detected in five samples at four locations at a maximum concentration of 28 mg/kg, which is above the XRF UTL of 22.1 mg/kg.
- Uranium (total) was detected in 11 samples at 10 locations at a maximum concentration of 17.7 mg/kg, which is above the XRF UTL of 5.33 mg/kg.
- Uranium-234 was detected in one sample at an activity of 2.761 pCi/g, which is above the mixed-soil UTL of 1.94 pCi/g.
- Uranium-235 was detected in three samples at three locations at a maximum activity of 0.3433 pCi/g, which is above the mixed-soil UTL of 0.084 pCi/g.
- Uranium-238 was detected in one sample at a concentration of 3.64 pCi/g, which is above the mixed-soil UTL of 1.82 pCi/g.
- Zinc was detected in two samples at two locations at concentrations of 96 and 117 mg/kg, which are above the XRF UTL of 76.6 mg/kg.

5.3.6 Evaluation of Organic Constituents

The organic chemicals analyzed for this PRS include SVOCs and PCBs. Twenty-seven soil samples from twelve locations were analyzed for SVOCs in the mobile laboratory facility. Ten soil samples from four locations were also analyzed for SVOCs in a fixed-site laboratory. Twenty-eight soil samples from eleven locations and ten samples from five locations were analyzed for PCBs in the mobile laboratory facility and in a fixed-site laboratory, respectively. In addition, VOCs were analyzed for in one sample (Location ID No. 35-2214).

For reasons described in Section 5.3.5, samples collected at depth at Location ID No. 35-2028 will not be included in this summary of detected organic constituents. However, no organic constituents were detected in these samples.

As discussed in Section 4.2 in Chapter 4.0 of this RFI report, the mobile laboratory sample results are qualified with an "S" flag and may be biased low because of less effective extraction methods.

Organic chemicals detected in soil are shown in Table 5.3.6-1 and are summarized below. The locations of these organic chemicals are shown in Figure 5.3.5-1.

Each of the following organic chemicals was detected at two locations: in a sample that was submitted to the mobile laboratory facility and in a sample that was submitted to both and mobile laboratory facility and a fixed-site laboratory.

- Acenaphthene
- Anthracene
- Benzo[a]anthracene
- Benzo[a]pyrene
- Benzo[b]fluoranthene
- Benzo[g,h,i]perylene

TABLE 5.3.6-1

PRS No. 35-003(r) SOIL CONCENTRATIONS* FOR DETECTED ORGANIC CHEMICALS

PART 1

Location ID	Sample ID	Depth (ft)	Acenaphthene	Acenaphthylene	Anthracene	Benzo[a] anthracene	Benzo[a]pyrene	Benzo[b] fluoranthene	Benzo[g,h,i] perylene	Benzo[k] fluoranthene	Chrysene
SAL	N/A	N/A	360	N.A.	19	0.61	0.061	0.61	N.A.	6.1	24
CRQL	N/A	N/A	0.33	0.1	0.33	0.33	0.33	0.33	0.33	0.33	0.33
35-2028	AAB4282	0-.5	6.4	ND	5.2	8.2	7.3 J	7.3 J	4.4 J	3.1 J	7.6
35-2214	AAC1140	0-1	1.7	9.432 S	1.4	2.4	2.5	2.6	1.9	1.9	2.8

PART 2

Location ID	Sample ID	Depth (ft)	Dibenzo[a,h] anthracene	Dibenzofuran	Dieldrin	Endosulfan II	Fluoranthene	Fluorene	Indeno [1,2,3-cd] pyrene	2-Methyl-naphthalene	Naphthalene	Phenanthrene	Pyrene
SAL	N/A	N/A	0.061	260	0.028	3.3	2600	300	0.61	N.A.	800	N.A.	2000
CRQL	N/A	N/A	0.33	0.33	0.001	0.003	0.33	0.33	0.33	0.33	0.33	0.33	0.33
35-2028	AAB4282	0-.5	2.2 J	3.5	0.00566 J+	0.0157 J+	24	4.8	4.8 J	1.7	7	30	22
35-2214	AAC1140	0-1	0.86	0.8	NA	NA	5.4	1200	1.9	ND	1.2	5.7	5.3

* mg/kg

- Benzo[k]fluoranthene
- Chrysene
- Dibenzo[a,h]anthracene
- Dibenzofuran
- Fluoranthene
- Fluorene
- Indeno[1,2,3-cd]pyrene
- Naphthalene
- Phenanthrene
- Pyrene

Each of the following organic chemicals was detected in one location in a sample that was submitted to both the mobile laboratory facility and a fixed-site laboratory.

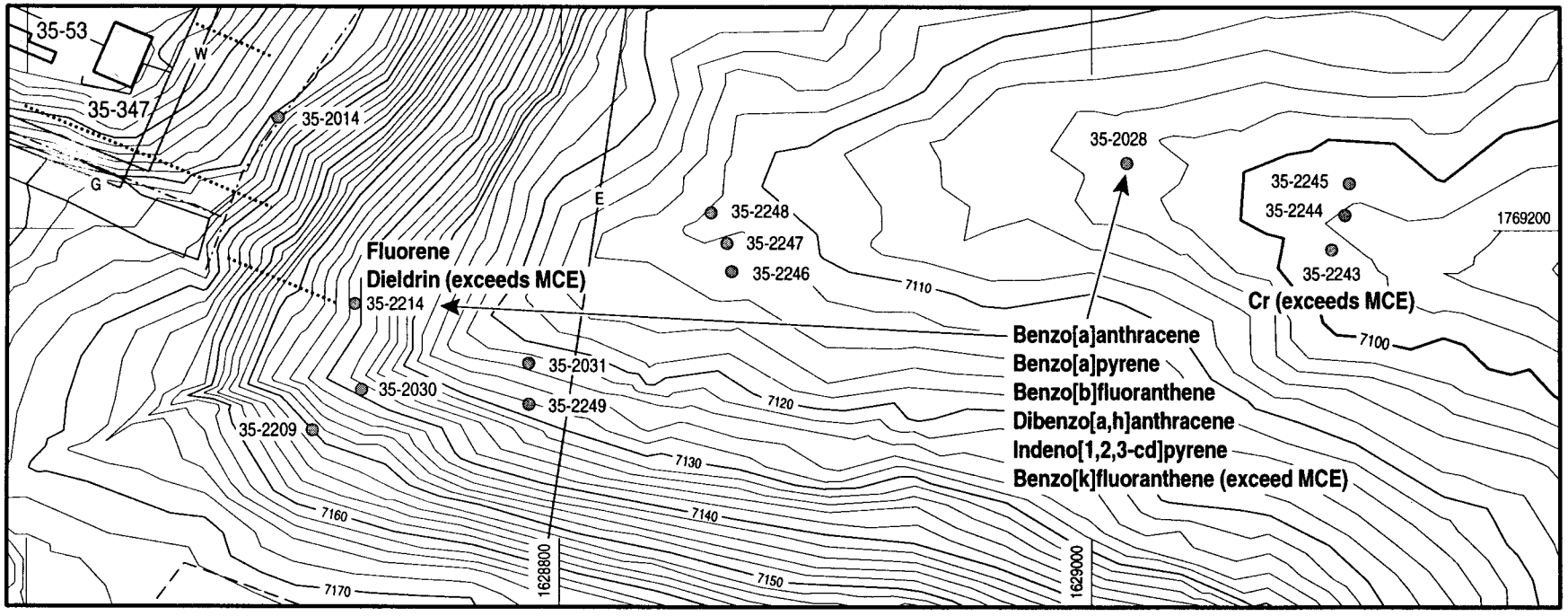
- Acenaphthylene
- Dieldrin
- Endosulfan II
- 2-Methylnaphthalene

5.3.7 Human Health Assessment

5.3.7.1 Screening Assessment

Eight inorganic chemicals, five radionuclides, and 20 organic chemicals were carried forward from the background and EQL comparisons, in addition to inorganic chemicals and radionuclides for which UTL values are unavailable. As described in Section 3.4.1 in Chapter 3.0 of this RFI report, analytes are divided into three classes for the screening assessment, depending on whether a reference dose (noncarcinogens), slope factor (chemical carcinogens), or dose conversion factor (radionuclides) is used to calculate their SAL, to evaluate possible additive effects within each class of chemical.

The chemical carcinogens benzo[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, dibenzo[a,h]anthracene, and indeno[1,2,3-cd]pyrene exceeded SAL values at sample Location ID Nos. 35-2214 and 35-2028. Fluorene (a noncarcinogen) also exceeded SAL values at sample Location ID No. 35-2214 (Figure 5.3.7-1). The screening assessment for noncarcinogens is presented in Table 5.3.7-1; samples that exceeded SAL values are highlighted with black. The MCE results for noncarcinogens and chemical carcinogens are 0.46 and 1.1, respectively. Benzo[k]fluoranthene, chromium, and dieldrin exceeded 10% of their SAL values in two, one, and one sample, respectively. Therefore, these three chemicals are also identified as COPCs in the screening assessment (Figure 5.3.7-1). The MCE value for radionuclides, 0.58, is less than unity; therefore, a potential human health risk based on additive effects is not identified for this class of chemicals. The screening assessment for chemical carcinogens is presented in Table 5.3.7-2. Sample results that exceeded SAL values are highlighted with black, and sample results that exceeded 10% of their SAL value and contributed to MCE exceedance are highlighted with a box in Table 5.3.7-2.



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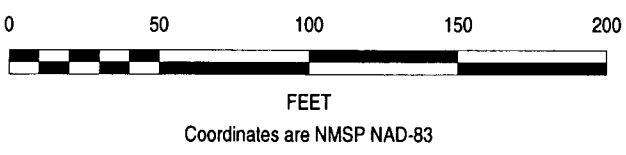

	Building or structure location	—E—	Power line
●	Sample location	—W—	Water line
—·—·	Fence	—G—	Gas line
·····	Sewer or waste line/storm drain	——	Paved area

Figure 5.3.7-1. Locations of analytes that exceed SALs and MCE at PRS No. 35-003(r).

TABLE 5.3.7-1

PRS No. 35-003(r) NONCARCINOGENS WITH CONCENTRATIONS* THAT EXCEED SALs

Location ID	Sample ID	Depth (ft)	Fluorene
SAL	N/A	N/A	300
35-2214	AAC1140	0-1	1200

* mg/kg

Inorganic chemicals measured above UTLs for which no SAL values are available include manganese and thorium. Manganese and thorium were measured above their UTL values in 2 out of 32 samples and 6 out of 32 samples, respectively. However, the distributions of these two chemicals at this PRS are not significantly different than background levels, as shown in Figures AI-10 and AI-14 in Attachment I of this RFI report. The only inorganic chemical for which neither a UTL nor a SAL value is available is titanium. Titanium is widely used as a food and cosmetics additive to whiten a product. It is generally considered to be physiologically inert in its common form as titanium dioxide.

The organic chemicals measured above EQL values for which no SAL values are available include the following: acenaphthylene, benzo[g,h,i]perylene, endosulfan II, 2-methylnaphthalene, and phenanthrene. These five chemicals were measured in the same two samples as the six organic chemicals that exceed SAL values. Additional SVOC data will be gathered at and adjacent to these locations, as described in Section 5.1.10.2.6. Therefore, these chemicals will be evaluated in a future RFI report when data from the additional sampling are available.

Nine radionuclides for which data are available have no UTL or SAL values. Except ^{210}Pb, these radionuclides have half-lives of 24 days or less. Data for these short-lived radionuclides can be useful when evaluating values reported for a parent radionuclide because the relative activity concentrations of parent and daughter isotopes is a known quantity. However, these short-lived isotopes are not evaluated as primary radionuclides because they decay to unmeasurable concentrations within the span of a year or less. Additional soil samples will be collected and analyzed for radionuclides, as described in Section 5.1.10.2.4. Therefore, assessment of these data will be performed in a future RFI report when data from the additional sampling are available.

TABLE 5.3.7-2

PRS No. 35-003(r) CHEMICAL CARCINOGENS WITH CONCENTRATIONS* THAT EXCEED SALs

Location ID	Sample ID	Depth (ft)	Benzo[a] anthracene	Benzo[a] pyrene	Benzo[b] fluoranthene	Benzo[k] fluoranthene	Chromium	Dibenzo[a,h] anthracene	Dieldrin	Indeno [1,2,3-cd] pyrene
SAL	N/A	N/A	0.610	0.061	0.610	6.1	2.10	0.061	0.028	0.61
35-2028	AAB4282	0-.5	8.2	7.3 J	7.3 J	3.1 J	20.8	2.2 J	0.005566	4.8 J
35-2214	AAC1140	0-1	2.4	2.5	2.6	1.9	<12	0.86	NA	1.9
35-2243	AAB4219	2-3	NA	NA	NA	NA	82.4	NA	NA	NA

* mg/kg

5.3.7.2 Risk Assessment

A quantitative human health risk assessment was not performed for this PRS because additional data are required to define the nature and extent of contamination, as described in Section 5.3.7.2.1.

5.3.7.2.1 Review of Chemicals of Potential Concern and Extent of Contamination

Eight organic chemicals and one inorganic chemical were identified as COPCs in the screening assessment. Benzo[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, dibenzo[a,h]anthracene, fluorene, and indeno[1,2,3-cd]pyrene exceeded SAL values at Location ID Nos. 35-2214 and 35-2028. In addition, benzo[k]fluoranthene, chromium, and dieldrin were identified as COPCs in the MCE process.

Additional data are required to determine the nature and extent of contamination at this PRS. As described in Sections 5.3.1 through 5.3.4, planned and unplanned discharges of wastewater from underground storage tanks near the head of Pratt Canyon resulted in the release of radionuclides (primarily ^{90}Sr and ^{137}Cs among the longer-liver isotopes) into the canyon. Elevated levels of radiation in soils and biota, measured with gross-beta/gamma meters, have been documented in the Phase I RFI (see Section 5.3.4.1, Figure 5.3.4-1, and Table 5.3.4-2). The areal extent, volume, and media-specific concentrations associated with this residual contamination have not yet been determined. Sample locations for laboratory analyses were biased using data from the radiological grid survey. However, fixed-site laboratory gamma spectroscopy was performed for only a few soil samples, and these analytical data are inadequate to confirm field survey measurements.

The likely presence of ^{90}Sr in a PRS located in a canyon raises concerns associated with surface water and sediment transport as well as unique ecological and human health assessment endpoints. Strontium-90 may be mobile in aqueous media, and it can achieve concentrations in biotic tissues that are higher than concentrations observed in source media. Laboratory data have not yet been obtained for biotic and aqueous media in Pratt Canyon.

5.3.8 Preliminary Ecological Assessment

The general landscape condition around this PRS is relatively undisturbed , and a high potential exists for receptors to come in contact with chemicals above background levels associated with the site (chromium, copper, lead, mercury, thorium, uranium, and several organic chemicals) (see Table 2.4-1 in Chapter 2.0 of this RFI report). Therefore, this PRS will be included as a potential contaminant source in the ecological risk assessment. An ecological risk assessment will be conducted when that approach has been approved by the regulators. Threatened and endangered species and/or sensitive habitat listed in Chapter 2.0 of this RFI report will be evaluated in the ecological risk assessment.

5.3.9 Conclusions and Recommendations

The objective of the Phase I RFI for PRS No. 35-003(r) was to determine the presence or absence of contamination associated with discharges from storage tanks for the former TA-35 wastewater treatment plant. COPCs identified in the human health screening assessment include benzo[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, dibenzo[a,h]anthracene, fluorene, indeno[1,2,3-cd]pyrene, benzo[k]fluoranthene, chromium, and dieldrin.

Field measurements of gross radioactivity and organic vapors, as well as samples for specific analytes, were collected from 1 borehole and 10 surface or shallow auger-hole locations in Pratt Canyon. In addition, data associated with Location ID No. 35-2214 have been included in this decision set because this sample is located within Pratt Canyon. COPCs were identified primarily in 2 surface samples at Location ID Nos. 35-2028 and 35-2214.

Further sampling is recommended to confirm the nature and determine the extent of contamination identified in field measurements and laboratory analyses associated with the Phase I RFI.

5.3.10 Sampling and Analysis Plan for PRS No. 35-003(r)

Because areas of contaminant accumulation for PRS No. 35-003(r) overlap with PRS Nos. 35-003(d, e, f, g, l, m, o, and q) and because of their geographical proximity, the sampling activities for these PRSs will be conducted as a combined event. Therefore, one SAP has been written for PRS Nos. 35-003(d, e, f, g, l, m, o, q, and r). The objectives of the sampling plan, including sample locations and analytical suites, are identified in the SAP in Section 5.1.10.

5.4 PRS No. 35-016(g)

PRS No. 35-016(g) is an active National Pollution Discharge Elimination System (NPDES)-permitted outfall (04A-127) that is located at the northern edge of Ten Site Mesa.

Chromium, as hexavalent chromium, was the only COPC identified in the screening assessment. In addition, saturated hydrocarbons and unknown organic compounds were reported in a soil sample collected adjacent to the discharge flow.

Further investigations are proposed for PRS No. 35-016(g). The SAP for this PRS is included in Section 5.4.10.

5.4.1 History

PRS No. 35-016(g) is described in Section 3.3.2 of the work plan and in Section 7.25 of the June 1994 addendum to the work plan (LANL 1992, 7666; Pratt 1994, 43475).

The outfall was originally established in 1979 to discharge water from a reverse-osmosis water-handling apparatus that was located in building TA-35-213. It was permitted as an NPDES outfall in 1990 to discharge noncontact cooling water that originates in Room 29 of TA-35-213. Before NPDES permitting, the outfall may have received tritium-contaminated water and cooling tower blowdown water containing corrosion- and bacterial-inhibiting chemicals.

The contaminants that were potentially present (and therefore investigated during this RFI) include gross-alpha, -beta, and -gamma radiation; VOCs; SVOCs; metals; and tritium.

5.4.2 Description

This PRS is located approximately 100 ft northwest of TA-35-213 at the western end of TA-35 north of Pecos Drive. The discharge point of the outfall is located about 30 ft north of the security fence that surrounds the parking area and is located at the base of the backfill material that forms the parking area. The discharge from the outfall has formed a small pool of water that has partially submerged the outfall pipe. A small channel has eroded in the bedrock tuff at the outlet from the pool where the water flows over the mesa edge and into Mortandad Canyon. At the time of the investigation, the outfall was flowing at a rate of 2 to 3 gal. per minute.

The topography includes a small, relatively flat area at the discharge point, which changes to steep mesa-side topography beyond the mesa edge (the estimated slope is approximately 70%). The surface water runoff and the discharge from the outfall flow northward into Mortandad Canyon. Abundant shrubs and bushes present at the discharge area appear to be normal and healthy.

5.4.3 Previous Investigations

No previous investigations have been performed at this site. However, pursuant to the NPDES permit, the Laboratory ESH Division monitors the flow volume and collects water samples from the outfall weekly. The samples are analyzed weekly for pH and annually for metals. The results of the sampling are reported monthly to the EPA and the New Mexico Environment Department.

5.4.4 Field Investigation

The objective of the Phase I RFI was to characterize the nature of potential contamination associated with the outfall discharge area.

The conceptual model for the RFI predicted that if contaminants had been released to the environment, the material would infiltrate the surface soils at the point of discharge and be mobilized by surface runoff to the adjacent mesa edge. A judgmental sampling approach was used, and the sampling activities were biased toward areas below the outfall discharge area where residual contamination was expected.

Field activities included an H&S radiation survey, an engineering survey, and an environmental survey including a radiation grid survey.

Field screening during site surveys and sample collection activities was performed using a Hazco 1256 OVA, a Ludlum Model 39 alpha meter, and an Eberline ESP-1 beta/gamma meter. Using this instrumentation, background radiation measurements at TA-35 range from 200 to 500 cpm beta/gamma radiation depending on the location and substrate rock type. Field screening measurements greater than 500 cpm beta/gamma radiation were generally considered to be above background levels. No beta/gamma radiation measurements above background levels were obtained during field screening at this site, and no alpha radiation or organic vapors were detected.

5.4.4.1 Environmental and Engineering Surveys

The H&S radiation survey was performed on September 8, 1994. The beta/gamma radiation measurement at the outfall area was 237 cpm, which is within background levels. On September 23, 1994, an additional survey was performed for alpha activity, and no alpha radiation was detected.

The engineering survey was performed on September 8, 1994. The survey consisted of a review of archival information, oblique photographs, aerial photographs, and engineering drawings of TA-35 as well as a field site inspection. It was noted that the outfall has created a pond and cattails area northwest of TA-35-213. A small channel has been created in the tuff by water flow from the pond area. Also, it was noted that the channel was coated with a whitish precipitate, although the vegetation in the area appeared healthy.

The radiation grid survey was performed on September 12, 1994. The 27 radiation grid locations included Location ID Nos. 35-7710 through 35-7736, which were spaced at approximately 5-ft intervals. Beta/gamma radiation measurements ranged from 120 to 355 cpm, and the average was 234 cpm, which is within background levels.

5.4.4.2 Deviations from the Sampling and Analysis Plan

Sampling activities followed the original SAP, which is described in the June 1994 addendum to the work plan (Pratt 1994, 43475).

5.4.4.3 Sampling Activities

Phase I sampling was performed on March 13, 1995. Two locations were sampled, and four soil samples were collected (not including duplicate QA/QC samples). One surface soil sample (Location ID No. 35-2156) was collected from bank sediments adjacent to the pond about 10 ft from the outfall. A 3-ft-deep hand-auger hole (Location ID No. 35-2157) was drilled adjacent to the outlet from the pond. Three soil samples were collected; the sample collection intervals are shown in Table 5.4.4-1. Beta/gamma radiation measurements obtained during field screening of the samples ranged from 194 to 237 cpm, which are within background levels.

Table 5.4.4-1 summarizes all sampling for PRS No. 35-016(g); Figure 5.4.4-1 shows the sample locations.

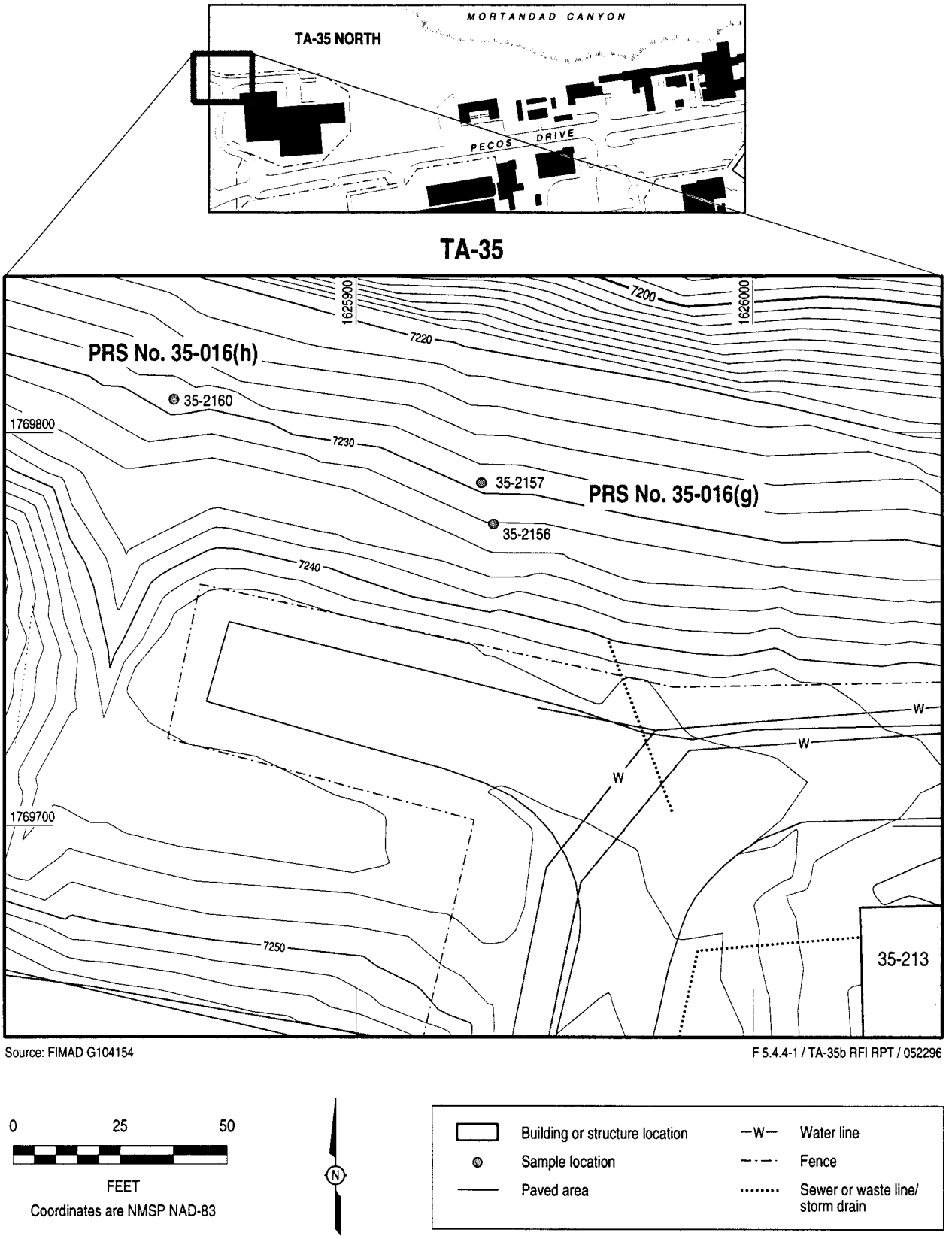

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Figure 5.4.4-1. Locations of samples at PRS Nos. 35-016(g) and 35-016(h).

TABLE 5.4.4-1

SUMMARY OF SAMPLES TAKEN AT PRS No. 35-016(g)

Location ID	Sample ID	Depth (ft)	Matrix	VOC Mobile Lab	PAH Mobile Lab	SVOC Fixed Lab	INORG Mobile Lab	Rad Van
35-2156	AAC1189	0-0.5	mixed soil	21556	21556	21553	21556	21555
35-2157	AAC1190	0-1	mixed soil	21556	21556	NR	21556	21555
35-2157	AAC1191	1-2	mixed soil	21556	21556	NR	21556	21555
35-2157	AAC1200	2-3	mixed soil	21556	21556	NR	21556	21555
35-2157	AAC1192	2-3	mixed soil	21556	21556	NR	21556	21555

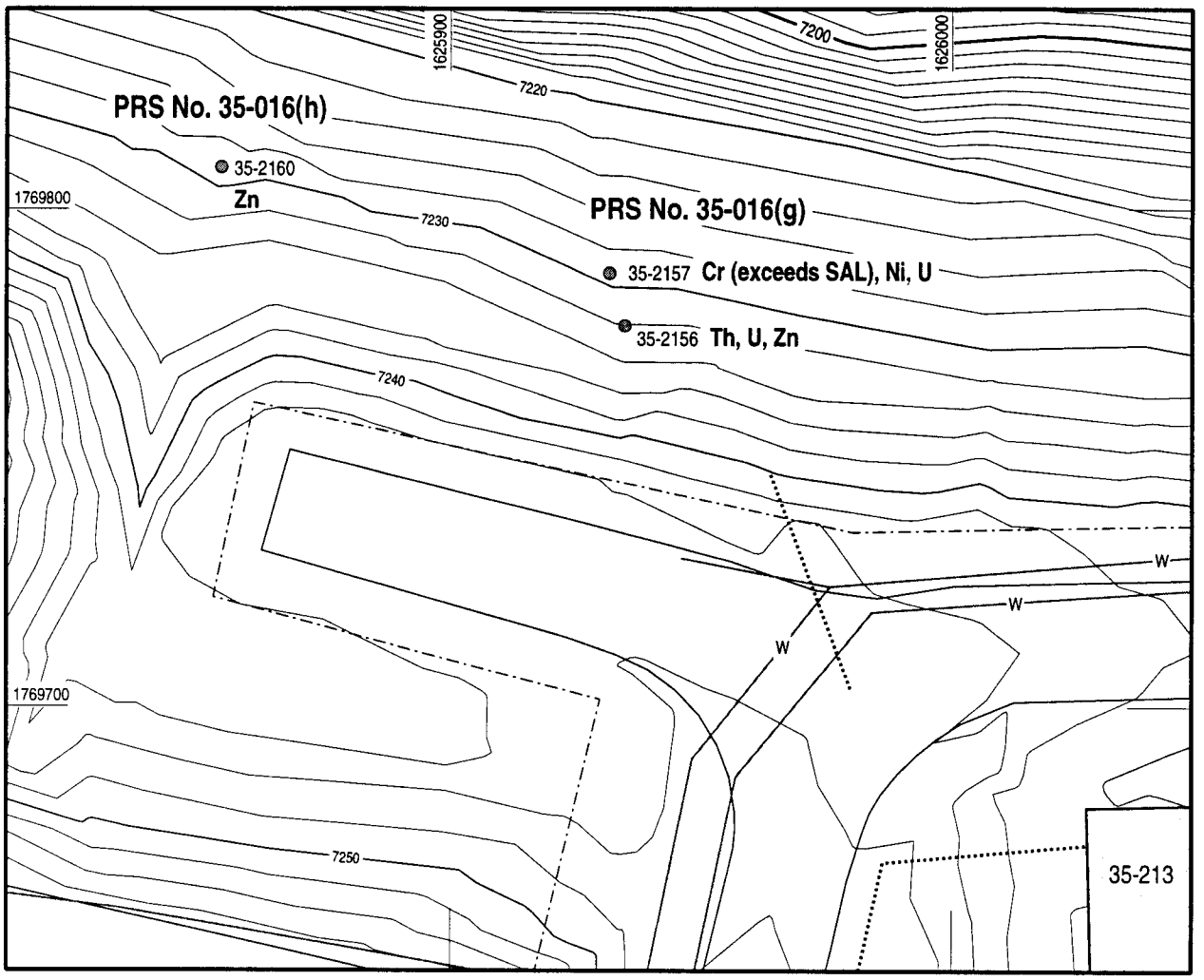
5.4.5 Background Comparisons

Background comparisons were performed for inorganic chemicals for which UTL values are available, as discussed in Section 3.2 in Chapter 3.0 of this RFI report. Inorganic chemicals at this PRS were analyzed by XRF in the mobile laboratory facility. The mixed-soil UTL values have been corrected for some analytes to account for method differences that generally result in higher measured background concentrations by XRF. Derivation of corrected UTL values for XRF data is discussed in Section 3.1.3 in Chapter 3.0 of this RFI report.

Four soil samples from a 3-ft hand-auger hole (including one field duplicate) and one surface sample were analyzed by XRF in the mobile laboratory facility for an analyte suite that included antimony, arsenic, barium, cadmium, calcium, chromium, copper, iron, lead, manganese, mercury, nickel, potassium, selenium, thorium, titanium, uranium, and zinc. As discussed in Section 4.1.3 in Chapter 4.0 of this RFI report, XRF data for antimony, cadmium, mercury, selenium, and uranium should be regarded as estimated, and nickel data may have a low bias. No fixed-site laboratory radionuclide data were obtained at this PRS. Radionuclide data from samples submitted to the mobile laboratory facility are not available, as discussed in Section 4.3 in Chapter 4.0 of this RFI report.

The sample matrices consisted of saturated tuff or tuff with sand. Because the tuff matrix was highly weathered, the saturated tuff samples were classified as mixed soil for the purposes of assigning a geologic unit for background comparisons. In Table 5.4.5-1 the values in the boxes indicate inorganic chemicals that were detected in soil at concentrations greater than or equal to their respective UTL values, or for which UTL values are unavailable. Sample locations where inorganic chemicals exceeded UTL values are shown in Figure 5.4.5-1. The highest observed concentrations above a UTL value at each location are summarized below.

- Chromium was detected in three samples at one location at a maximum concentration of 107 mg/kg, which is above the XRF UTL of 45.1 mg/kg.
- Nickel was detected in three samples at one location at a maximum concentration of 44.2 mg/kg, which is above the XRF UTL of 22.5 mg/kg.
- Thorium was detected in one sample at a concentration of 23.2 mg/kg, which is above the XRF UTL of 22.1 mg/kg.
- Uranium (total) was detected in two samples at two locations at concentrations of 10.9 and 9.34 mg/kg, which are above the XRF UTL of 5.33 mg/kg.
- Zinc was detected in one sample at a concentration of 139 mg/kg, which is above the XRF UTL of 76.6 mg/kg.



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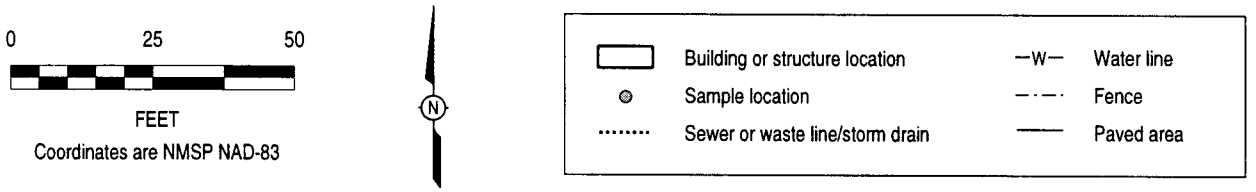

Figure 5.4.5-1. Locations of analytes that exceed UTLs and SALs at PRS Nos. 35-016(g) and 35-016(h).

TABLE 5.4.5-1

INORGANIC CHEMICALS WITH CONCENTRATIONS* GREATER THAN BACKGROUND UTLs FOR PRS No. 35-016(g)

Location ID	Sample ID	Depth (ft)	Cd	Cr	Hg	Ni	Sb	Se	Th	Ti	U	Zn
SAL	N/A	N/A	38	30	23	1500	31	380	N.A.	N.A.	230	23000
Mixed soil UTL	N/A	N/A	2.7	19.3	0.1	15.2	1	1.7	14.6	N.A.	1.87	50.8
XRF UTL	N/A	N/A	N.A.	45.1	N.A.	22.5	1.45	N.A.	22.1	N.A.	5.33	76.6
35-2156	AAC1189	0-.5	<3	<12	<5	<13	<4	<4	23.2	1671	10.9	139
35-2157	AAC1190	0-1	<3	107	<5	32.7	<4	<4	8.16	706	<8	51.5
35-2157	AAC1191	1-2	<3	99.5	<5	34.8	<4	<4	14.8	725	9.34	52
35-2157	AAC1192	2-3	<3	88.1	<5	44.2	<4	<4	18.2	1008	<8	70

*mg/kg

5.4.6 Evaluation of Organic Constituents

Four soil samples from a 3-ft hand-auger hole (including one field duplicate) and one surface sample were analyzed for VOCs and SVOCs in the mobile laboratory facility. The surface sample was also analyzed for SVOCs in a fixed-site laboratory. No organic chemical was measured above its EQL value in any soil sample. However, the mobile laboratory facility reported the presence of saturated hydrocarbons (approximately 6 mg/kg) and numerous unknown organic compounds at Location ID No. 35-2156.

As discussed in Section 4.2 in Chapter 4.0 of this RFI report, the sample results from the mobile laboratory facility are qualified with an "S" flag and may be biased low because of less effective extraction methods.

5.4.7 Human Health Assessment

5.4.7.1 Screening Assessment

Five inorganic chemicals were carried forward from the background comparison. As described in Section 3.4.1 in Chapter 3.0 of this RFI report, analytes are divided into three classes for the screening assessment, depending on whether a reference dose (noncarcinogens), slope factor (chemical carcinogens), or dose conversion factor (radionuclides) is used to calculate their SAL, to evaluate possible additive effects within each class of chemical. Because radionuclide data are not available for this PRS, only two classes of chemicals are evaluated here.

In general, the SAL used to evaluate chromium is based on an assumed ratio of six to one for chromium in its trivalent and hexavalent oxidation states, respectively. This ratio, used by EPA Region IX for calculating residential preliminary remediation goals, which are the basis of the ER Project SALs (Environmental Restoration Decision Support Council 1996, 53751), reflects the fact that chromium is generally stable in the environment in its less oxidized state. However, the NPDES outfall for which this PRS was designated is reported in the work plan to discharge blowdown water from a cooling tower operation (LANL 1992, 7666). Chromium compounds used to inhibit fouling in cooling towers commonly contain chromium in its hexavalent state. Therefore, the SAL for hexavalent chromium is used in the screening assessment.

Chromium, as hexavalent chromium, exceeded its SAL value in all three sample intervals in the 3-ft hand-auger hole. The MCE result for noncarcinogens was 0.41, which indicates that a potential human health risk based on

Appendix A

Analytical Data

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APPENDIX A. ANALYTICAL DATA

All analytical data are available on FIMAD. If FIMAD is not accessible, data will be provided upon request.

Appendix B

Data Quality Evaluation Tables

APPENDIX B. DATA QUALITY EVALUATION TABLES

Data quality evaluation tables are presented in this appendix for the PRS decision sets evaluated for this RFI report.

TABLE B-1

DATA QUALITY EVALUATION FOR PRS Nos. 35-003(e, f, g, m, and o)

Request No.	Location ID No.	Sample ID No.	Analytical Suite	QC Parameter	Explanation
16975	D35-2016-B1	AAA6589	SVOC screen	Accuracy	Di-n-butyl phthalate present in sample; sample result attributed to laboratory contamination.
16975	D35-2016-B5	AAA6581	SVOC screen	Accuracy	Di-n-butyl phthalate present in sample; sample result attributed to laboratory contamination.
17070	D35-2010-B3	AAB0963	SVOC screen	Accuracy	Di-n-butyl phthalate present in method blank and sample; sample result attributed to laboratory contamination.
17051	D35-2024-B1	AAA6601	SVOC screen	Hold time	Extraction hold time missed by three days; no impact on data quality.
17051	D35-2024-B2	AAA6602	SVOC screen	Hold time	Extraction hold time missed by three days; no impact on data quality.
17051	D35-2024-B3	AAA6603	SVOC screen	Hold time	Extraction hold time missed by three days; no impact on data quality.
17051	D35-2024-B4	AAA6604	SVOC screen	Hold time	Extraction hold time missed by three days; no impact on data quality.
17153	D35-2012-B5	AAB0973	Metals	Accuracy	Due to poor recovery from laboratory control sample, the reported values for all ICPES metals should be regarded as estimated and biased low; the sample EQL for Sb should be regarded as estimated.
17185	D35-2010-B2	AAB0962	Metals	Accuracy	Due to poor recovery from laboratory control sample, the reported value(s) for the following analyte(s) should be regarded as estimated and biased high: Al and Sb.
17215	D35-2017-B4	AAA6540	Metals	Accuracy	Due to poor recovery from laboratory control sample, the reported value for Pb should be regarded as estimated and biased low; the reported detection limits for Sb and Tl should be regarded as estimated.
17217	D35-2020-B2	AAA6626	Metals	Accuracy	Due to poor recovery from laboratory control sample, the reported values for all ICPES metals should be regarded as estimated and biased low; the sample EQL for Sb should be regarded as estimated.
17218	D35-2019-B4	AAA6624	Metals	Accuracy	Due to poor recovery from laboratory control sample, the sample EQL value for Sb should be regarded as estimated.
17218	D35-2025-B1	AAA6613	Metals	Accuracy	Due to poor recovery from Laboratory Control Sample, the sample EQL for Sb should be regarded as estimated.
17245	D35-2020-B4	AAA6628	Gamma spec	Accuracy	Due to outside criteria recovery from QC sample, sample result for Cs-137 should be regarded as estimated and biased high.
17245	D35-2215-B1	AAB1011	Gamma spec	Accuracy	Due to outside criteria recovery from QC sample, sample result for Cs-137 should be regarded as estimated and biased high.
17301	D35-2019-B3	AAA6623	Gamma spec	Accuracy	Due to outside criteria recovery from QC sample, sample result for Cs-137 should be regarded as estimated and biased high.
17301	D35-2025-B3	AAA6615	Gamma spec	Accuracy	Due to outside criteria recovery from QC sample, sample result for Cs-137 should be regarded as estimated and biased high.

TABLE B-1 (continued)

DATA QUALITY EVALUATION FOR PRS Nos. 35-003(e, f, g, m, and o)

Request No.	Location ID No.	Sample ID No.	Analytical Suite	QC Parameter	Explanation
17357	D35-2026-B1	AAA6617	Iso-Pu	Accuracy	Due to outside criteria recovery from QC sample, sample result for Pu-239,240 should be regarded as estimated and biased high.
17357	D35-2026-B2	AAA6618	Iso-Pu	Accuracy	Due to outside criteria recovery from QC sample, sample result for Pu-239,240 should be regarded as estimated and biased high.
17357	D35-2026-B3	AAA6619	Iso-Pu	Accuracy	Due to outside criteria recovery from QC sample, sample result for Pu-239,240 should be regarded as estimated and biased high.
17357	D35-2026-B4	AAA6620	Gamma spec	Accuracy	Due to outside criteria recovery from QC sample, sample result for Am-241 should be regarded as estimated and biased low.
17357	D35-2026-B4	AAA6620	Iso-Pu	Accuracy	Due to outside criteria recovery from QC sample, sample result for Pu-239,240 should be regarded as estimated and biased high.
17360	D35-2017-B1	AAA6537	Iso-Pu	Accuracy	Due to outside criteria recovery from QC sample, sample result for Pu-239,240 should be regarded as estimated and biased high.
17360	D35-2017-B2	AAA6538	Iso-Pu	Accuracy	Due to outside criteria recovery from QC sample, sample result for Pu-239,240 should be regarded as estimated and biased high.
17360	D35-2017-B3	AAA6539	Iso-Pu	Accuracy	Due to outside criteria recovery from QC sample, sample result for Pu-239,240 should be regarded as estimated and biased high.
17360	D35-2017-B4	AAA6540	Iso-Pu	Accuracy	Due to outside criteria recovery from QC sample, sample result for Pu-239,240 should be regarded as estimated and biased high.
17360	D35-2017-B4	AAA6573	Iso-Pu	Accuracy	Due to outside criteria recovery from QC sample, sample result for Pu-239,240 should be regarded as estimated and biased high.
17360	D35-2021-A1	AAA6574	Gamma spec	Accuracy	Due to outside criteria recovery from QC sample, sample result for Am-241 should be regarded as estimated and biased low.
17360	D35-2021-A1	AAA6574	Iso-Pu	Accuracy	Due to outside criteria recovery from QC sample, sample result for Pu-239,240 should be regarded as estimated and biased high.
17360	D35-2021-A2	AAA6575	Iso-Pu	Accuracy	Due to outside criteria recovery from QC sample, sample result for Pu-239,240 should be regarded as estimated and biased high.

TABLE B-2

DATA QUALITY EVALUATION FOR PRS Nos. 35-003(d, l, and q)

Request No.	Location ID No.	Sample ID No.	Analytical Suite	QC Parameter	Explanation
17153	D35-2007-B1	AAB1037	Metals	Accuracy	Due to poor recovery from laboratory control sample, the reported values for all ICPES metals should be regarded as estimated and biased low; the sample EQL for Sb should be regarded as estimated.
17204	D35-2008-B5	AAB1460	SVOC screen	Accuracy	Di-n-butyl phthalate in sample attributed to laboratory contamination.
17295	D35-2009-B1	AAB0977	Iso-Pu	Accuracy	Due to method blank contamination, sample result for Pu-238 should be regarded as estimated and biased high.
17295	D35-2009-B1	AAB1029	Iso-Pu	Accuracy	Due to method blank contamination, sample result for Pu-238 should be regarded as estimated and biased high.
17295	D35-2009-B1	AAB0977	Iso-U	Accuracy	Due to method blank contamination, sample result for U-235 should be regarded as estimated and biased high.
17295	D35-2009-B1	AAB1029	Iso-U	Accuracy	Due to method blank contamination, sample result for U-235 should be regarded as estimated and biased high.
17295	D35-2009-B2	AAB0978	Iso-Pu	Accuracy	Due to method blank contamination, sample result for Pu-238 should be regarded as estimated and biased high.
17295	D35-2009-B2	AAB0978	Iso-U	Accuracy	Due to method blank contamination, sample result for U-235 should be regarded as estimated and biased high.
17295	D35-2009-B3	AAB0979	Iso-Pu	Accuracy	Due to method blank contamination, sample result for Pu-238 should be regarded as estimated and biased high.
17295	D35-2009-B3	AAB0979	Iso-U	Accuracy	Due to method blank contamination, sample result for U-235 should be regarded as estimated and biased high.
17295	D35-2009-B4	AAB0980	Iso-Pu	Accuracy	Due to method blank contamination, sample result for Pu-238 should be regarded as estimated and biased high.
17295	D35-2009-B4	AAB0980	Iso-U	Accuracy	Due to method blank contamination, sample result for U-235 should be regarded as estimated and biased high.
17347	D35-2011-B4	AAB1004	SVOC screen	Accuracy	Di-n-butyl phthalate present in method blank and sample; sample result attributed to laboratory contamination.
17347	D35-2011-B5	AAB1005	SVOC screen	Accuracy	Di-n-butyl phthalate present in method blank and sample; sample result attributed to laboratory contamination.
17352	D35-2006-B4	AAB1000	SVOC screen	Accuracy	Di-n-butyl phthalate present in method blank and sample; sample result attributed to laboratory contamination.
17376	D35-2208-S1	AAB1024	SVOC screen	Accuracy	Di-n-butyl phthalate present in method blank and sample; sample result attributed to laboratory contamination.
17376	D35-2209-S1	AAB1028	SVOC screen	Accuracy	Di-n-butyl-pthalate present in method blank and samples; sample result attributed to laboratory contamination.
17376	D35-2212-S1	AAB1044	SVOC screen	Accuracy	Di-n-butyl phthalate present in method blank and sample; sample result attributed to laboratory contamination.
17376	D35-2212-S1	AAB0987	SVOC screen	Accuracy	Di-n-butyl phthalate present in method blank and samples; sample result attributed to laboratory contamination.
17943	D35-2014-B4	AAB0952	Gamma spec	Precision	Due to large uncertainty, sample result for Ba-140 should be regarded as estimated.
19577	D35-2006-B1	AAB0997	Gamma spec	Precision	Due to uncertainty of ±210%, sample result for Ba-140 should be regarded as estimated.

TABLE B-2 (continued)

DATA QUALITY EVALUATION FOR PRS Nos. 35-003(d, l, and q)

Request No.	Location ID No.	Sample ID No.	Analytical Suite	QC Parameter	Explanation
19577	D35-2006-B1	AAB0997	Iso-U	Accuracy	Due to poor recovery from laboratory control sample, sample result for U-235 should be regarded as estimated and biased low.
19577	D35-2006-B2	AAB0998	Iso-U	Accuracy	Due to poor recovery from laboratory control sample, sample result for U-235 should be regarded as estimated and biased low.
19577	D35-2006-B3	AAB0999	Iso-U	Accuracy	Due to poor recovery from laboratory control sample, sample result for U-235 should be regarded as estimated and biased low.
19577	D35-2011-B4	AAB1004	Iso-U	Accuracy	Due to poor recovery from laboratory control sample, sample result for U-235 should be regarded as estimated and biased low.
19577	D35-2011-B4	AAB1004	Tritium	Completeness	Due to extremely low moisture content, sample analysis for tritium could not be performed.
19577	D35-2011-B5	AAB1005	Gamma spec	Precision	Due to uncertainty of ±214%, sample result for Ba-140 should be regarded as estimated.
19577	D35-2011-B5	AAB1005	Iso-Pu	Accuracy	Due to tracer recovery <30%, sample result for Pu-238 and Pu-239,240 should be regarded as estimated and biased low.
19577	D35-2011-B5	AAB1005	Iso-U	Accuracy	Due to poor recovery from laboratory control sample, sample result for U-235 should be regarded as estimated and biased low.
19577	D35-2011-B5	AAB1005	Tritium	Accuracy	Due to extremely low moisture content, sample result for tritium should be regarded as estimated.
19582	D35-2005-B4	AAB0992	Gamma spec	Precision	Due to uncertainty of ±118%, sample result for Ba-140 should be regarded as estimated.

TABLE B-3

DATA QUALITY EVALUATION FOR PRS No. 35-003(r)

Request No.	Location ID No.	Sample ID No.	Analytical Suite	QC Parameter	Explanation
17376	D35-2014-A1	AAB1020	SVOC screen	Accuracy	Di-n-butyl phthalate present in method blank and samples; sample result attributed to laboratory contamination.
17376	D35-2209-S1	AAB1028	SVOC screen	Accuracy	Di-n-butyl phthalate present in method blank and samples; sample result attributed to laboratory contamination.
19529	D35-2243-A1	AAB4217	Iso-Pu	Precision	Due to outside criteria duplicate sample analysis, sample results for Pu-238 and Pu-239,240 should be regarded as estimated.
19529	D35-2243-A1	AAB4217	Iso-Pu	Accuracy	Due to method blank contamination, sample result for Pu-238 should be regarded as estimated and biased high.
19529	D35-2243-A1	AAB4217	Iso-U	Precision	Due to outside criteria duplicate sample analysis, sample results for U-234 and U-238 should be regarded as estimated.
19529	D35-2243-A2	AAB4218	Iso-Pu	Precision	Due to outside criteria duplicate sample analysis, sample results for Pu-238 and Pu-239,240 should be regarded as estimated.
19529	D35-2243-A2	AAB4218	Iso-Pu	Accuracy	Due to method blank contamination, sample result for Pu-238 should be regarded as estimated and biased high.
19529	D35-2243-A2	AAB4218	Iso-U	Precision	Due to outside criteria duplicate sample analysis, sample results for U-234 and U-238 should be regarded as estimated.
19529	D35-2243-A3	AAB4219	Iso-Pu	Precision	Due to outside criteria duplicate sample analysis, sample results for Pu-238 and Pu-239,240 should be regarded as estimated.
19529	D35-2243-A3	AAB4219	Iso-Pu	Accuracy	Due to method blank contamination, sample result for Pu-238 should be regarded as estimated and biased high.
19529	D35-2243-A3	AAB4219	Iso-U	Precision	Due to outside criteria duplicate sample analysis, sample results for U-234 and U-238 should be regarded as estimated.
19529	D35-2244-A1	AAB4220	Iso-Pu	Precision	Due to outside criteria duplicate sample analysis, sample results for Pu-238 and Pu-239,240 should be regarded as estimated.
19529	D35-2244-A1	AAB4220	Iso-Pu	Accuracy	Due to method blank contamination, sample result for Pu-238 should be regarded as estimated and biased high.
19529	D35-2244-A1	AAB4220	Iso-U	Precision	Due to outside criteria duplicate sample analysis, sample results for U-234 and U-238 should be regarded as estimated.
19529	D35-2244-A2	AAB4221	Iso-Pu	Accuracy	Due to method blank contamination, sample result for Pu-238 should be regarded as estimated and biased high.
19529	D35-2244-A2	AAB4221	Iso-Pu	Precision	Due to outside criteria duplicate sample analysis, sample results for Pu-238 and Pu-239,240 should be regarded as estimated.
19529	D35-2244-A2	AAB4221	Iso-U	Precision	Due to outside criteria duplicate sample analysis, sample results for U-234 and U-238 should be regarded as estimated.
19529	D35-2244-A3	AAB4222	Iso-Pu	Precision	Due to outside criteria duplicate sample analysis, sample results for Pu-238 and Pu-239,240 should be regarded as estimated.
19529	D35-2244-A3	AAB4222	Iso-Pu	Accuracy	Due to method blank contamination, sample result for Pu-238 should be regarded as estimated and biased high.
19529	D35-2244-A3	AAB4222	Iso-U	Precision	Due to outside criteria duplicate sample analysis, sample results for U-234 and U-238 should be regarded as estimated.
19529	D35-2245-A1	AAB4223	Iso-Pu	Precision	Due to outside criteria duplicate sample analysis, sample results for Pu-238 and Pu-239,240 should be regarded as estimated.
19529	D35-2245-A1	AAB4223	Iso-Pu	Accuracy	Due to method blank contamination, sample result for Pu-238 should be regarded as estimated and biased high.
19529	D35-2245-A1	AAB4224	Iso-Pu	Accuracy	Due to method blank contamination, sample result for Pu-238 should be regarded as estimated and biased high.

TABLE B-3 (continued)

DATA QUALITY EVALUATION FOR PRS No. 35-003(r)

Request No.	Location ID No.	Sample ID No.	Analytical Suite	QC Parameter	Explanation
19529	D35-2245-A1	AAB4224	Iso-Pu	Precision	Due to outside criteria duplicate sample analysis, sample results for Pu-238 and Pu-239,240 should be regarded as estimated.
19529	D35-2245-A1	AAB4223	Iso-U	Precision	Due to outside criteria duplicate sample analysis, sample results for U-234 and U-238 should be regarded as estimated.
19529	D35-2245-A1	AAB4224	Iso-U	Precision	Due to outside criteria duplicate sample analysis, sample results for U-234 and U-238 should be regarded as estimated.
19529	D35-2245-A2	AAB4226	Iso-Pu	Precision	Due to outside criteria duplicate sample analysis, sample results for Pu-238 and Pu-239,240 should be regarded as estimated.
19529	D35-2245-A2	AAB4226	Iso-Pu	Accuracy	Due to method blank contamination, sample result for Pu-238 should be regarded as estimated and biased high.
19529	D35-2245-A2	AAB4226	Iso-U	Precision	Due to outside criteria duplicate sample analysis, sample results for U-234 and U-238 should be regarded as estimated.
19529	D35-2245-A3	AAB4225	Iso-Pu	Precision	Due to outside criteria duplicate sample analysis, sample results for Pu-238 and Pu-239,240 should be regarded as estimated.
19529	D35-2245-A3	AAB4225	Iso-Pu	Accuracy	Due to method blank contamination, sample result for Pu-238 should be regarded as estimated and biased high.
19529	D35-2245-A3	AAB4225	Iso-U	Precision	Due to outside criteria duplicate sample analysis, sample results for U-234 and U-238 should be regarded as estimated.
19529	D35-2246-A1	AAB4227	Iso-Pu	Precision	Due to outside criteria duplicate sample analysis, sample results for Pu-238 and Pu-239,240 should be regarded as estimated.
19529	D35-2246-A1	AAB4227	Iso-Pu	Accuracy	Due to method blank contamination, sample result for Pu-238 should be regarded as estimated and biased high.
19529	D35-2246-A1	AAB4227	Iso-U	Precision	Due to outside criteria duplicate sample analysis, sample results for U-234 and U-238 should be regarded as estimated.
19529	D35-2246-A2	AAB4228	Iso-Pu	Precision	Due to outside criteria duplicate sample analysis, sample results for Pu-238 and Pu-239,240 should be regarded as estimated.
19529	D35-2246-A2	AAB4228	Iso-Pu	Accuracy	Due to method blank contamination, sample result for Pu-238 should be regarded as estimated and biased high.
19529	D35-2246-A2	AAB4228	Iso-U	Precision	Due to outside criteria duplicate sample analysis, sample results for U-234 and U-238 should be regarded as estimated.
19529	D35-2246-A3	AAB4229	Iso-Pu	Precision	Due to outside criteria duplicate sample analysis, sample results for Pu-238 and Pu-239,240 should be regarded as estimated.
19529	D35-2246-A3	AAB4229	Iso-Pu	Accuracy	Due to method blank contamination, sample result for Pu-238 should be regarded as estimated and biased high.
19529	D35-2246-A3	AAB4229	Iso-U	Precision	Due to outside criteria duplicate sample analysis, sample results for U-234 and U-238 should be regarded as estimated.
19594	D35-2248-A3	AAB4239	Gamma spec	Precision	Due to outside criteria duplicate sample analysis, sample result for Ba-140 should be regarded as estimated.
19594	D35-2030-A1	AAB4240	Gamma Spec	Precision	Due to outside criteria duplicate sample analysis, sample result for Ba-140 should be regarded as estimated.
19594	D35-2030-A1	AAB4240	Iso-Pu	Precision	Due to outside criteria duplicate sample analysis, sample result for Pu-239,240 should be regarded as estimated.
19594	D35-2030-A2	XAAB4241	Iso-Pu	Precision	Due to outside criteria duplicate sample analysis, sample result for Pu-239,240 should be regarded as estimated.
19594	D35-2030-A3	XAAB4242	Iso-Pu	Precision	Due to outside criteria duplicate sample analysis, sample result for Pu-239,240 should be regarded as estimated.

TABLE B-3 (continued)

DATA QUALITY EVALUATION FOR PRS No. 35-003(r)

Request No.	Location ID No.	Sample ID No.	Analytical Suite	QC Parameter	Explanation
19594	D35-2031-A1	XAAB4243	Iso-Pu	Precision	Due to outside criteria duplicate sample analysis, sample result for Pu-239,240 should be regarded as estimated.
19594	D35-2031-A2	XAAB4244	Iso-Pu	Precision	Due to outside criteria duplicate sample analysis, sample result for Pu-239,240 should be regarded as estimated.
19594	D35-2031-A3	XAAB4245	Iso-Pu	Precision	Due to outside criteria duplicate sample analysis, sample result for Pu-239,240 should be regarded as estimated.
19594	D35-2247-A1	AAB4233	Iso-Pu	Precision	Due to outside criteria duplicate sample analysis, sample result for Pu-239,240 should be regarded as estimated.
19594	D35-2247-A2	AAB4234	Iso-Pu	Precision	Due to outside criteria duplicate sample analysis, sample result for Pu-239,240 should be regarded as estimated.
19594	D35-2247-A3	AAB4235	Iso-Pu	Precision	Due to outside criteria duplicate sample analysis, sample result for Pu-239,240 should be regarded as estimated.
19594	D35-2248-A1	AAB4236	Iso-Pu	Precision	Due to outside criteria duplicate sample analysis, sample result for Pu-239,240 should be regarded as estimated.
19594	D35-2248-A1	AAB4237	Iso-Pu	Accuracy	Due to tracer recovery <30%, sample results for Pu-238 and Pu-239,240 should be regarded as estimated and biased low.
19594	D35-2248-A1	AAB4237	Iso-Pu	Precision	Due to outside criteria duplicate sample analysis, sample result for Pu-239,240 should be regarded as estimated.
19594	D35-2248-A2	AAB4238	Iso-Pu	Precision	Due to outside criteria duplicate sample analysis, sample result for Pu-239,240 should be regarded as estimated.
19594	D35-2248-A3	AAB4239	Iso-Pu	Precision	Due to outside criteria duplicate sample analysis, sample result for Pu-239,240 should be regarded as estimated.
19594	D35-2249-S1	XAAB4246	Iso-Pu	Precision	Due to outside criteria duplicate sample analysis, sample result for Pu-239,240 should be regarded as estimated.
19836	D35-2028-B1	AAB4282	Pesticides	Accuracy	Due to outside criteria surrogate recovery, the sample results for detected compounds should be regarded as estimated and biased high.
19836	D35-2028-B1	AAB4282	Pesticides	Precision	Quantitation values for Dieldrin from the two analytical columns differed by >25% indicating a possible false positive; the sample results should be regarded as estimated.
19836	D35-2028-B1	AAB4282	SVOC	Accuracy	Due to high internal standard area response for perylene-d12, sample results for detected compounds that are quantified using perylene-d12 should be regarded as estimated.
20155	D35-2028-B3	XAAB4273	Iso-U	Accuracy	Due to outside criteria recovery from laboratory control sample, sample results for U-234, U-235, and U-238 should be regarded as estimated and biased high.
20158	D35-2248-A3	AAB4239	Iso-U	Accuracy	Due to outside criteria recovery from laboratory control sample, sample results for U-234, U-235, and U-238 should be regarded as estimated and biased low.
20158	D35-2248-A3	AAB4239	Tritium	Completeness	Due to extremely low moisture content, sample analysis for tritium could not be performed.
20159	D35-2246-A3	AAB4229	Iso-U	Accuracy	Due to outside criteria recovery from laboratory control sample, sample results for U-234, U-235, and U-238 should be regarded as estimated and biased high.
20159	D35-2248-B15	XAAB4229	Iso-U	Accuracy	Due to outside criteria recovery from laboratory control sample, sample results for U-234, U-235, and U-238 should be regarded as estimated and biased high.

TABLE B-3 (continued)

DATA QUALITY EVALUATION FOR PRS No. 35-003(r)

Request No.	Location ID No.	Sample ID No.	Analytical Suite	QC Parameter	Explanation
20160	D35-2243-A3	AAB4219	Iso-U	Accuracy	Due to outside criteria recovery from laboratory control sample, sample results for U-234 and U-238 should be regarded as estimated and biased high.
20160	D35-2243-A3	AAB4219	Tritium	Completeness	Due to extremely low moisture content, sample analysis for tritium could not be performed.
20163	D35-2028-B1	AAB4282	Iso-U	Precision	Due to outside criteria duplicate sample analysis, sample results for U-234 and U-238 should be regarded as estimated.
20163	D35-2028-B1	AAB4282	Iso-U	Accuracy	Due to outside criteria recovery from laboratory control sample, sample results for U-234 and U-238 should be regarded as estimated and biased high.
20163	D35-2028-B2	AAB4283	Iso-U	Precision	Due to outside criteria duplicate sample analysis, sample results for U-234 and U-238 should be regarded as estimated.
20163	D35-2028-B2	AAB4283	Iso-U	Accuracy	Due to outside criteria recovery from laboratory control sample, sample results for U-234 and U-238 should be regarded as estimated and biased high.
20163	D35-2028-B2	AAB4283	Tritium	Completeness	Due to extremely low moisture content, sample analysis for tritium could not be performed.
20163	D35-2028-B3	AAB4284	Iso-U	Precision	Due to outside criteria duplicate sample analysis, sample results for U-234 and U-238 should be regarded as estimated.
20163	D35-2028-B3	AAB4284	Iso-U	Accuracy	Due to outside criteria recovery from laboratory control sample, sample results for U-234, and U-238 should be regarded as estimated and biased high.
20163	D35-2028-B4	AAB4285	Iso-U	Precision	Due to outside criteria duplicate sample analysis, sample results for U-234 and U-238 should be regarded as estimated.
20163	D35-2028-B4	AAB4285	Iso-U	Accuracy	Due to outside criteria recovery from laboratory control sample, sample results for U-234 and U-238 should be regarded as estimated and biased high.
21434	D35-2214-A1	AAC1140	SVOC	Accuracy	TICs reported: numerous unknown PAHs.
21434	D35-2214-A1	AAC1140	SVOC screen	Accuracy	Large peak consistent with motor oil reported.

TABLE B-4

DATA QUALITY EVALUATION FOR PRS No. 35-016(g)

Request No.	Location ID No.	Sample ID	Analyte Suite	QC Parameter	Explanation
21553	35-2156-S1	AAC1189	SVOC	Accuracy	TICs reported: saturated hydrocarbons, 6.01 mg/kg; multiple unknown organic compounds.

TABLE B-5

DATA QUALITY EVALUATION FOR PRS No. 35-016(h)

Request No.	Location ID No.	Sample ID	Analyte Suite	QC Parameter	Explanation
21556	35-2161-S1	AAC1196	VOC screen	Accuracy	Low internal standard area due to matrix effect; sample EQLs should be regarded as estimated and biased low.
21556	35-2163-S1	AAC1198	VOC screen	Accuracy	Low internal standard area due to matrix effect; sample EQLs should be regarded as estimated and biased low.

Appendix C

Risk Assessment Calculations

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APPENDIX C. RISK ASSESSMENT CALCULATIONS

No quantitative risk assessment was performed for any of the potential release site decision sets evaluated for this Resource Conservation and Recovery Act facility investigation report.

Attachment I

Distributions and Statistical Tests for XRF Data

Likewise, this test is sensitive to shifts affecting only part of the data from the PRS (or group of PRSs).

The plots for titanium and antimony have been rescaled to delete one very high outlier in each case. Including the outliers would compress the plot on the horizontal scale and make the distribution of data unintelligible. The titanium outlier is located in PRS No. 35-004(a); the antimony outlier is located in PRS No. 35-016(q).

I.2 Description of the Plots

I.2.1 Box Plots

In the side-by-side box plots, the distribution of concentrations at a PRS (or group of PRSs) is represented by a central "box" with "whiskers" and sometimes additional lines representing outliers that are far removed from most of the data.

- The central box includes the middle 50% of the data (at least). Its width estimates the interquartile range (IQR), which is the difference between the 75th and 25th percentile of the underlying distribution.
- The white bar across this box designates the median concentration (the 50th percentile of the data).
- Whiskers, which are the dashed horizontal lines extending left and right of the box to the staple end bars, cover all the data observed within a distance 1.5*IQR of the ends of the central box. For a normal distribution, this would include approximately 90% of the data, except 5% at each end.
- Each value beyond the whiskers is plotted explicitly with a vertical line. Because the distributions illustrated in these plots are mostly skewed rather than symmetric, these outliers tend to be on the high side much more frequently than on the low side.

Below-detection-limit results are included in these distributions at one-half the reported detection limit. Additional information shown on these plots include

- sample sizes (shown in parentheses to the right of the largest observation at each PRS);
- UTLs, where applicable (shown by vertical dashed lines for the XRF measurements and dotted lines for results of samples prepared by using total digestion methods); and
- statistical test results, indicated next to the PRS (or group of PRSs) label on the y-axis. For example, "t" indicates that the t-test rejected the hypothesis that the PRS data come from the background level at the 5% significance level, and "g," "q," and "s" indicate rejection of the same null hypothesis by the gehan, quantile, and slippage tests, respectively.

As an example, consider the box plot for chromium (see Figure AI-5). Only about 42% of the chromium XRF measurements are above the detection limit, which is 12 mg/kg in most cases. Therefore, for some PRSs the box plot collapses to a single line at one-half the detection level (for example, see PRS No. 35-003[e]). In several other cases, at least half the samples are below the detection level so the median line is at 6 mg/kg (for example, see PRS No. 35-010[a] and the background distribution). A PRS with consistently elevated results stands out relative to the others, such as PRS No. 35-016(g), which is an outfall permitted by the National Pollutant Discharge Elimination System that receives cooling tower blowdown.

ATTACHMENT I. DISTRIBUTIONS AND STATISTICAL TESTS FOR XRF DATA

I.1 Discussion

This attachment presents a discussion of the statistical tests that were performed on the x-ray fluorescence (XRF) data for the potential release sites (PRSs) in Technical Area (TA) -35. It also contains the distribution plots, which provide an overview of the XRF data for inorganic chemicals in soil, sediment, and tuff samples across all TA-35 PRSs (or groups of PRSs in decision sets). The following two types of plots are provided:

- side-by-side box plots for the distribution of concentrations within a PRS (or group of PRSs) for elements that are measured above detection levels in at least 20% of the samples (barium, calcium, chromium, copper, iron, lead, manganese, potassium, thorium, titanium, and zinc) and

- side-by-side point plots of the concentrations within a PRS (or group of PRSs) for elements that are usually measured below detection levels (antimony, arsenic, cadmium, mercury, nickel, selenium, and uranium).

The distribution of the TA-35 data combined across all PRSs is also shown at the bottom of each plot.

XRF background data are available for eight of the elements in the first class (all except thorium and titanium) and for most elements in the second class (all except selenium and uranium), as described in Section 3.1.3 in Chapter 3.0 of this Resource Conservation and Recovery Act facility investigation (RFI) report. Where available, the distribution of the background data is also shown at the bottom of the plot.

For the eight elements in the first class with XRF background data, four statistical tests were applied to compare XRF background data with data from each PRS and group of PRSs. These tests supplement the comparison to upper tolerance limits (UTLs) described in the background comparison sections in Chapter 5.0 of this RFI report. The tests, which are summarized below, are described in Ryti et al. (1996, 53953).

- The t-test looks for an upward shift in mean at the PRS (or group of PRSs) relative to background. For the purposes of this test, below-detection-limit data are accommodated by using one-half of the reported detection limit as if it were the measured result for a given sample.

- Likewise, the nonparametric Wilcoxon-Gehan test looks for an upward shift in the distribution at the PRS (or group of PRSs) relative to the background distribution. This test, based on ranks rather than actual data values, accommodates below-detection-limit data without the necessity for making arbitrary replacement decisions. Results from this test tend to be well correlated with results from the t-test, unless the t-test is influenced by one or more extreme outliers.

- The quantile test determines whether the number of PRS (or group of PRSs) samples included among the highest 20% of the combined set of data from that PRS (or group of PRSs) plus the background data is larger than would be expected if the PRS data came from the background distribution. Because the test looks only at the highest 20% of the data, nondetects are not a problem when they constitute less than 80% of the population. This test is sensitive to shifts affecting only part of the data from the PRS (or group of PRSs).

- The slippage test determines whether the number of PRS (or group of PRSs) samples exceeding the largest background measurement is larger than would be expected if the PRS data came from the background distribution. Again, nondetects are not a problem for this test unless for some reason there are nondetect values above the maximum positive value in the background data set.

At least one statistical background comparison test was failed by the combined TA-35 data for the elements chromium, copper, lead, and zinc. All these elements are expected in a heavily industrialized area such as TA-35. Consistently, statistical comparisons of these elements with background for individual PRSs (or groups of PRSs) rejected the null hypothesis more than the expected 5% of the time: the t-test and gehan test failed for more than 40% of the PRSs; the quantile test and the slippage test failed for at least 10% of the PRSs, except the slippage test for chromium. The test results also provide some less consistent evidence for releases of nickel.

PRSs for which a relatively large number of statistical background comparison failures were reported were PRS Nos. 35-003(d, l, q, and r); 35-004(b) (where the only inorganic chemical actually above its UTL was one copper result); and 35-016(e, g, and h).

RFI results for PRS Nos. 35-003(d, l, q, and r) are discussed in Section 5.2 in Chapter 5.0 of this RFI report; RFI results for PRS No. 35-016(g and h) are discussed in Sections 5.4 and 5.5 respectively. Chemicals that failed background comparison tests were carried forward to the screening assessment as described in Section 3.2 in Chapter 3.0 of this RFI report.

The large number of PRSs for which the statistical background comparison tests fail indicates that chromium is an element that has been widely released at TA-35.

- The t-test and the gehan test fail for the combined data. However, note that 17 samples above the background maximum out of a total of 429 is not statistically excessive given that only 44 background samples were analyzed.

- In most cases where the null hypothesis was rejected, both a test for overall shift (the t-test or the gehan test) and a test for a shift in the tail (the quantile test or the slippage test) failed. The t-test and gehan test generally fail together; therefore, they do not provide independent information.

- Frequently these tests fail when no individual observation exceeds the UTL (for example, PRS Nos. 35-010[e] and 35-016[c and d]). The opposite situation is more rare, where one observation exceeds the UTL but no statistical test fails (for chromium, only PRS No. 35-016[q]).

I.2.2 Point Plots

Where most (approximately 80%) of the observations are nondetects, box plots are uninformative and are replaced by point plots in a similar format.

- Below-detection-limit results are represented by a square plotted at one-half the detection level. Multiple below-detection-limit results are usually overplotted.

- Above-detection-limit results are represented by a plus symbol at the appropriate level.

- As before, sample sizes are indicated, and total digestion UTLs and background comparisons are presented where available.

As an example, consider the point plot for arsenic (see Figure AI-1). Fewer than 10% of the observations are reported above the detection level, which for most TA-35 samples was 5 mg/kg. A handful of higher detection levels, up to 33 mg/kg, were reported in both PRS and background samples. Only one positive background result was reported, and it was also at 5 mg/kg. Only a handful of the positive results exceed the mixed soil partial digestion UTL (7.8 mg/kg), and none exceed the total digestion UTL of 18 mg/kg.

Statistical tests were performed for arsenic, but the results are not meaningful and are not shown in Figure AI-1 because they are artifacts of the different detection levels, and only a single background sample was reported above detection level. PRSs for which all results were reported as below the higher limits (PRS Nos. 35-016[m, o, and p]) fail the t-test, and some PRSs with more than one result out of only five or six above 5 mg/kg fail the slippage test. Only one gehan test comparison failed (PRS No. 35-016[d], which has five samples including two reported above 5 mg/kg). The quantile test could not be performed because less than 20% of the data were above the detection level. Overall, the number of tests failed is not out of line with an expected false positive rate of 5% (see below). Together with the fact that no observation exceeds the total digestion UTL for arsenic, this low failure rate is taken as an indication that arsenic has not been released at TA-35.

I.3 Summary of Statistical Test Results

All tests were conducted at the 5% significance level, which means that they can be expected to fail 5% of the time even where there is no true difference between the PRS (or group of PRSs) and background. Because four tests are being applied to nine elements, for a total of 36 tests in each PRS, occasional false positive results are expected. Therefore, it is most useful to look for patterns in the results: elements that are above background at several PRSs or multiple elements above background at the same PRS (or group of PRSs).

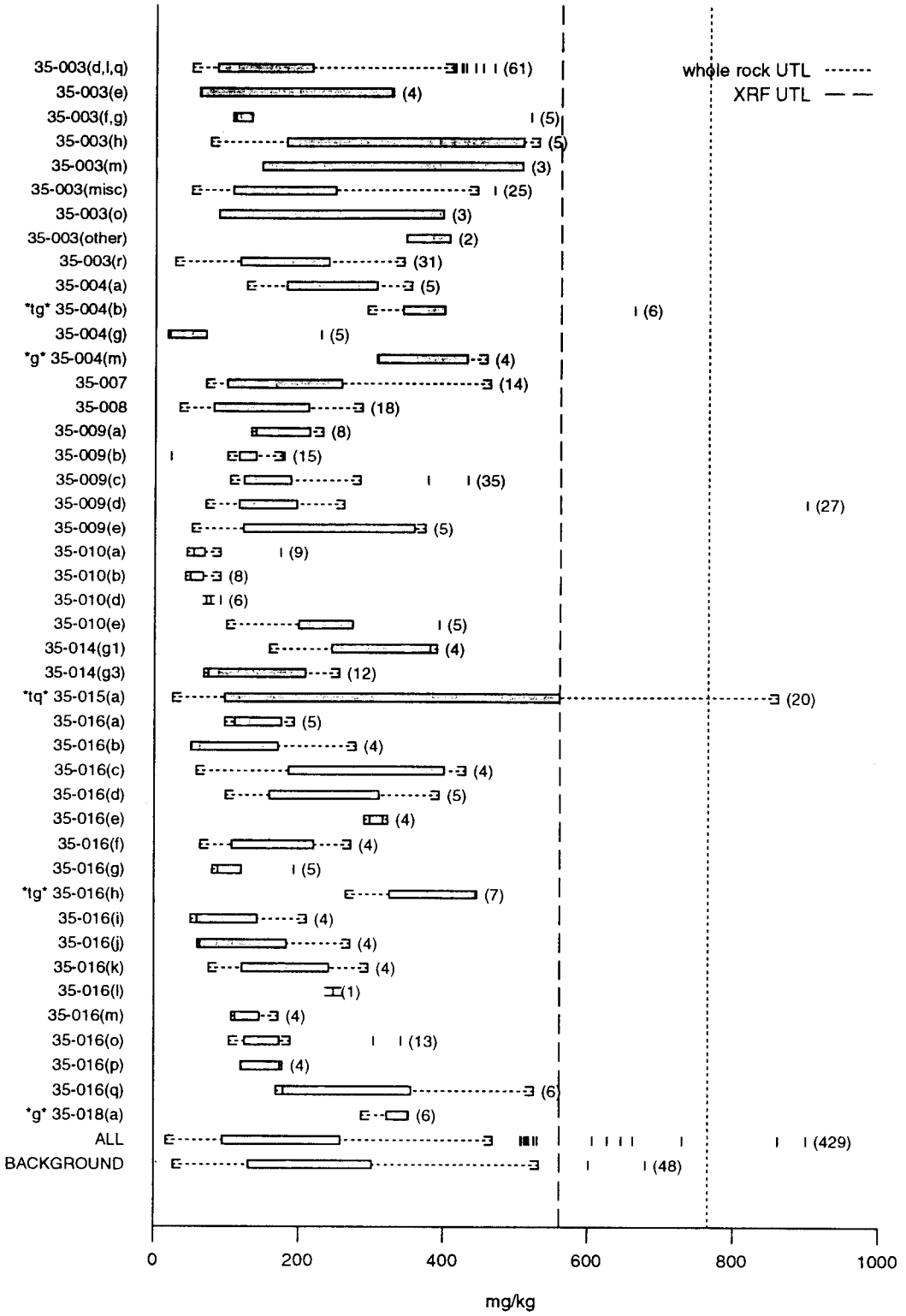

Figure AI-2. Distribution of barium in TA-35 PRSs.

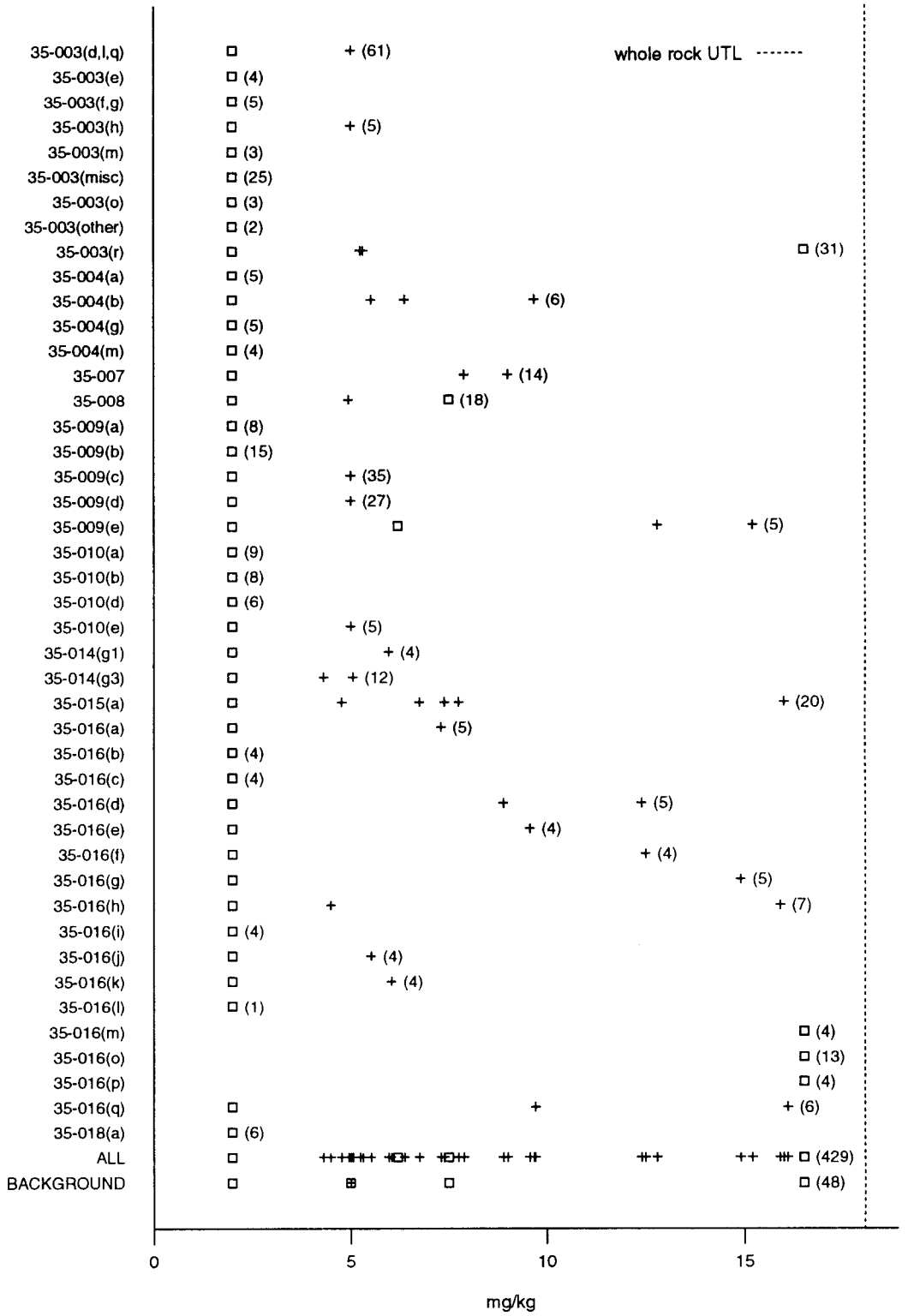

Figure AI-1. Distribution of arsenic in TA-35 PRSs.

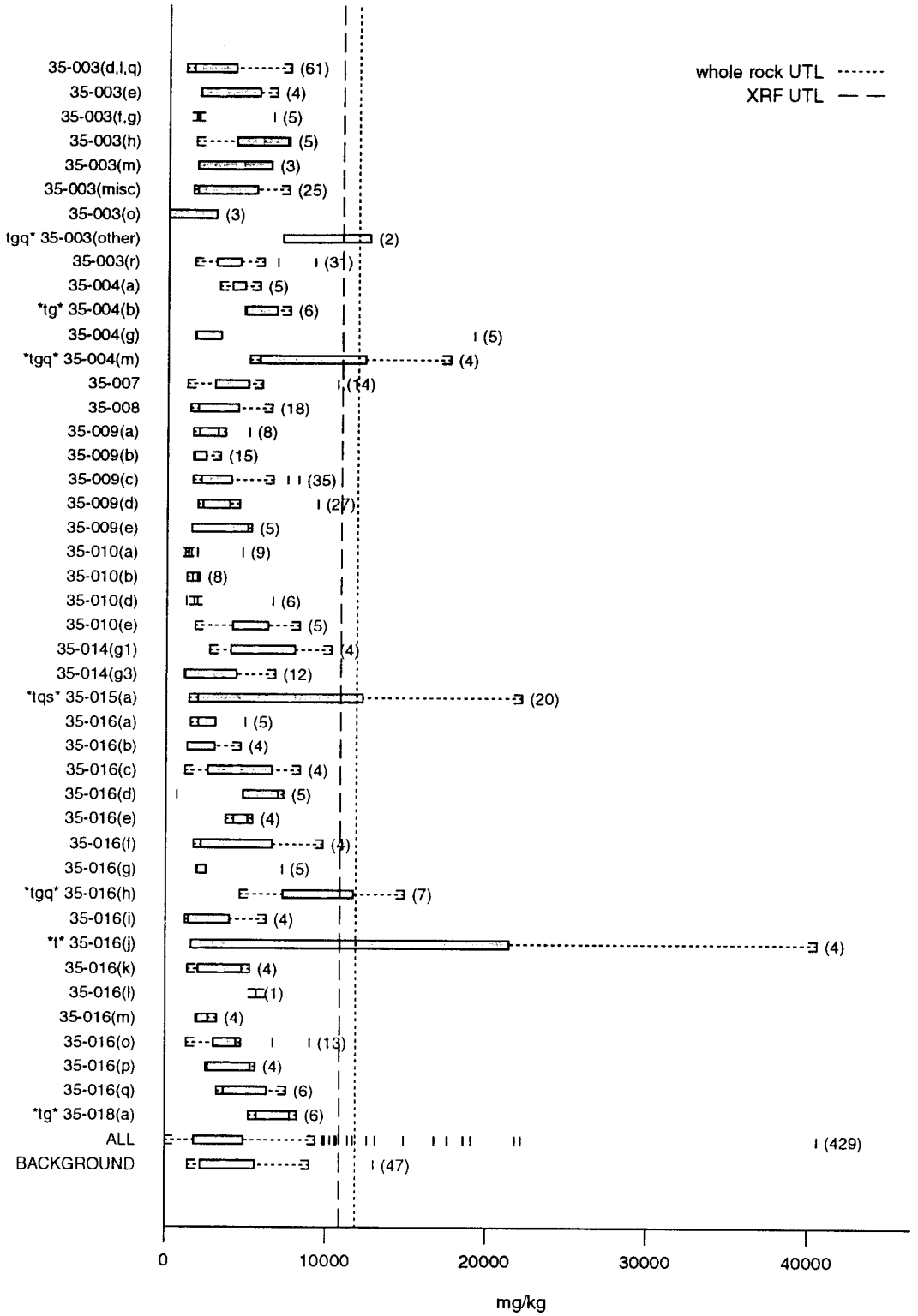

Figure AI-3. Distribution of calcium in TA-35 PRSs.

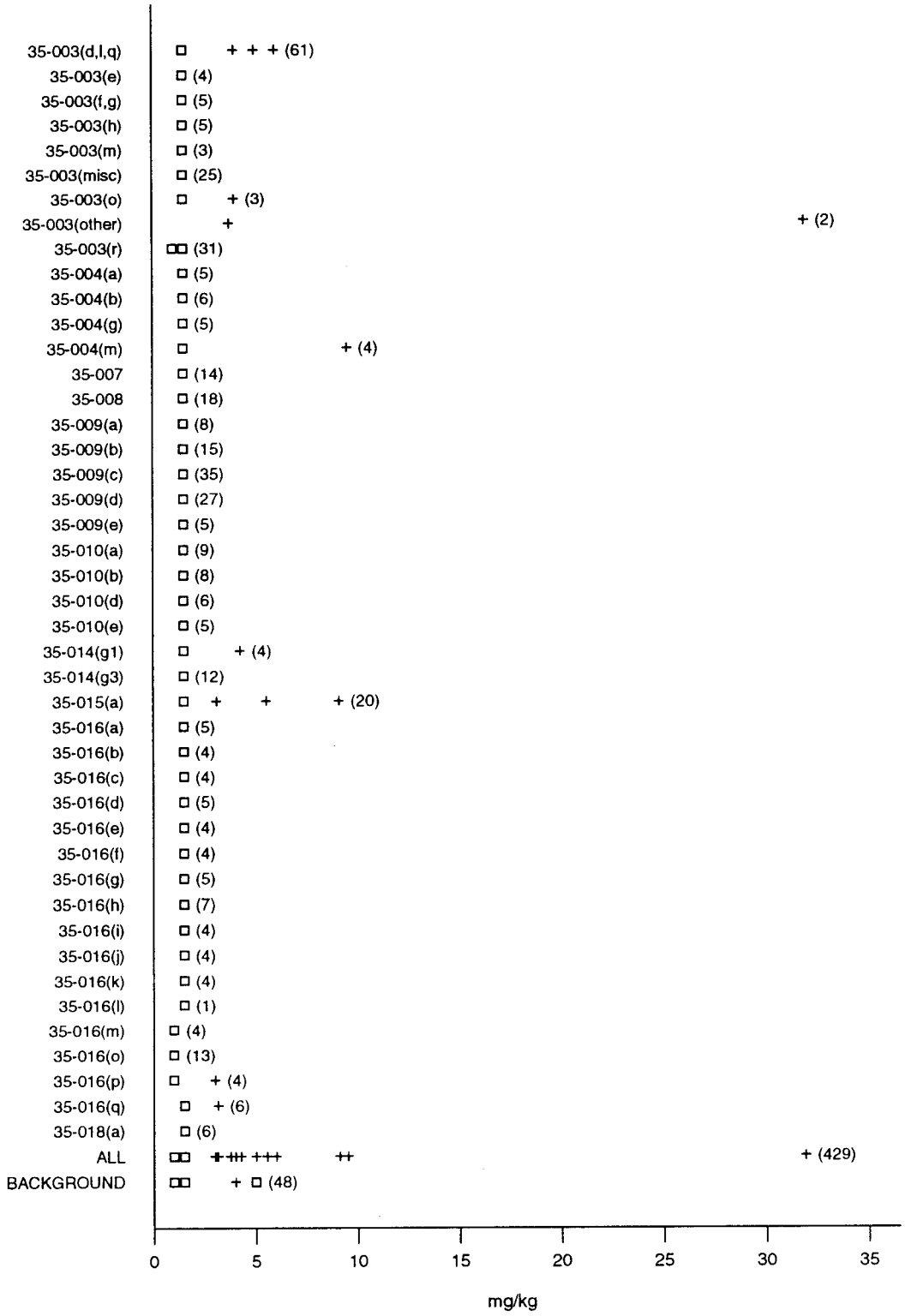

Figure AI-4. Distribution of cadmium in TA-35 PRSs.

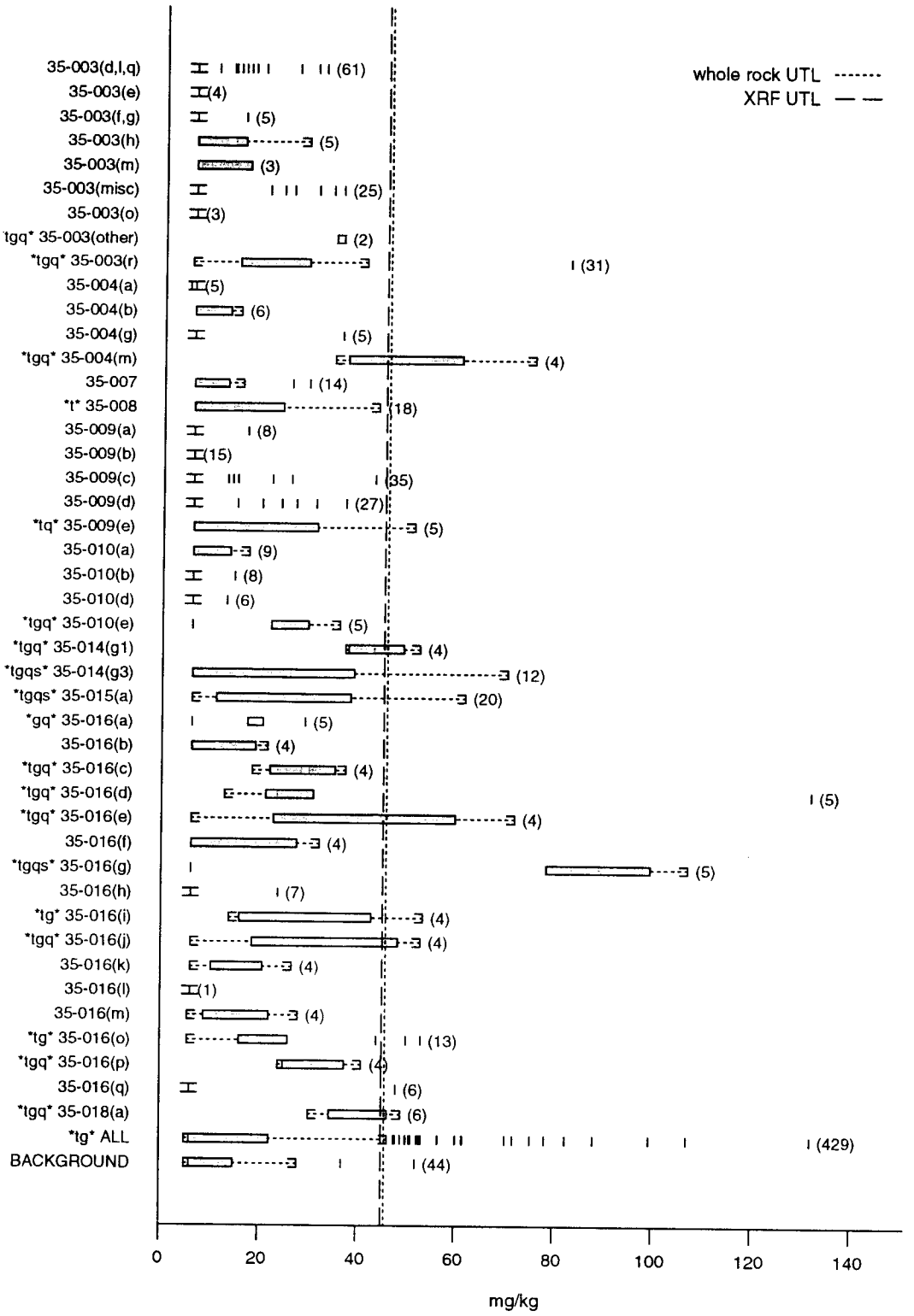

Figure AI-5. Distribution of chromium in TA-35 PRSs.

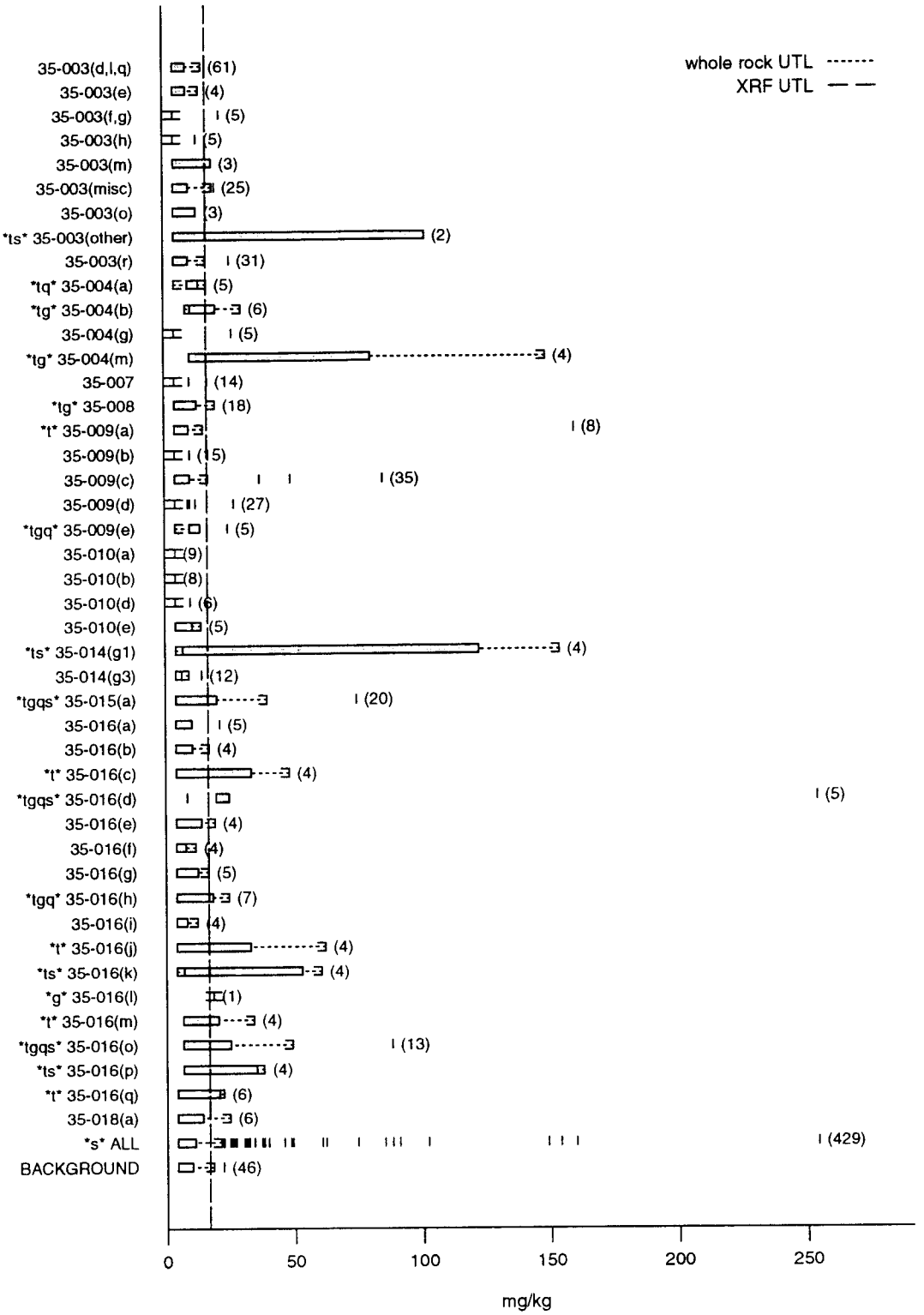

Figure AI-6. Distribution of copper in TA-35 PRSs.

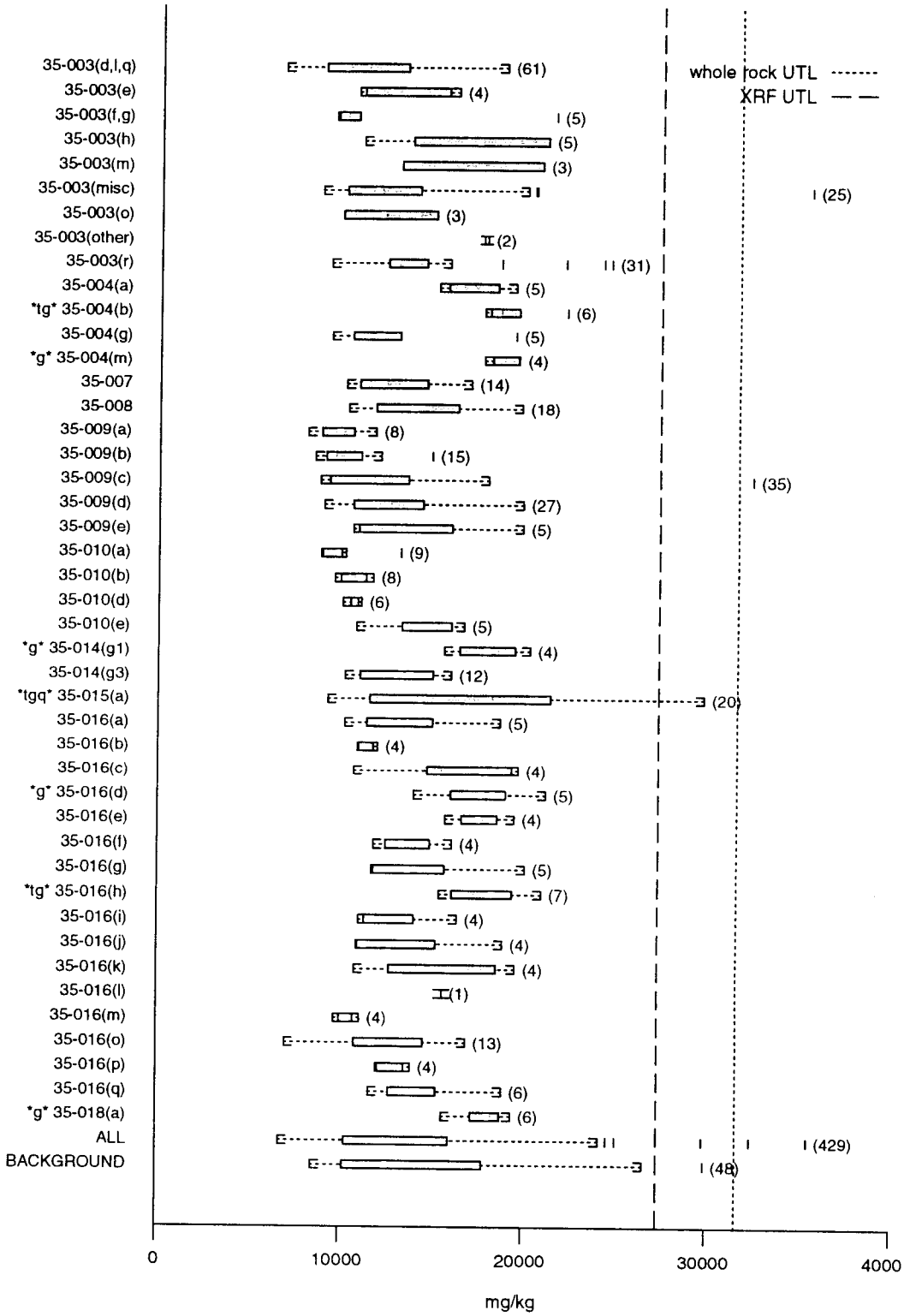

Figure AI-7. Distribution of iron in TA-35 PRSs.

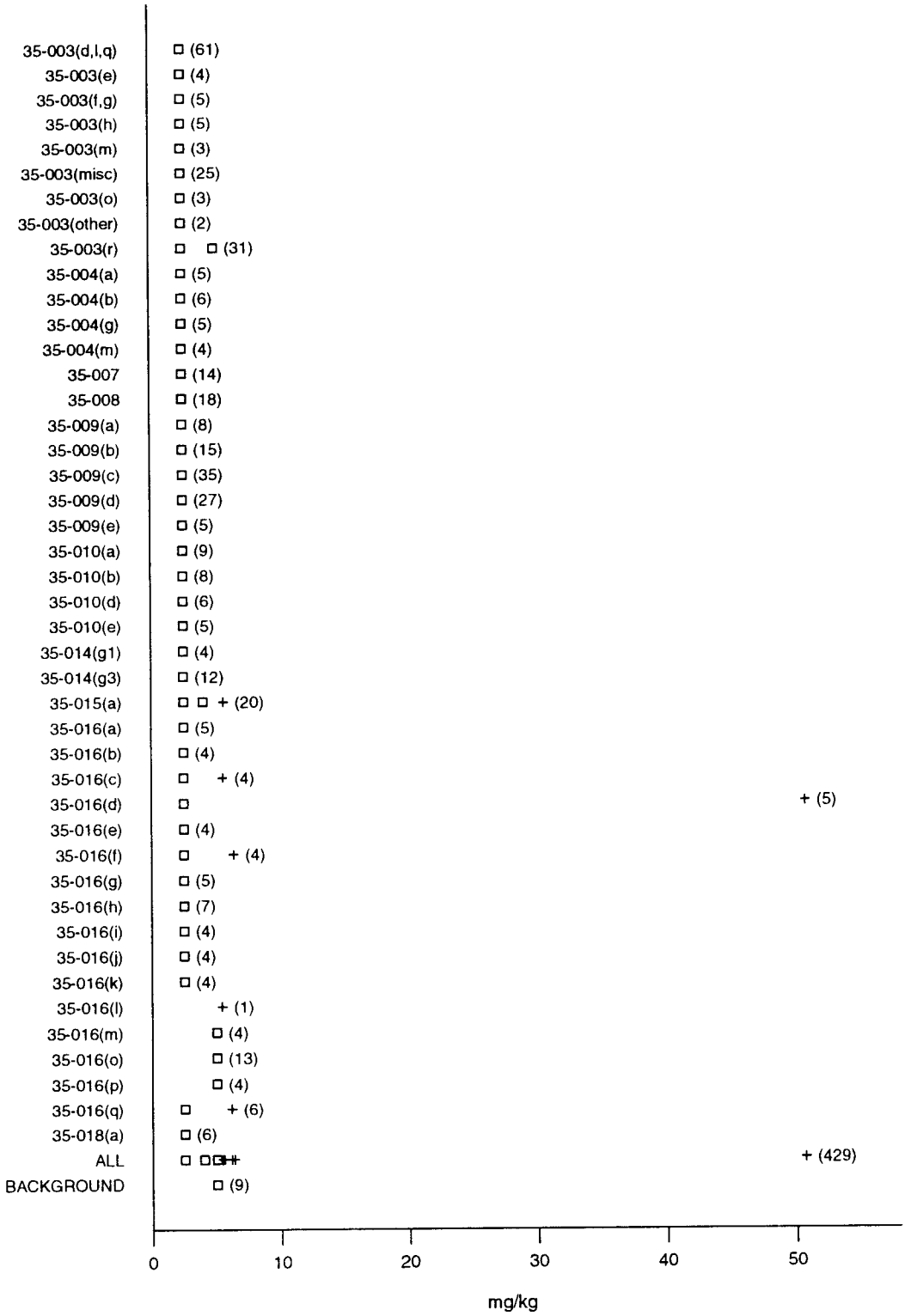

Figure AI-8. Distribution of mercury in TA-35 PRSs.

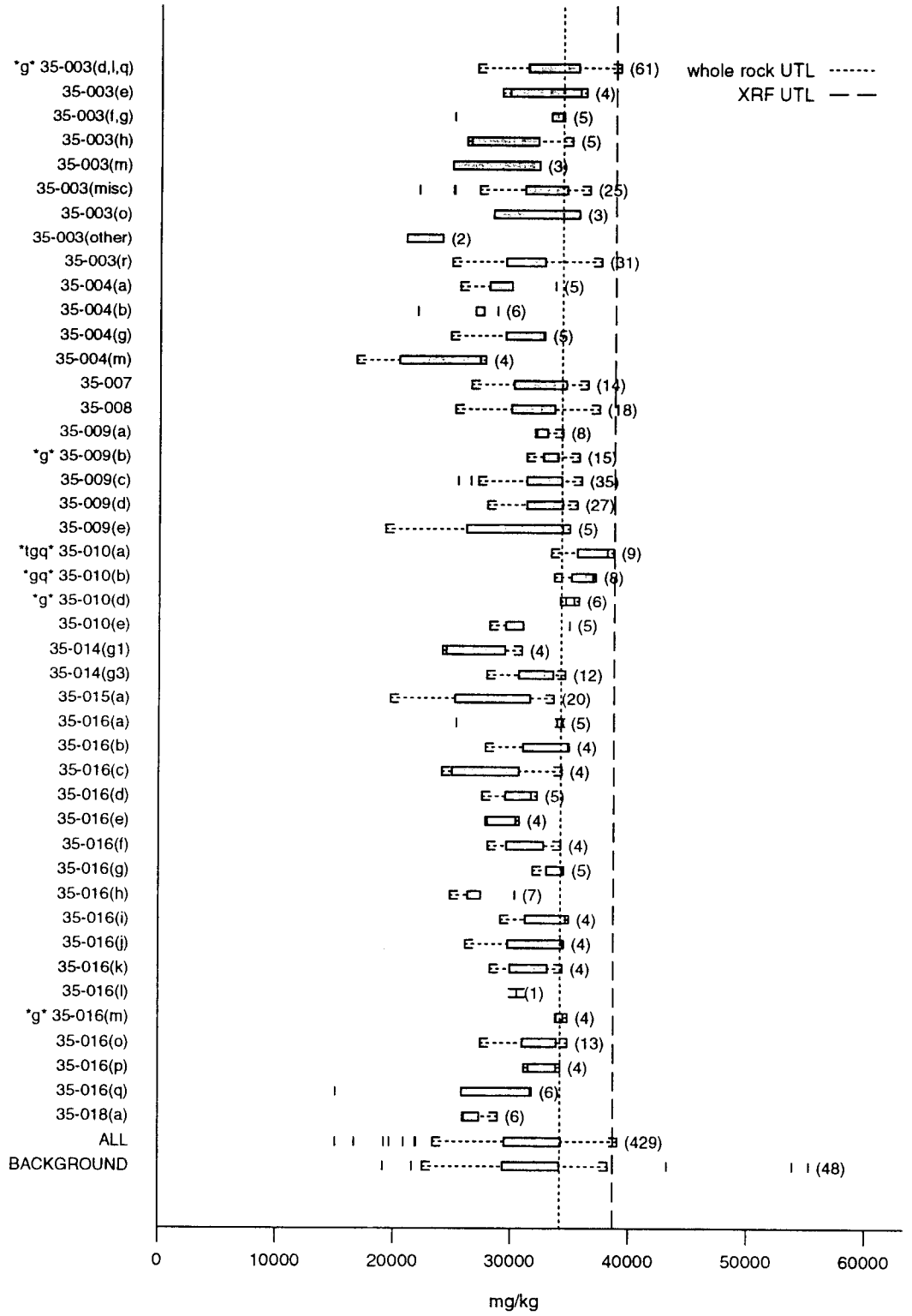

Figure AI-9. Distribution of potassium in TA-35 PRSs.

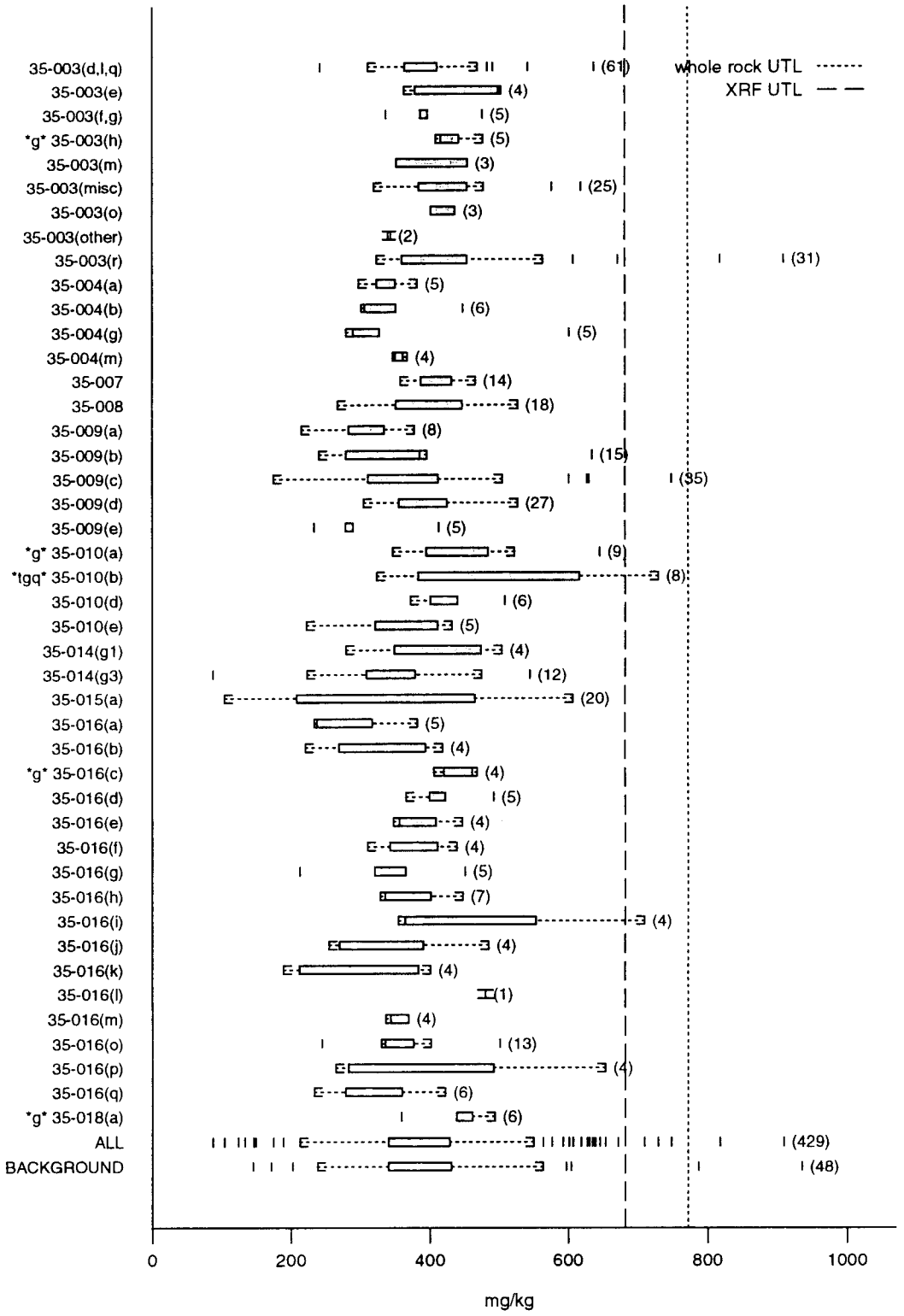

Figure AI-10. Distribution of manganese in TA-35 PRSs.

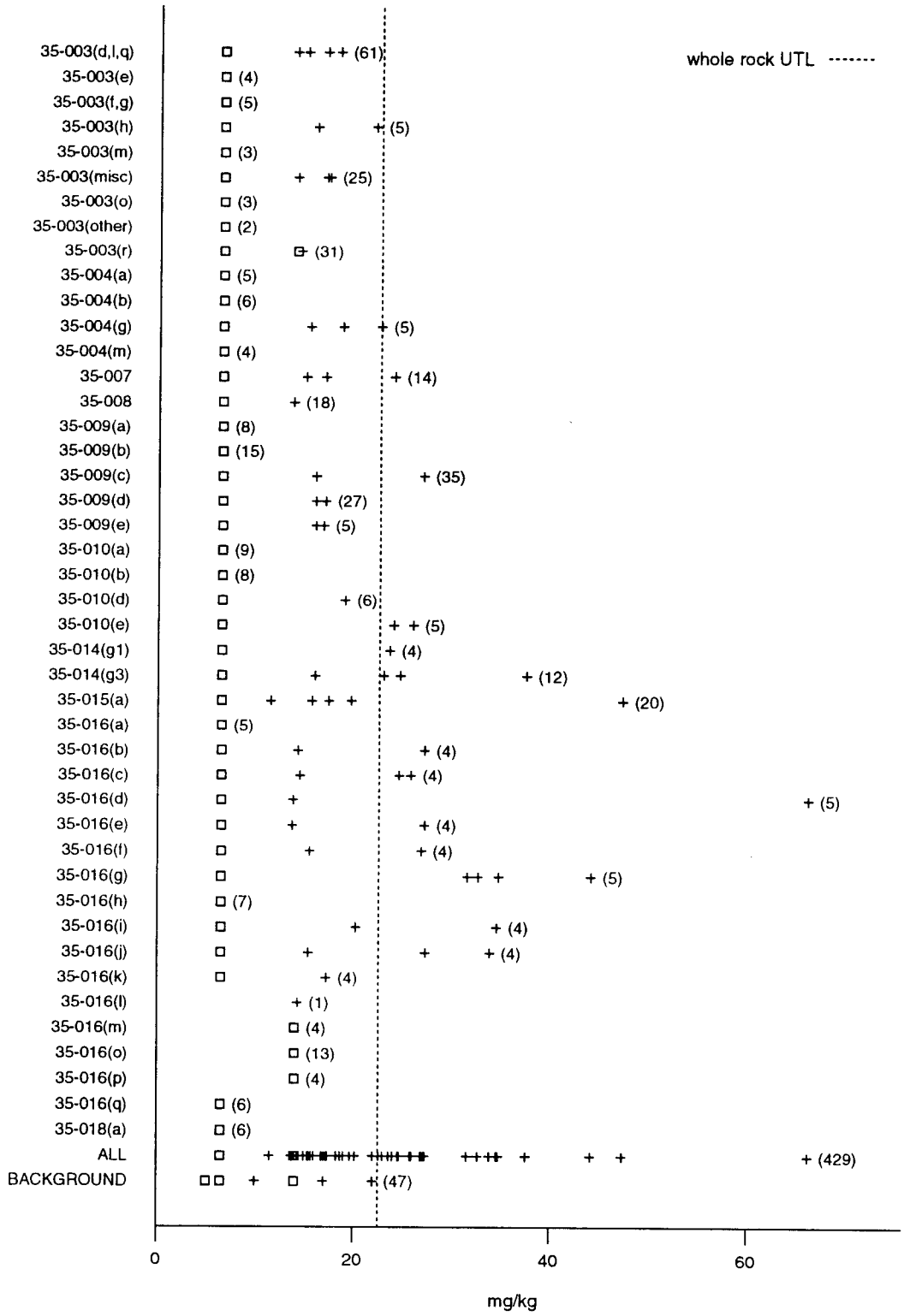

Figure AI-11. Distribution of nickel in TA-35 PRSs.

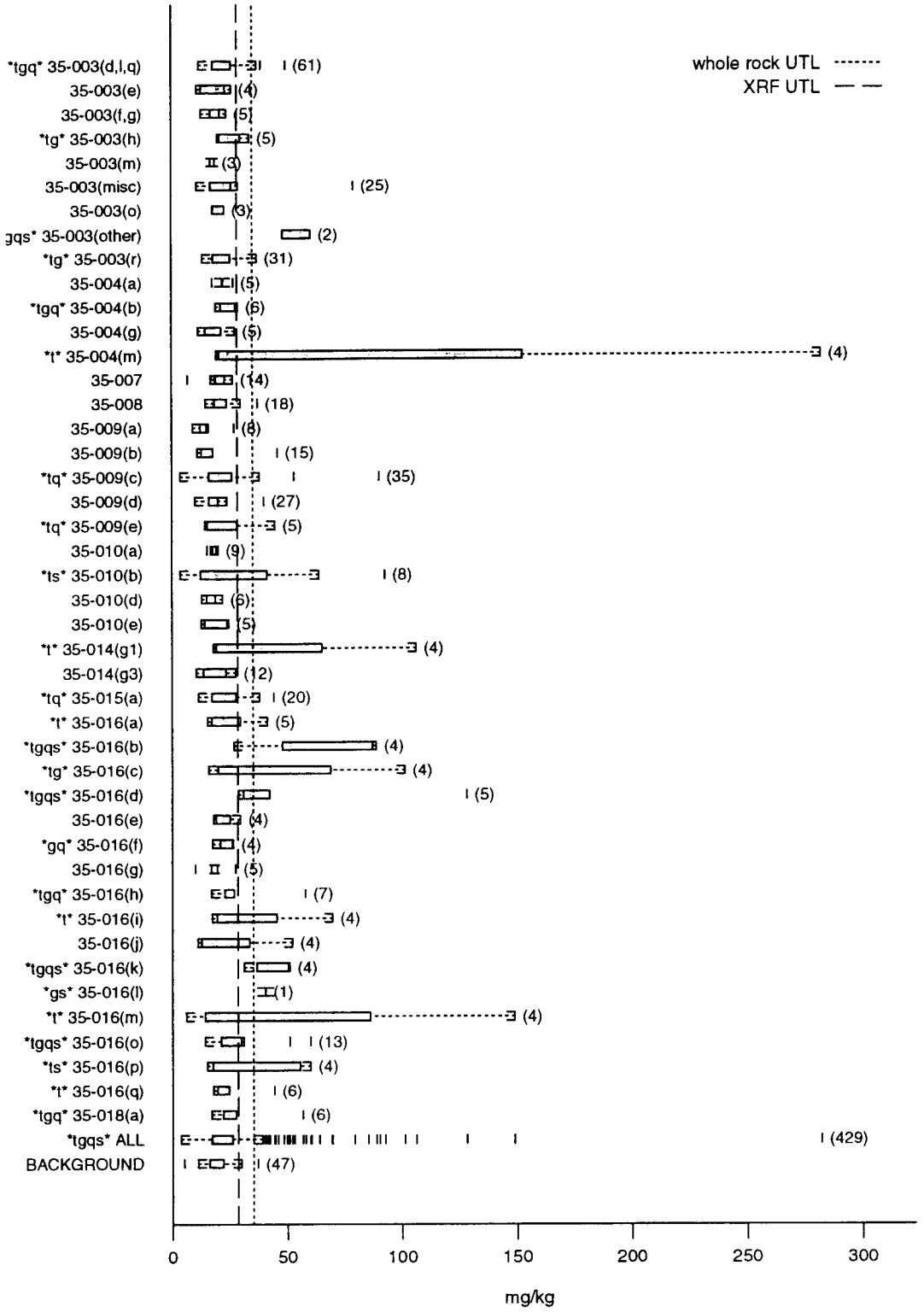

Figure AI-12. Distribution of lead in TA-35 PRSs.

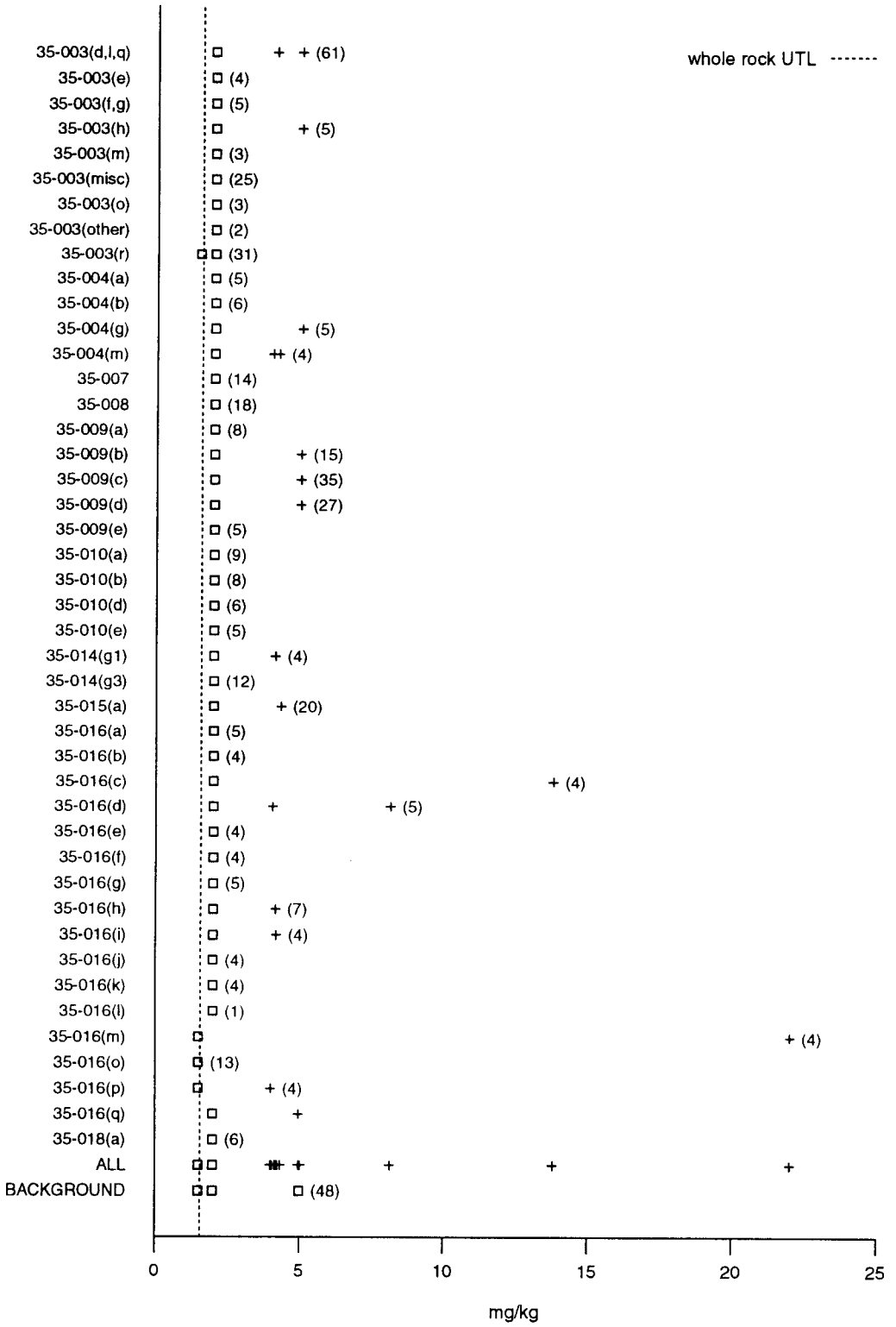

Figure AI-13. Distribution of antimony in TA-35 PRSs.

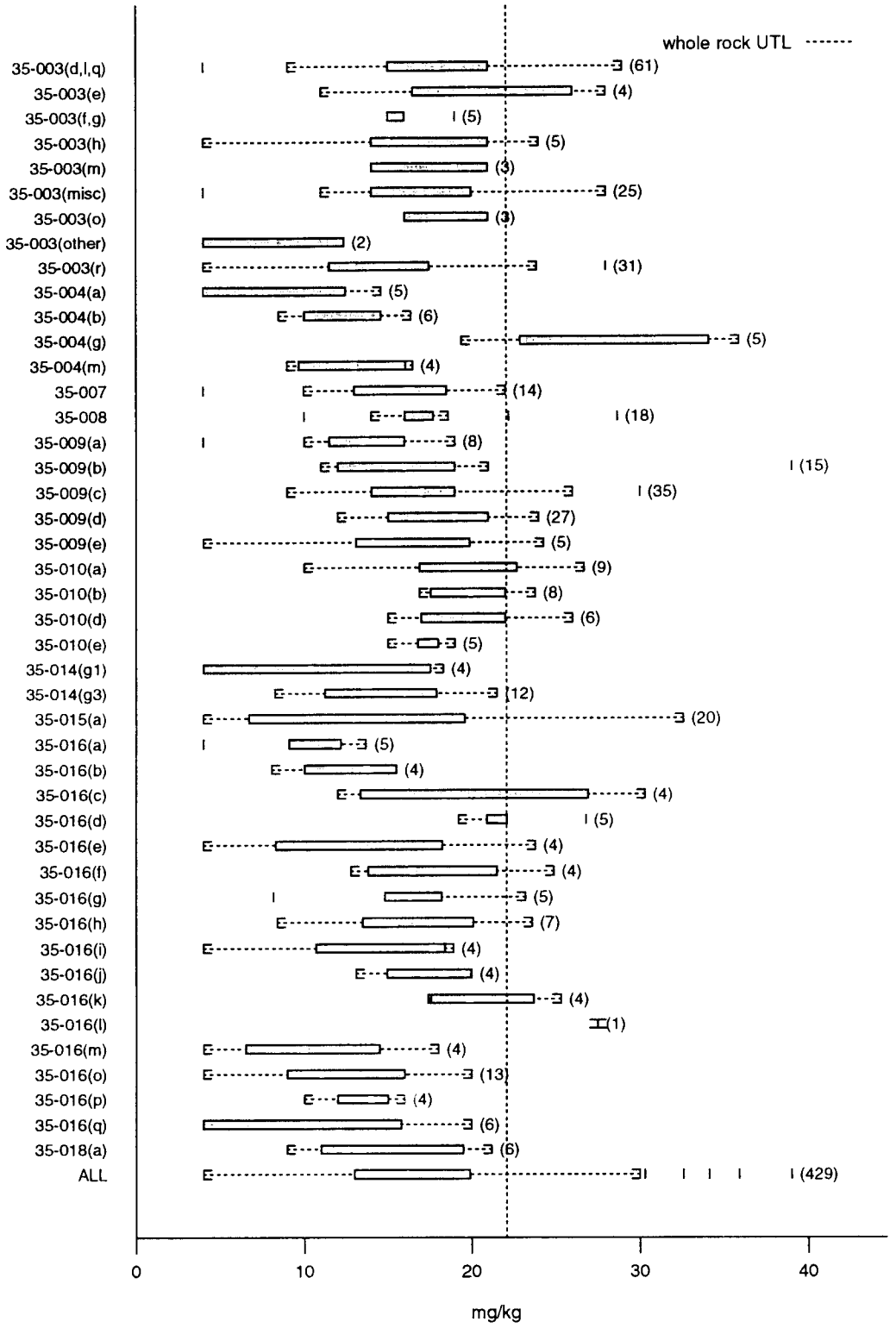

Figure AI-14. Distribution of thorium in TA-35 PRSs.

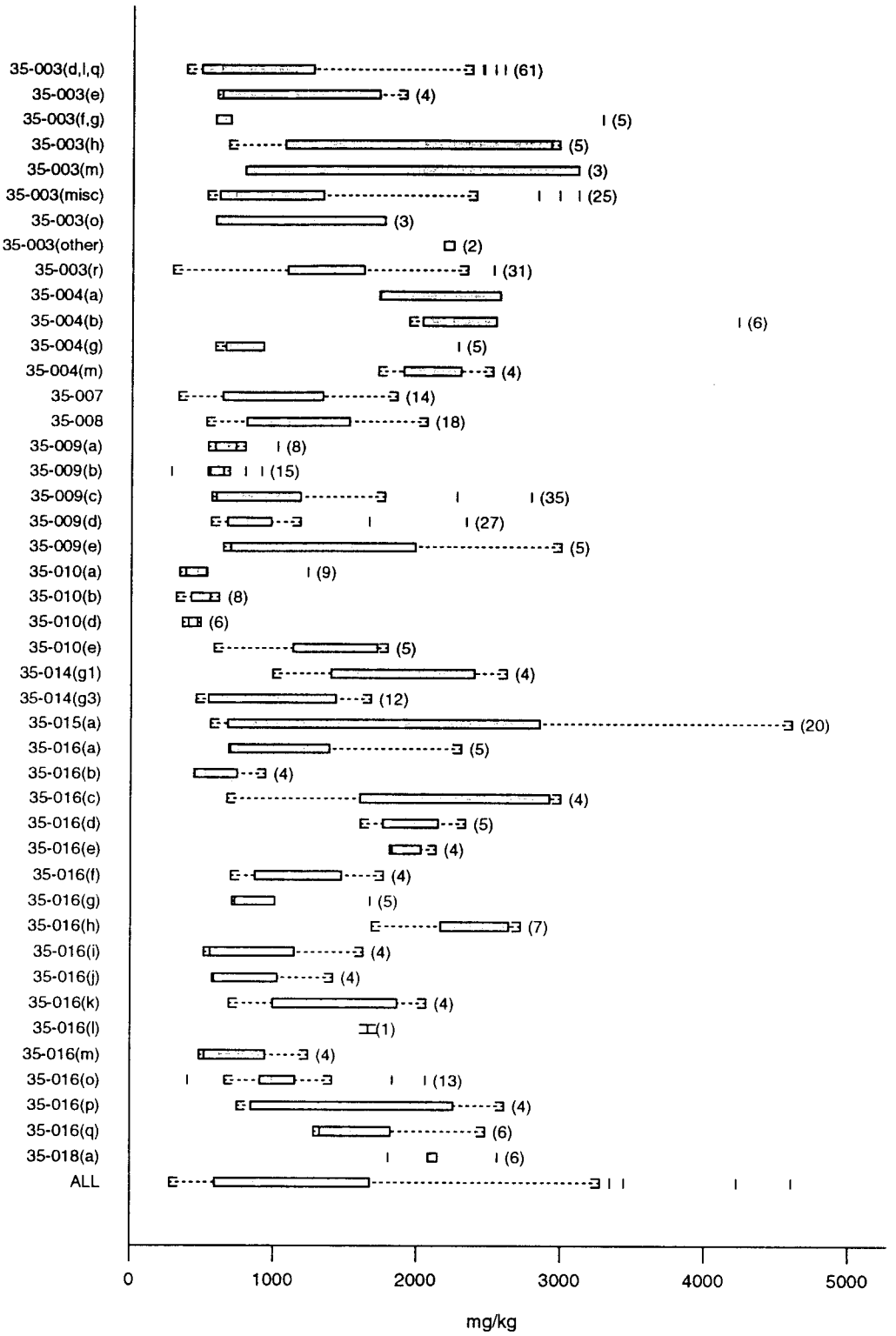

Figure AI-15. Distribution of titanium in TA-35 PRSs.

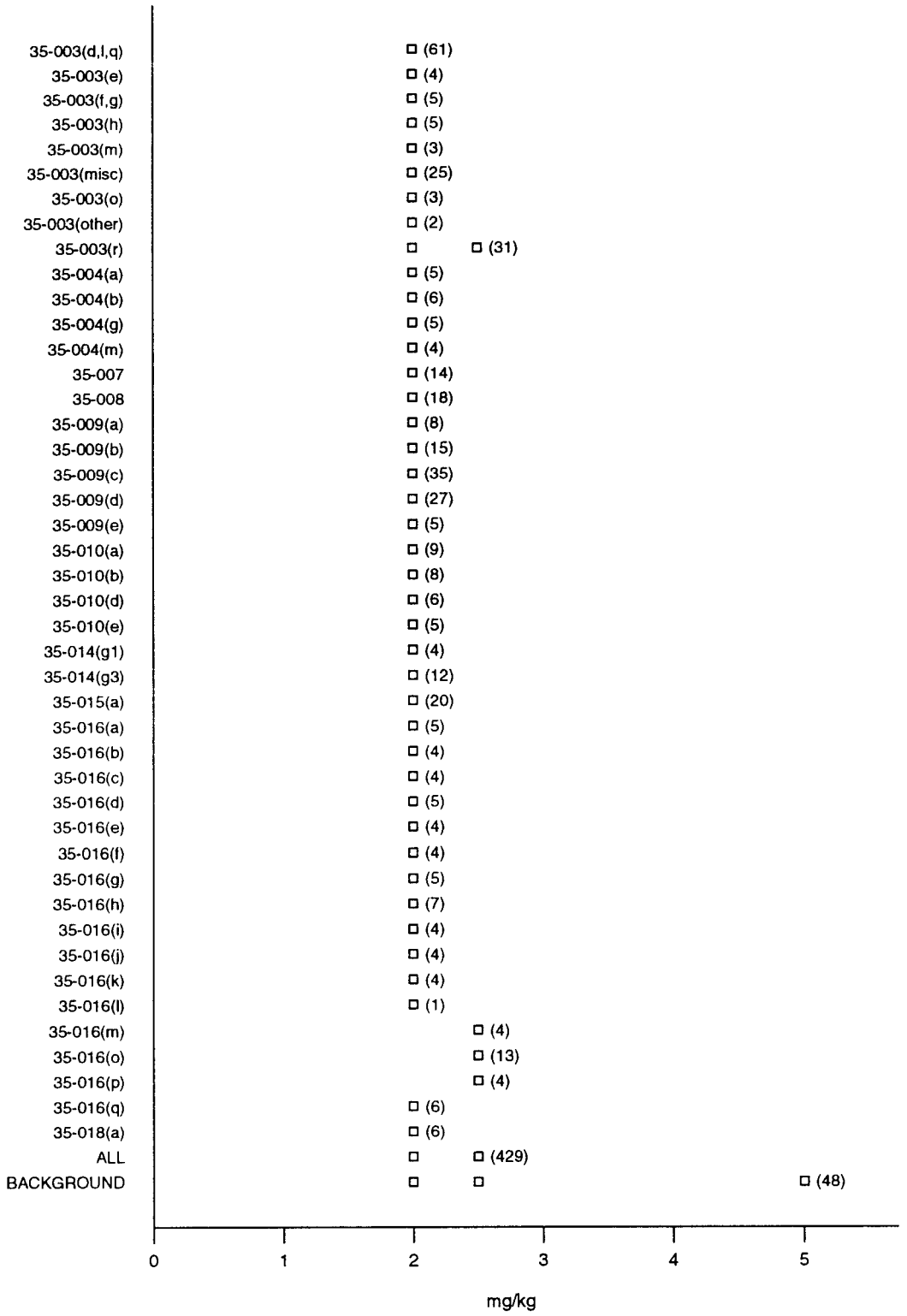

Figure AI-16. Distribution of selenium (uniformly nondetect) in TA-35 PRSs.

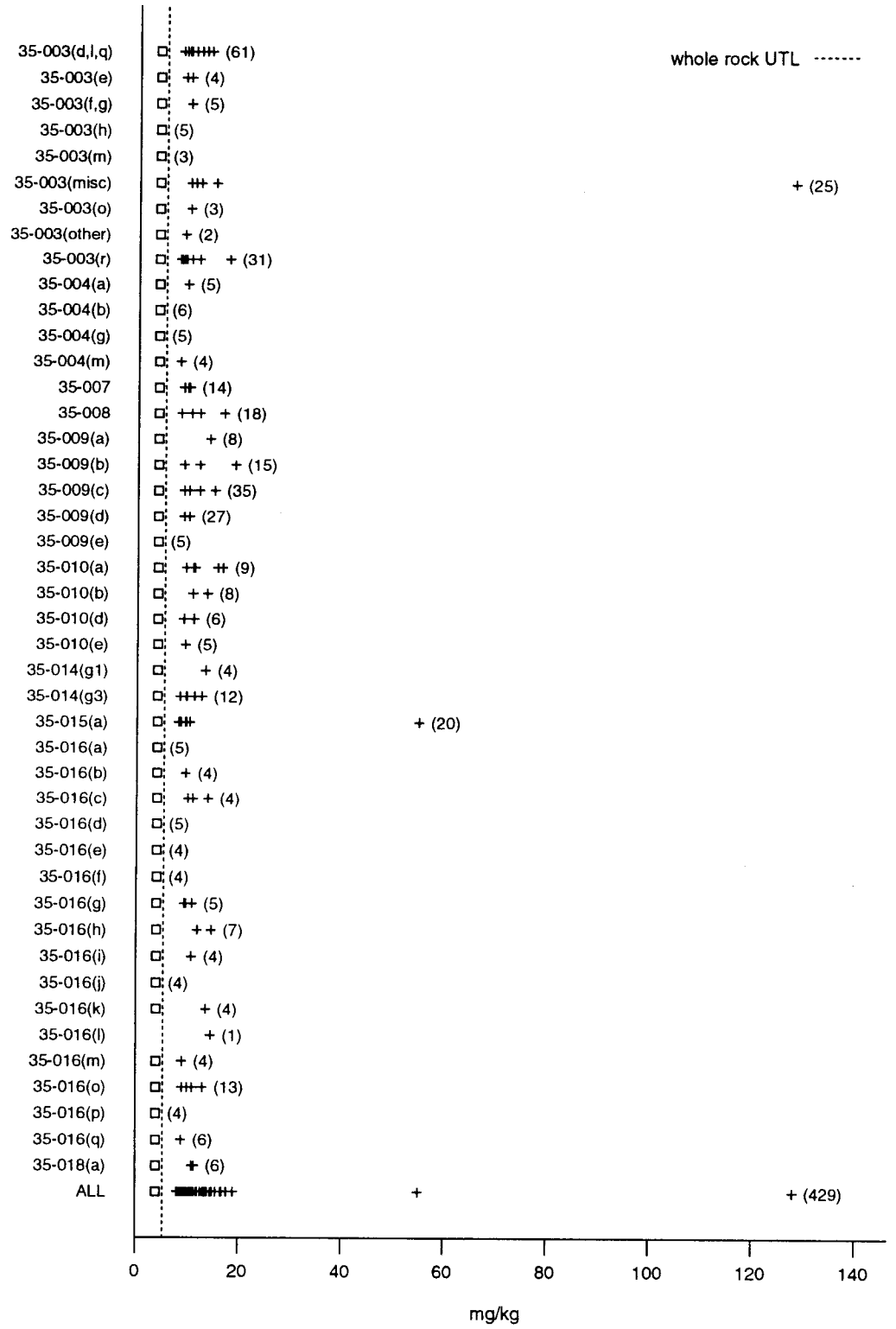

Figure AI-17. Distribution (point plot) of uranium in TA-35 PRSs.

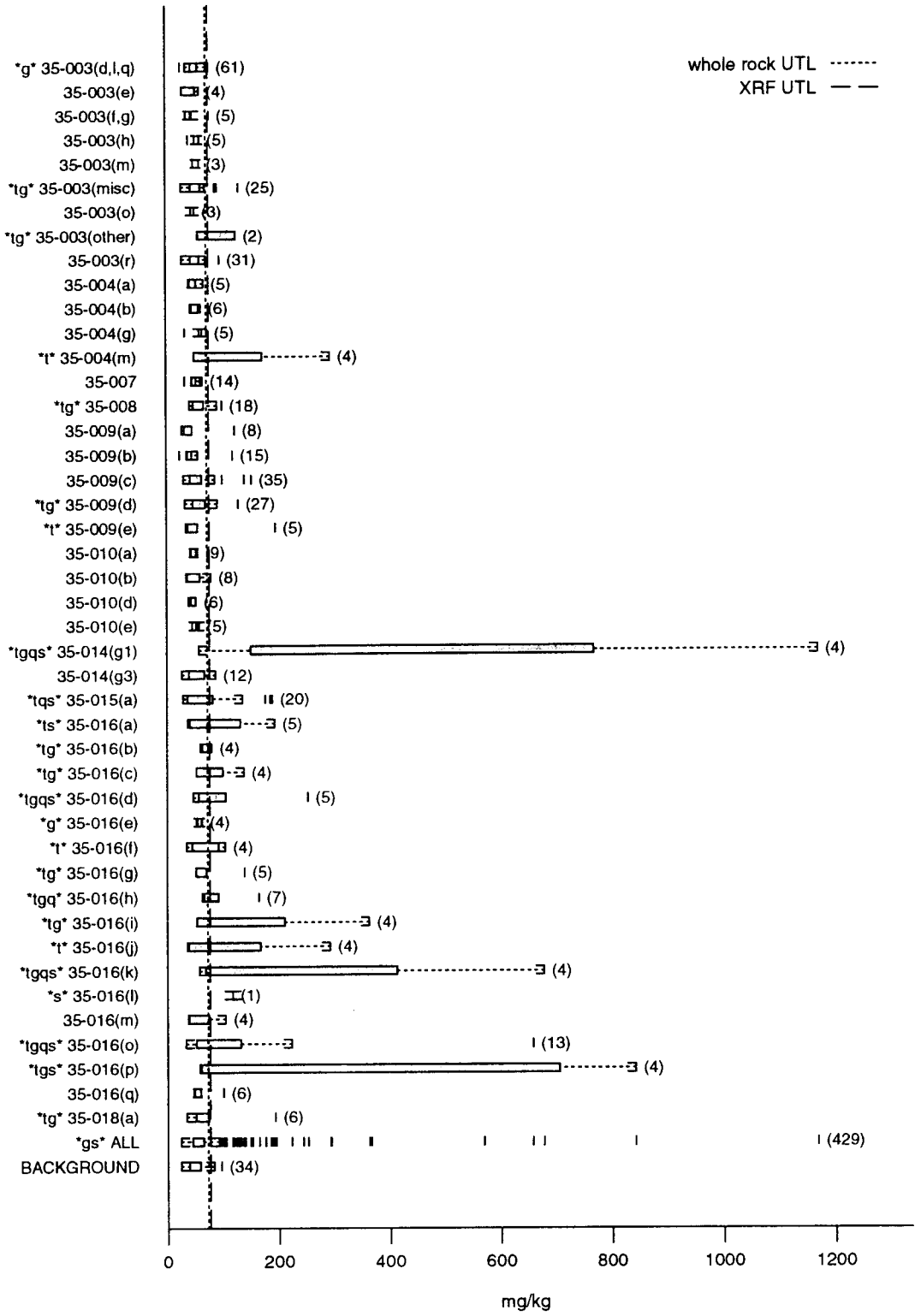

Figure AI-18. Distribution of zinc in TA-35 PRSs.

Attachment II

Geological Logs

ATTACHMENT II. GEOLOGICAL LOGS

This attachment contains geological logs for hollow-stem auger and hand-auger boreholes greater than 10 ft deep in the following potential release sites discussed in this Resource Conservation and Recovery Act facility investigation report.

- 35-003(h)
- 35-003(j)
- 35-003(k)
- 35-009(a)
- 35-009(b)
- 35-009(c)
- 35-009(d)

The geological logs contain lithologic descriptions, sample intervals and identification numbers, moisture content, and field screening values.

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Field Unit 4 Geological Log

Technical Area:	35	PRS No.:	35-003(d,l,q)	Page:	1 of 3
Location ID:	35-2004	Surface Elevation:	7,174 ft	Date:	04-25-94
Core Size:	3.25 in.	Total Depth:	100 ft		
Method:	Hollow-stem auger			Geologist:	Stephen Stellavato
				Field Team Leader:	Stephen Stellavato

Depth in feet	Sample Interval	Sample ID	Moisture (Dry / Wet)	OVA (ppm)	Beta-gamma (cpm)	Lithology	Description
0							
-1				0	200		SAND: dark brown, medium grain with roots
-2		AAB0993					CLAY with TUFF cobbles: dark brown and hard
-3					200		
-4							
-5							
-6				0	200		
-7							
-8					200		
-9							
-10		AAB0994					
-11				0	200		
-12							
-13					200		SAND with CLAY and TUFF cobbles
-14							
-15							Tuffaceous CLAY
-16				0	200		
-17		AAB1457					TUFF: light gray, non-welded, consolidated, (75% ash, 20% crystals, 5% pumice), crumbles easily
-18					200		
-19							
-20		AAB1048					
-21				0	200		
-22							
-23							
-24							
-25							
-26				0	200		TUFF: same as above with decreasing hardness
-27							
-28							
-29							
-30							
-31				0	200		TUFF: light gray, non-welded, (70% ash, 20% crystals, 10% pumice), alternating layers of hardness and softness
-32							
-33							
-34							
-35							

Field Unit 4 Geological Log

Technical Area:	35	PRS No.:	35-003(d,l,q)	Page:	2 of 3
Location ID:	35-2004	Surface Elevation:	7,174 ft	Date:	04-25-94
Core Size:	3.25 in.	Total Depth:	100 ft		
Method:	Hollow-stem auger			Geologist:	Stephen Stellavato
				Field Team Leader:	Stephen Stellavato

Depth in feet	Sample Interval	Sample ID	Moisture (Dry / Wet)	OVA (ppm)	Beta-gamma (cpm)	Lithology	Description
-35				0	200		TUFF: light gray, non-welded, (70% ash, 20% crystals, 10% pumice), consolidated but soft, some andesitic clasts
-36							
-37							
-38							
-39							
-40		AAB0974		0	200		
-41							
-42							
-43							TUFF: same as above. Some soft light brown clay zones and andesitic clasts interspersed throughout
-44							
-45				0	200		
-46							
-47							
-48							
-49							
-50				0	200		
-51							
-52							
-53					200		TUFF: light pink, non-welded, consolidated but soft. (70% ash, 20% crystals, 10% pumice) Some andesitic clasts and some clay zones
-54							
-55				0	200		
-56							
-57							
-58					200		
-59							
-60				0	200		
-61							
-62							
-63		AAB0975			200		
-64							
-65		AAB0995		0	200		
-66							
-67							
-68					200		
-69							
-70							

Field Unit 4 Geological Log

Technical Area:	35	PRS No.:	35-003(d,l,q)	Page:	3 of 3
Location ID:	35-2004	Surface Elevation:	7,174 ft	Date:	04-26-94
Core Size:	3.25 in.	Total Depth:	100 ft		
Method:	Hollow-stem auger			Geologist:	Stephen Stellavato
				Field Team Leader:	Stephen Stellavato

Depth in feet	Sample Interval	Sample ID	Moisture (Dry / Wet)	OVA (ppm)	Beta-gamma (cpm)	Lithology	Description
-70				0	200		TUFF: light pink, non-welded, consolidated but crumbles easily. (70% ash, 20% crystals, 10% pumice) Some andesitic zenolyths
-71							
-72							
-73					200		
-74							
-75							
-76				0	200		
-77							
-78					200		
-79							
-80		AAB0976					
-81				0	200		TUFF: same as above, increasing hardness with depth
-82							
-83					200		CLAY: light-brown, soft
-84							TUFF: light pink, non-welded, hard (60% ash, 30% crystals, 10% pumice)
-85							
-86		AAB1441		0	200		TUFF: pink, welded, hard (40% ash, 40% crystals, 20% pumice) upper contact of Cooling Unit 2
-87							
-88					200		
-89							
-90							
-91				0	200		
-92							
-93					200		
-94							
-95							
-96				0	200		
-97							
-98					200		
-99							
-100		AAB0996					

Field Unit 4 Geological Log

Technical Area:	35	PRS No.:	35-003(d,l,q)	Page:	1 of 3
Location ID:	35-2005	Surface Elevation:	7,171 ft	Date:	04-21-94
Core Size:	3.25 in.	Total Depth:	100 ft	Geologist:	Stephen Stellavato
Method:	Hollow-stem auger			Field Team Leader:	Stephen Stellavato

Depth in feet	Sample Interval	Sample ID	Moisture (Dry / Wet)	OVA (ppm)	Beta-gamma (cpm)	Lithology	Description
0				0	200		SAND: light brown, medium with roots
-1							CLAY with TUFF cobbles: light brown, hard
-2		AAB0989					
-3					200		
-4							
-5				0	200		
-6							
-7							
-8							
-9					200		
-10							
-11				0	200		
-12							
-13							NO RECOVERY
-14							
-15							SAND: light brown, medium
-16		AAB1458		0	200		TUFF: Light gray, non-welded, competent core (70% ash, 20% crystals, 10% pumice) crumbles easily
-17							
-18					200		Fractured TUFF: weathered fracture zone with light red, soft clay
-19							
-20							TUFF
-21				0	200		Fractured TUFF: weathered fracture zone with light-red, soft clay
-22							TUFF: Light gray, non-welded, competent core (70% ash, 20% crystals, 10% pumice) crumbles easily
-23							
-24							
-25							
-26				0			
-27							Fractured TUFF: weathered fracture zone with light red, soft clay
-28							
-29							TUFF
-30							
-31				0	200		Fractured TUFF
-32							TUFF: light gray, non-welded, competent core (70% ash, 20% crystals, 10% pumice), crumbles easily, some olive-gray soft clay
-33					200		
-34							
-35		AAB0991					

Field Unit 4 Geological Log

Technical Area: **35**
Location ID: **35-2005**
Core Size: **3.25 in.**
Method: **Hollow-stem auger**

PRS No.: **35-003(d,l,q)**
Surface Elevation: **7,171 ft**
Total Depth: **100 ft**

Page: **2 of 3**
Date: **04-21-94**
Geologist: **Stephen Stellavato**
Field Team Leader: **Stephen Stellavato**

Depth in feet	Sample Interval	Sample ID	Moisture (Dry / Wet)	OVA (ppm)	Beta-gamma (cpm)	Lithology	Description
-35							
-36				0	200		TUFF: light gray, non-welded, incompetent core (75% ash, 20% crystals, 5% pumice) crumbles easily
-37							
-38							
-39							
-40							
-41				0	200		
-42							TUFF: same as above with interspersed olive-gray, soft clay and andesitic zenolyths
-43					200		
-44							
-45							
-46				0	200		TUFF: light gray, non-welded, competent core (70% ash, 20% crystals, 10% pumice) crumbles easily
-47							
-48							
-49							
-50		AAB0990					
-51				0	200		
-52							TUFF: light pink, non-welded, competent core (70% ash, 20% crystals, 10% pumice) crumbles easily, interspersed olive-gray, soft clay
-53					200		
-54							
-55							
-56				0	200		
-57							
-58							
-59					200		
-60							
-61				0	200		
-62							NO RECOVERY
-63							
-64							
-65							
-66				0	200		TUFF: light pink, non-welded, competent core (70% ash, 20% crystals, 10% pumice) crumbles easily, interspersed olive-gray, soft clay
-67							
-68					200		NO RECOVERY
-69							TUFF: light pink, non-welded, competent core (70% ash, 20% crystals, 10% pumice) crumbles easily, interspersed olive-gray, soft clay
-70							

Field Unit 4 Geological Log

Technical Area:	35	PRS No.:	35-003(d,l,q)	Page:	3 of 3
Location ID:	35-2005	Surface Elevation:	7,171 ft	Date:	04-21-94
Core Size:	3.25 in.	Total Depth:	100 ft	Geologist:	Stephen Stellavato
Method:	Hollow-stem auger			Field Team Leader:	Stephen Stellavato

Depth in feet	Sample Interval	Sample ID	Moisture (Dry Wet)	OVA (ppm)	Beta-gamma (cpm)	Lithology	Description
-70				0	200		TUFF: light pink, non-welded, competent core (70% ash, 20% crystals, 10% pumice) crumbles easily, interspersed olive-gray, soft clay
-71							
-72							
-73					200		
-74							
-75							
-76				0	200		
-77							
-78					200		
-79							
-80							
-81				0	200		TUFF: light pink, non-welded, hard, competent core (60% ash, 30% crystals, 10% pumice)
-82							
-83							
-84							
-85							
-86				0	200		
-87							
-88					200		TUFF: dark pink, welded very hard, competent core (40% ash, 40% crystals, 20% pumice) upper contact of Cooling Unit 2
-89							
-90							
-91				0	200		
-92							
-93					200		TUFF: same as above, decreasing hardness with depth, interspersed olive-gray clay
-94							
-95							
-96				0	200		
-97							
-98					200		
-99							
-100		AAB0992					

Field Unit 4 Geological Log

Technical Area:	35	PRS No.:	35-003(d,l,q)	Page:	1 of 3
Location ID:	35-2006	Surface Elevation:	7,180 ft	Date:	04/28/94
Core Size:	3.25 in.	Total Depth:	100 ft		
Method:	Hollow-stem auger			Geologist:	Stephen Stellavato
				Field Team Leader:	Stephen Stellavato

Depth in feet	Sample Interval	Sample ID	Moisture (Dry / Wet)	OVA (ppm)	Beta-gamma (cpm)	Lithology	Description
0							SAND: dark brown, medium grain
-1							CLAY with TUFF cobbles: dark brown, hard, with some wood fragments
-2					200		
-3		AAB1459		0	200		TUFF: light gray, non-welded (70% ash, 20% crystals, 10% pumice), consolidated
-4					200		
-5							
-6							
-7					200		
-8				0			Fractured TUFF: light gray, non-welded as above, with light brown, soft clay in fractures
-9							
-10					200		TUFF: light gray, non-welded (80% ash, 10% crystals, 10% pumice), decreasing hardness with depth
-11							
-12					200		
-13				0			NO RECOVERY TUFF: light gray, non-welded as above
-14							
-15					200		
-16							
-17							
-18				0	200		
-19							
-20							
-21							Fractured TUFF: as above, but highly fractured with light brown, soft clay fill
-22					200		
-23				0			
-24					200		
-25		AAB0997			300		
-26							TUFF: light gray, non-welded as above
-27					200		
-28				0			
-29					200		NO RECOVERY
-30							
-31							TUFF: light gray, non-welded as above
-32					200		
-33				0			
-34					200		Fractured TUFF: light gray, nonwelded, highly fractured, with light brown soft clay fill
-35							

Field Unit 4 Geological Log

Technical Area:	35	PRS No.:	35-003(d,l,q)	Page:	2 of 3
Location ID:	35-2006	Surface Elevation:	7,180 ft	Date:	04/28/94
Core Size:	3.25 in.	Total Depth:	100 ft	Geologist:	Stephen Stellavato
Method:	Hollow-stem auger			Field Team Leader:	Stephen Stellavato

Depth in feet	Sample Interval	Sample ID	Moisture (Dry / Wet)	OVA (ppm)	Beta-gamma (cpm)	Lithology	Description
-35							TUFF: light gray, non-welded (80% ash, 10% crystals, 10% pumice), soft
-36							
-37					300		Fractured TUFF: light gray, non-welded as above, with large fracture zones filled with light brown, soft clay
-38				0			
-39					200		
-40							
-41							TUFF: light gray, non-welded as above
-42					200		
-43				0			Fractured TUFF: as above
-44					200		
-45							
-46							
-47					200		TUFF: light gray, non-welded (80% ash, 10% crystals, 10% pumice), some weathered zones, andesitic clast at 54.2 ft
-48				0			
-49					200		
-50							
-51							
-52					200		
-53				0			
-54					200		
-55		AAB0998		0	200		
-56							
-57					200		
-58				0			
-59					200		
-60							
-61							
-62					200		
-63				0			
-64					200		TUFF: light pink, non-welded (70% ash, 20% crystals, 10% pumice), consolidated, but crumbles easily in hand
-65							
-66							
-67					200		
-68				0			
-69							
-70		AAB0999		0	300		

Field Unit 4 Geological Log

Technical Area:	35	PRS No.:	35-003(d,l,q)	Page:	3 of 3
Location ID:	35-2006	Surface Elevation:	7,180 ft	Date:	04/28/94
Core Size:	3.25 in.	Total Depth:	100 ft		
Method:	Hollow-stem auger			Geologist:	Stephen Stellavato
				Field Team Leader:	Stephen Stellavato

Depth in feet	Sample Interval	Sample ID	Moisture (Dry / Wet)	OVA (ppm)	Beta-gamma (cpm)	Lithology	Description
-70							TUFF: light pink, non-welded (70% ash, 20% crystals, 10% pumice), consolidated but crumbles easily
-71							
-72					200		
-73				0			
-74					200		
-75							
-76							
-77					200		
-78				0			
-79					200		
-80							
-81							
-82					200		TUFF: light pink, (60% ash, 30% crystals, 10% pumice), crumbled easily
-83				0			TUFF: light pink, non-welded to moderately welded
-84					200		
-85							
-86							TUFF: light pink, non-welded (70% ash, 20% crystals, 10% pumice), consolidated but crumbles easily
-87					200		
-88				0			
-89					200		
-90							
-91							
-92					200		TUFF: light pink, non-welded to welded (70% ash, 20% crystals, 10% pumice)
-93				0			
-94					200		TUFF: light pink, non-welded to welded (60% ash, 30% crystals, 10% pumice)
-95							
-96							TUFF: pink, moderately welded (60% ash, 30% crystals, 10% pumice) upper contact of Cooling Unit 2
-97					200		
-98				0			TUFF: light pink, non-welded
-99					250		TUFF: pink, moderately welded
-100		AAB1000		0	250		TUFF: pink to pinkish gray, moderately welded

Field Unit 4 Geological Log

Technical Area:	35	PRS No.:	35-003(d,l,q)	Page:	1 of 3
Location ID:	35-2007	Surface Elevation:	7,175 ft	Date:	04-06-94
Core Size:	3.25 in.	Total Depth:	92 ft	Geologist:	Stephen Stellavato
Method:	Hollow-stem auger			Field Team Leader:	Stephen Stellavato

Depth in feet	Sample Interval	Sample ID	Moisture (Dry / Wet)	OVA (ppm)	Beta-gamma (cpm)	Lithology	Description
0							
-1		AAB1037		0	280		Clay and Sand: dark brown, soft clay, some fine sand with roots
-2							TUFF: light gray, welded, (60% ash, 30% crystals, 10% pumice, some lithics), hard
-3							Fractured TUFF: weathered fracture zone with red, soft clay
-4							TUFF: same as above
-5							
-6				0	200		
-7							
-8							
-9							
-10							
-11				0	250		TUFF: light gray, welded, (70% ash, 20% crystals, 10% pumice, some lithics), hard
-12							
-13							Fractured TUFF: weathered fracture zone with light red clay
-14							TUFF: same as above.
-15							
-16				0	150		
-17							
-18							
-19							
-20							
-21				0	200		TUFF: same as above, decreasing hardness
-22							
-23							
-24							
-25							
-26				0	200		TUFF: light gray, welded, (70% ash, 30% crystals) hard, but decreasing hardness.
-27							
-28							
-29							Fractured TUFF: weathered fracture zone with light red clay
-30							
-31				0	250		TUFF: light gray, welded, (70% ash, 30% crystals) hard, but decreasing hardness.
-32							
-33							
-34							Fractured TUFF
-35							TUFF: same as above

Field Unit 4 Geological Log

Technical Area:	35	PRS No.:	35-003(d,l,q)	Page:	2 of 3
Location ID:	35-2007	Surface Elevation:	7,175 ft	Date:	04-6-94
Core Size:	3.25 in.	Total Depth:	92 ft		
Method:	Hollow-stem auger			Geologist:	Stephen Stellavato
				Field Team Leader:	Stephen Stellavato

Depth in feet	Sample Interval	Sample ID	Moisture (Dry Wet)	OVA (ppm)	Beta-gamma (cpm)	Lithology	Description
-35				0	200		Fractured TUFF: light gray, welded, (70% ash, 20% crystals, 10% pumice) hardness increasing/decreasing at different intervals
-36							
-37							
-38							
-39							
-40		AAB1038		0	200		TUFF: light gray, welded, (70% ash, 20% crystals, 10% pumice)
-41							
-42							
-43							
-44							Fractured TUFF
-45							
-46				0	200		TUFF: light gray, welded, (70% ash, 20% crystals, 10% pumice)
-47							
-48							
-49							
-50							
-51				0	200		Fractured tuff
-52							TUFF: same as above
-53							
-54							Fractured TUFF
-55							
-56				0	200		TUFF: light gray, non-welded, (75% ash, 20% crystals, 5% pumice) consolidated, but crumbles easily
-57							
-58							Fractured TUFF
-59							TUFF: Same as above
-60							
-61				0	200		
-62							
-63							
-64							
-65		AAB1039					
-66				0	200		TUFF: light gray, non-welded, (90% ash, 10% crystals), soft, andesitic clast
-67							
-68							TUFF: light gray, non-welded, (70% ash, 20% crystals, 10% pumice), consolidated, but crumbles easily
-69							
-70							NO RECOVERY

Field Unit 4 Geological Log

Technical Area:	35	PRS No.:	35-003(d,l,q)	Page:	3 of 3
Location ID:	35-2007	Surface Elevation:	7,175 ft	Date:	04-06-94
Core Size:	3.25 in.	Total Depth:	92 ft	Geologist:	Stephen Stellavato
Method:	Hollow-stem auger			Field Team Leader:	Stephen Stellavato

Depth in feet	Sample Interval	Sample ID	Moisture (Dry Wet)	OVA (ppm)	Beta-gamma (cpm)	Lithology	Description
-70				0	200		TUFF: light gray, non-welded, (70% ash, 20% crystals, 10% pumice), andesitic clasts
-71							
-72							Fractured TUFF
-73							TUFF: very light pink, non-welded, (65% ash 25% crystals, 10% pumice), friable core
-74							
-75				0	200		
-76							
-77							
-78							TUFF: 0.3 ft zone of white tuff (50% ash, 40% crystals, 10% pumice)
-79							TUFF: very light pink, non-welded, (65% ash 25% crystals, 10% pumice), friable core
-80				0	200		TUFF: light pink, non-welded, (65% ash 20% crystals, 15% pumice), consolidation increasing
-81							
-82							
-83							
-84							
-85				0	200		
-86							
-87							
-88							
-89							
-90				0	200		
-91		AAB1040					TUFF: pink, welded, (40% ash 40% crystals, 20% pumice), dense and hard, drill rig refusal
-92							

Field Unit 4 Geological Log

Technical Area:	35	PRS No.:	35-003(d,l,q)	Page:	1 of 3
Location ID:	35-2008	Surface Elevation:	7,172 ft	Date:	04-14-94
Core Size:	3.25 in.	Total Depth:	100 ft		
Method:	Hollow-stem auger			Geologist:	Stephen Stellavato
				Field Team Leader:	Stephen Stellavato

Depth in feet	Sample Interval	Sample ID	Moisture (Dry / Wet)	OVA (ppm)	Beta-gamma (cpm)	Lithology	Description
0							
-1				0	200		SAND: dark brown, fine with roots
-2		AAB1033					CLAY with TUFF cobbles: dark brown, hard
-3					200		
-4							
-5							
-6				0	200		
-7							
-8					200		
-9							
-10							
-11				0	200		
-12					200		
-13					200		NO RECOVERY
-14		AAB1460			200		CLAY with TUFF cobbles: dark brown, hard
-15					1000		TUFF: light gray, non-welded, soft, consolidated (70% ash, 20% crystals, 10% pumice)
-16				0	200		
-17							
-18					200		Fractured TUFF
-19							TUFF: light gray, non-welded, (70% ash, 20% crystals, 10% pumice), soft, friable core, crumbles easily
-20							
-21				0	200		
-22							
-23							
-24							NO RECOVERY
-25							
-26				0	200		TUFF: light gray, non-welded, (70% ash, 20% crystals, 10% pumice), soft, friable core, crumbles easily
-27							
-28					200		
-29							
-30							CLAY: light brown, soft
-31				0	200		TUFF: light gray, non-welded, very soft, consolidated (80% ash, 20% crystals) crumbles easily
-32							
-33					200		NO RECOVERY
-34							TUFF: as above
-35							Fractured TUFF: large fracture zone with light brown, soft clay
							TUFF: large andesitic clast, consolidation increasing

Field Unit 4 Geological Log

Technical Area:	35	PRS No.:	35-003(d,l,q)	Page:	2 of 3
Location ID:	35-2008	Surface Elevation:	7,172 ft	Date:	04-14-94
Core Size:	3.25 in.	Total Depth:	100 ft	Geologist:	Stephen Stellavato
Method:	Hollow-stem auger			Field Team Leader:	Stephen Stellavato

Depth in feet	Sample Interval	Sample ID	Moisture (Dry / Wet)	OVA (ppm)	Beta-gamma (cpm)	Lithology	Description
-35				0	200		TUFF: light gray, non-welded, (80% ash 10% crystals, 10% pumice) soft, friable core, crumbles easily
-36							
-37							
-38					200		
-39							
-40							
-41				0	200		
-42							
-43					200		
-44							Fractured TUFF: weathered fracture zone with light brown, soft clay
-45							TUFF: light gray, non-welded, (80% ash 10% crystals, 10% pumice) soft, friable core, crumbles easily
-46				0	200		
-47							
-48					200		
-49							
-50					200		TUFF: light pink, non-welded, (70%ash, 20% crystals, 10% pumice) soft, consolidated, crumbles easily
-51							
-52							
-53					200		
-54							
-55							
-56					200		
-57							
-58					200		
-59							
-60							Fractured TUFF
-61				0	200		TUFF: same as above
-62							
-63					200		
-64		AAB1034					Tuffaceous CLAY: brown, soft, lacking defined fracture and interlaced with tuff
-65							NO RECOVERY
-66				0	200		TUFF: light pink, non-welded, (70%ash, 20% crystals, 10% pumice) soft, consolidated, crumbles easily
-67							
-68					200		
-69							
-70							Tuffaceous CLAY: brown, soft, lacking defined fracture and interlaced with tuff

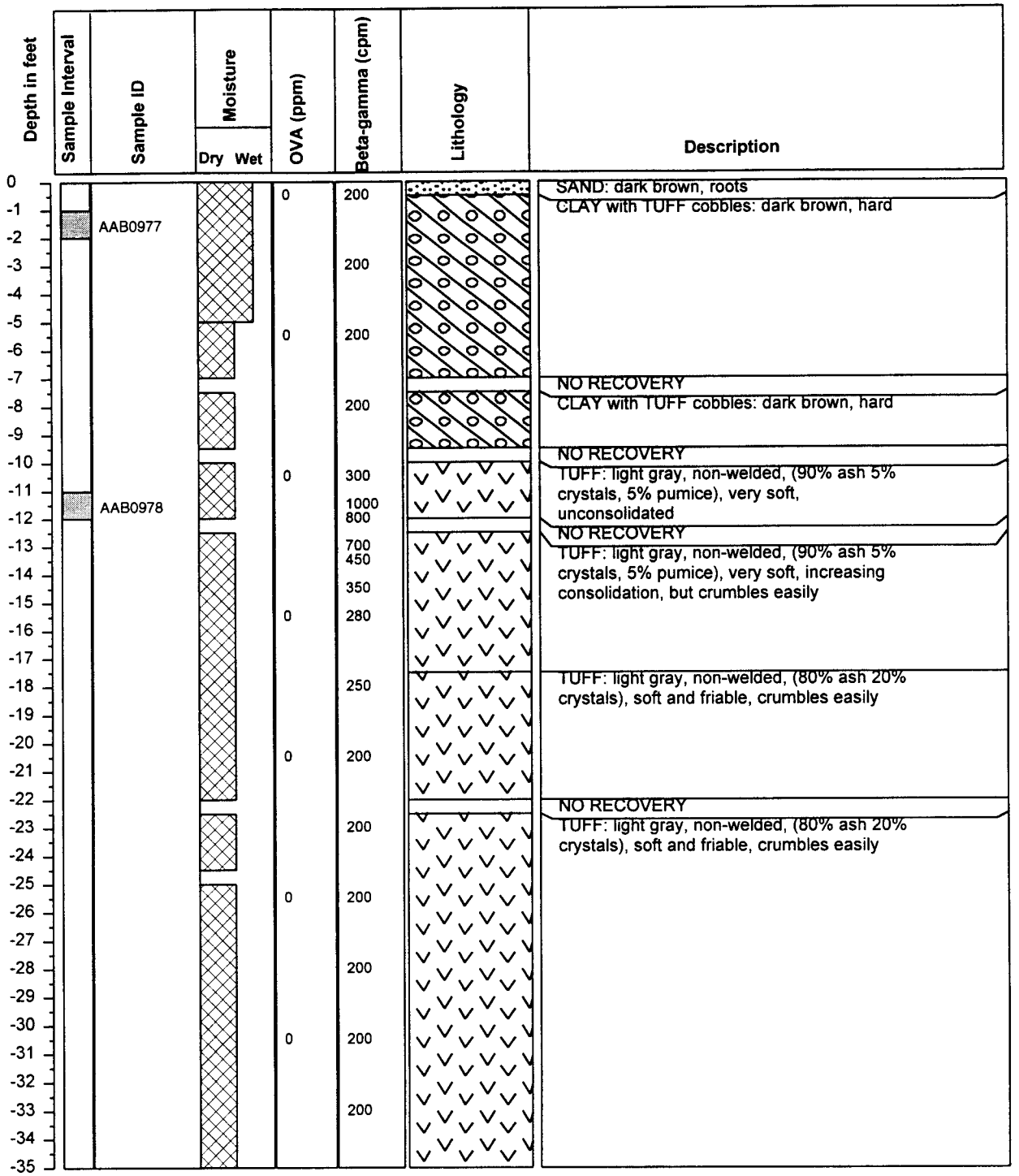
Field Unit 4 Geological Log

Technical Area:	35	PRS No.:	35-003(d,l,q)	Page:	3 of 3
Location ID:	35-2008	Surface Elevation:	7,172 ft	Date:	04-14-94
Core Size:	3.25 in.	Total Depth:	100 ft		
Method:	Hollow-stem auger			Geologist:	Stephen Stellavato
				Field Team Leader:	Stephen Stellavato

Depth in feet	Sample Interval	Sample ID	Moisture (Dry / Wet)	OVA (ppm)	Beta-gamma (cpm)	Lithology	Description
-70				0	200		TUFF: light pink, non-welded, (80% ash, 10% crystals, 10% pumice) soft, consolidated
-71							
-72							
-73					200		TUFF: light pink, non-welded, (65% ash, 20% crystals, 15% pumice) consolidation increasing to hard, very competent core from 73.2 ft
-74							
-75		AAB1035					
-76				0	200		
-77							
-78					200		
-79							
-80							
-81				0	200		TUFF: light pink, non-welded, (60% ash, 30% crystals, 10% pumice) hard, very competent core, alternating layers of hardness.
-82							
-83					200		
-84							
-85							
-86				0	200		Tuffaceous CLAY: brown, soft, incompetent core
-87							
-88					200		NO RECOVERY Tuffaceous CLAY: brown, soft, incompetent core
-89							
-90							TUFF: dark pink, welded, (40% ash, 40% crystals, 20% pumice) very hard, upper contact of Cooling Unit 2
-91				0	200		
-92							
-93					200		
-94							
-95							
-96				0	200		
-97							
-98					200		
-99							
-100		AAB1036					

Field Unit 4 Geological Log

Technical Area:	35	PRS No.:	35-003(d,l,q)	Page:	1 of 3
Location ID:	35-2009	Surface Elevation:	7,165 ft	Date:	04-06-94
Core Size:	3.25 in.	Total Depth:	100 ft		
Method:	Hollow-stem auger			Geologist:	Stephen Stellavato
				Field Team Leader:	Stephen Stellavato



Field Unit 4 Geological Log

Technical Area:	35	PRS No.:	35-003(d,l,q)	Page:	1 of 3
Location ID:	35-2009	Surface Elevation:	7,165 ft	Date:	04-06-94
Core Size:	3.25 in.	Total Depth:	100 ft		
Method:	Hollow-stem auger			Geologist:	Stephen Stellavato
				Field Team Leader:	Stephen Stellavato

Depth in feet	Sample Interval	Sample ID	Moisture (Dry / Wet)	OVA (ppm)	Beta-gamma (cpm)	Lithology	Description
-35							
-36				0	200		TUFF: light gray, non-welded, (90% ash 10% crystals), soft, unconsolidated
-37							
-38					200		Fractured TUFF: light brown, soft clay
-39							TUFF: light gray, non-welded, (90% ash 10% crystals), soft, unconsolidated, small andesitic clasts
-40							
-41				0	200		
-42							
-43					200		
-44							
-45							Fractured TUFF: light brown, soft clay
-46				0	200		TUFF: light gray, non-welded, (90% ash 10% crystals), soft, unconsolidated
-47							
-48					200		Fractured TUFF: Light brown, soft clay
-49							TUFF: same as above
-50							NO RECOVERY
-51				0	200		TUFF: light gray, non-welded, (95% ash, little crystals and pumice), soft
-52							NO RECOVERY
-53							
-54							
-55							
-56				0	200		TUFF: light gray, non-welded, (90% ash 10% crystals), soft, unconsolidated
-57							NO RECOVERY
-58					200		TUFF: light pink, non-welded, (75% ash 20% crystals, 5% pumice), consolidated but crumbles easily
-59							
-60							
-61				0	200		
-62							
-63							
-64							
-65							Fractured TUFF
-66							TUFF: light pink, non-welded, (75% ash 20% crystals, 5% pumice), consolidation increasing but crumbles easily
-67							
-68							
-69							
-70							

Field Unit 4 Geological Log

Technical Area:	35	PRS No.:	35-003(d,l,q)	Page:	3 of 3
Location ID:	35-2009	Surface Elevation:	7,165 ft	Date:	04-13-94
Core Size:	3.25 in.	Total Depth:	100 ft	Geologist:	Stephen Stellavato
Method:	Hollow-stem auger			Field Team Leader:	Stephen Stellavato

Depth in feet	Sample Interval	Sample ID	Moisture (Dry Wet)	OVA (ppm)	Beta-gamma (cpm)	Lithology	Description
-70							TUFF: light pink, non-welded, (70% ash 25% crystals, 5% pumice), hard, consolidation increasing, some small andesitic clasts
-71							
-72					200		
-73				0			
-74					200		Fractured TUFF
-75							TUFF: light pink, non-welded, (70% ash 25% crystals, 5% pumice), hard, consolidation increasing, some small andesitic clasts
-76							
-77							Fractured TUFF: brown, soft clay
-78				0	200		TUFF: light pink, non-welded, (70% ash 25% crystals, 5% pumice), hard, consolidation increasing, some small andesitic clasts
-79							
-80							Fractured TUFF: brown, soft clay
-81		AAB0979		0	200		TUFF: same as above
-82							TUFF: light pink, welded (50% ash 40% crystals, 10% pumice), very hard, consolidated core, upper contact of Cooling Unit 2
-83				0	200		
-84							
-85							TUFF: same as above. Color change to dark pink - light red
-86							
-87				0	200		
-88							TUFF: light brown, (70% ash 20% crystals, 10% pumice), soft, but consolidated
-89				0	200		TUFF: light to dark pink, welded, (50% ash 40% crystals, 10% pumice), hard, dense, very competent
-90							
-91							TUFF: light brown, (70% ash, 30% crystals), soft, but consolidated
-92				0	200		
-93							TUFF: dark pink, welded, (50% ash 40% crystals, 5% pumice, 5% brown, soft clay)
-94				0	200		
-95							
-96							
-97							
-98				0	200		
-99							
-100		AAB0980			200		

Field Unit 4 Geological Log

Technical Area:	35	PRS No.:	35-003(d,l,q)	Page:	1 of 3
Location ID:	35-2010	Surface Elevation:	7,189 ft	Date:	03/31-04/01/94
Core Size:	3.25 in.	Total Depth:	100 ft		
Method:	Hollow-stem auger			Geologist:	Stephen Stellavato
				Field Team Leader:	Stephen Stellavato

Depth in feet	Sample Interval	Sample ID	Moisture (Dry / Wet)	OVA (ppm)	Beta-gamma (cpm)	Lithology	Description
0							HUMUS (topsoil): dark brown, with roots
-1							
-2		AAB0961		0.5	350		Tuffaceous CLAY: dark brown, hard, 10% tuff
-3							SAND: light brown, medium grain, some rounded cobbles
-4				0.6	242		Tuffaceous CLAY: dark brown, hard, 10% tuff
-5							
-6							SAND: light brown, medium grain, some rounded cobbles
-7				0.6	178		Tuffaceous CLAY: dark brown, hard, 20% tuff
-8							
-9				0.6	298		
-10							
-11							Tuffaceous CLAY: dark brown, hard, 50% tuff
-12				0.6	172		
-13							
-14		AAB0962		0.6	498		
-15							TUFF: gray, non-welded (70% ash, 20% crystals, 10% pumice); consolidation decreases to 17 ft, then increases to 20 ft
-16							
-17							
-18				0.6	226		
-19							
-20							
-21							TUFF: gray, non-welded (95% ash, 5% crystals), extremely soft, which contributed to lack of recovery
-22				0.8	258		
-23							NO RECOVERY
-24							
-25							
-26							TUFF: gray, non-welded (95% ash, 5% crystals), extremely soft; starting 2.5 ft core runs to enhance recovery
-27				0.8	261		
-28							TUFF: gray, non-welded (70% ash, 20% crystals, 10% pumice)
-29				0.8	323		TUFF: gray, non-welded (95% ash, 5% crystals), extremely soft
-30							
-31							
-32				0.8	318		TUFF: gray, non-welded (70% ash, 30% crystals)
-33							TUFF: gray, soft, non-welded, (95% ash, 5% crystals)
-34				0.8	485		
-35							

Field Unit 4 Geological Log

Technical Area:	35	PRS No.:	35-003(d,l,q)	Page:	2 of 3
Location ID:	35-2010	Surface Elevation:	7,189 ft	Date:	03/31-04/01/94
Core Size:	3.25 in.	Total Depth:	100 ft	Geologist:	Stephen Stellavato
Method:	Hollow-stem auger			Field Team Leader:	Stephen Stellavato

Depth in feet	Sample Interval	Sample ID	Moisture (Dry / Wet)	OVA (ppm)	Beta-gamma (cpm)	Lithology	Description
-35							TUFF: gray, non-welded, soft (90% ash, 10% crystals)
-36							
-37				0.8	277		
-38				1.0	215		
-39		AAB0963					NO RECOVERY
-40							TUFF: gray, non-welded, soft (90% ash, 10% crystals), with andesitic pyroclasts
-41							
-42				1.0	226		NO RECOVERY
-43							TUFF: gray, non-welded, soft (90% ash, 10% crystals)
-44				1.0	305		
-45							TUFF: gray, non-welded, soft (95% ash, 5% crystals)
-46							
-47				0.8	242		
-48							NO RECOVERY
-49							
-50							TUFF: gray, non-welded, soft (95% ash, 5% crystals), with clasts of harder tuff (70% ash, 20% crystals, 10% pumice)
-51							
-52				1.2	216		NO RECOVERY
-53							TUFF: gray, non-welded, soft (95% ash, 5% crystals), with clasts of harder tuff (70% ash, 20% crystals, 10% pumice)
-54				1.4	197		
-55							NO RECOVERY
-56							TUFF: gray, non-welded, soft (95% ash, 5% crystals), with clasts of harder tuff (70% ash, 20% crystals, 10% pumice), and small andesitic fragments
-57				1.6	310		
-58							
-59				1.6	141		NO RECOVERY
-60							TUFF: as above
-61							NO RECOVERY
-62				1.6	278		TUFF: as above
-63							NO RECOVERY
-64				1.4	263		TUFF: as above
-65							NO RECOVERY
-66							TUFF: as above
-67				1.6	259		NO RECOVERY
-68							TUFF: as above
-69				2.0	300		
-70							NO RECOVERY

Field Unit 4 Geological Log

Technical Area:	35	PRS No.:	35-003(d,l,q)	Page:	3 of 3
Location ID:	35-2010	Surface Elevation:	7,189 ft	Date:	03/31-04/01/94
Core Size:	3.25 in.	Total Depth:	100 ft		
Method:	Hollow-stem auger			Geologist:	Stephen Stellavato
				Field Team Leader:	Stephen Stellavato

Depth in feet	Sample Interval	Sample ID	Moisture (Dry / Wet)	OVA (ppm)	Beta-gamma (cpm)	Lithology	Description
-70							
-71							TUFF: gray, non-welded, soft (95% ash, 5% crystals), with clasts of harder tuff (70% ash, 20% crystals, 10% pumice)
-72							NO RECOVERY
-73							TUFF: gray, non-welded, soft (95% ash, 5% crystals), with clasts of harder tuff (70% ash, 20% crystals, 10% pumice), hardness increasing with depth
-74							
-75							
-76							TUFF: gray, non-welded, soft (90%ash, 10% crystals), hardness increasing with depth, moisture decreaing
-77				0.6	357		
-78							
-79				0.6	350		TUFF: gray, brecciated (70% ash, 30% crystals)
-80							
-81							TUFF: gray, non-welded, soft (90% ash, 10% crystals)
-82				0.6	260		
-83							
-84				0.8	200		TUFF: dark gray, hard
-85							TUFF: gray, non-welded, soft (90% ash, 10% crystals)
-86							
-87							
-88				0.8	275		
-89							Fractured TUFF: gray, non-welded (80% ash, 10% crystals, 10% clay), fractures filled with light brown, soft clay
-90							
-91							TUFF: gray, welded (60% ash, 20% crystals, 20% pumice), increasing hardness to 94 ft, decreasing hardness to 95 ft
-92				0.8	210		
-93		AAB0964 AAB0966					
-94				0.8	315		
-95							
-96							TUFF: gray, welded, core is friable
-97				0.8	210		
-98		AAB0965					TUFF: gray, welded (60% ash, 30% crystals, 10% pumice)
-99				0.8	300		
-100							

Field Unit 4 Geological Log

Technical Area:	35	PRS No.:	35-003(d,l,q)	Page:	1 of 3
Location ID:	35-2011	Surface Elevation:	7,167 ft	Date:	04/26/94
Core Size:	3.25 in.	Total Depth:	100 ft	Geologist:	Stephen Stellavato
Method:	Hollow-stem auger			Field Team Leader:	Stephen Stellavato

Depth in feet	Sample Interval	Sample ID	Moisture (Dry / Wet)	OVA (ppm)	Beta-gamma (cpm)	Lithology	Description
0							SAND: dark brown, medium grain, with roots
-1							CLAY with TUFF cobbles: dark brown, hard
-2		AAB1001			200		
-3				0			
-4					200		
-5							
-6							
-7							
-8				0	200		NO RECOVERY
-9							
-10					200		Tuffaceous SAND: light brown, medium grain, some cobbles
-11		AAB1002					TUFF: light gray, non-welded (70% ash, 20% crystals, 10% pumice), soft
-12					200		Fractured TUFF: light gray, non-welded, highly fractured, filled with light red hard clay and some roots
-13				0			
-14					200		
-15					300		
-16							
-17					200		
-18				0			
-19					200		
-20							
-21							
-22					200		
-23				0			TUFF: light gray non-welded (70% ash, 20% crystals, 10% pumice), crumbles easily in hand,some andesitic clasts, fracture at 25.5 ft
-24					200		
-25		AAB1003					
-26							
-27							
-28				0	200		
-29		AAB1442					TUFF: as above, increasing hardness, fracture at 29.3 ft
-30							
-31							TUFF: light gray, non-welded (80% ash, 20% crystals), soft
-32							
-33				0	200		
-34							
-35					200		

Field Unit 4 Geological Log

Technical Area:	35	PRS No.:	35-003(d,l,q)	Page:	2 of 3
Location ID:	35-2011	Surface Elevation:	7,167 ft	Date:	04/26/94
Core Size:	3.25 in.	Total Depth:	100 ft		
Method:	Hollow-stem auger			Geologist:	Stephen Stellavato
				Field Team Leader:	Stephen Stellavato

Depth in feet	Sample Interval	Sample ID	Moisture (Dry Wet)	OVA (ppm)	Beta-gamma (cpm)	Lithology	Description
-35							TUFF: light gray, non-welded (75% ash, 20% crystals, 5% pumice), crumbles easily in hand
-36							
-37							
-38				0	200		
-39							
-40							
-41							
-42					200		TUFF: as above, with andiesitic clasts, and some light brown soft clay
-43				0			
-44					200		
-45							NO RECOVERY
-46							TUFF: light gray, non-welded (80% ash, 10% crystals, 10% pumice), very soft core; weathered? zones consisting of light brown soft clay
-47					200		
-48				0			
-49					200		
-50							
-51							
-52					200		
-53				0			
-54					200		
-55							
-56							
-57					200		
-58				0			
-59					200		
-60							
-61							
-62					200		
-63				0			
-64					200		
-65		AAB1004					
-66							TUFF: light pink, non-welded (70% ash, 20% crystals, 10% pumice), crumbles easily in hand
-67					200		
-68				0			
-69							
-70					200		

Field Unit 4 Geological Log

Technical Area:	35	PRS No.:	35-003(d,l,q)	Page:	3 of 3
Location ID:	35-2011	Surface Elevation:	7,167 ft	Date:	04/26/94
Core Size:	3.25 in.	Total Depth:	100 ft	Geologist:	Stephen Stellavato
Method:	Hollow-stem auger			Field Team Leader:	Stephen Stellavato

Depth in feet	Sample Interval	Sample ID	Moisture (Dry Wet)	OVA (ppm)	Beta-gamma (cpm)	Lithology	Description
-70							TUFF: light pink, non-welded (65% ash, 25% crystals, 10% pumice), hardness increasing witrh depth
-71							
-72					200		
-73				0			
-74					200		
-75							
-76		AAB1443					
-77					200		
-78				0			
-79					200		
-80							
-81							
-82					200		
-83				0			
-84					200		TUFF: dark pink, welded (40% ash, 50% crystals, 10% pumice), hard, competent core; upper contact of Cooling Unit 2
-85							
-86							
-87					200		
-88				0			
-89					200		
-90							
-91							
-92					200		
-93				0			
-94					200		
-95							
-96							
-97					200		
-98				0			
-99					200		
-100		AAB1005					

Field Unit 4 Geological Log

Technical Area:	35	PRS No.:	35-003(d,l,q)	Page:	1 of 3
Location ID:	35-2012	Surface Elevation:	7,190 ft	Date:	04-01-94
Core Size:	3.25 in.	Total Depth:	100 ft		
Method:	Hollow-stem auger			Geologist:	Stephen Stellavato
				Field Team Leader:	Stephen Stellavato

Depth in feet	Sample Interval	Sample ID	Moisture (Dry / Wet)	OVA (ppm)	Beta-gamma (cpm)	Lithology	Description
0							
-1				0	240		HUMUS (topsoil): Brown, with roots
-2		AAB0969					SAND with CLAY and TUFF cobbles: dark brown, sandy clay with tuff cobbles
-3					320		
-4							
-5							
-6				0	260		
-7							
-8					140		
-9							
-10							
-11				0	180		
-12							
-13					220		
-14							
-15							
-16				0	200		
-17							
-18					220		
-19							
-20							SAND: dark brown, medium to coarse grain
-21		AAB0971		0	400		
-22							TUFF: gray, non-welded, (70% ash, 20% crystal, 10% pumice), moderate hardness
-23					450		
-24							
-25							
-26		AAB0970		0	550		TUFF: gray, non-welded, (95% ash, 5% crystals), soft
-27							NO RECOVERY
-28					500		TUFF
-29							
-30							NO RECOVERY
-31				0	380		TUFF: gray, non-welded, (70% ash, 20% crystal, 10% pumice)
-32							
-33					280		
-34							
-35		AAB0972					

Field Unit 4 Geological Log

Technical Area:	35	PRS No.:	35-003(d,l,q)	Page:	2 of 3
Location ID:	35-2012	Surface Elevation:	7,190 ft	Date:	04-01-94
Core Size:	3.25 in.	Total Depth:	100 ft	Geologist:	Stephen Stellavato
Method:	Hollow-stem auger			Field Team Leader:	Stephen Stellavato

Depth in feet	Sample Interval	Sample ID	Moisture (Dry / Wet)	OVA (ppm)	Beta-gamma (cpm)	Lithology	Description
-35				0	320		TUFF: gray, non-welded (70% ash, 20% crystsal, 10% pumice)
-36							
-37							
-38					260		
-39							
-40				0	300		
-41							
-42							
-43				0	300		TUFF: decreasing hardness (higher ash content)
-44							TUFF: increasing hardness (lower ash content, ~70%)
-45				0	300		TUFF: decreasing hardness
-46							TUFF: gray, welded, (70% ash, 20% crystsal, 10% pumice)
-47							
-48				0	300		
-49							
-50				0	300		TUFF: gray, non-welded, (90% ash, 5% crystal, 5% clay), clay content increasing
-51							
-52							
-53				0	300		
-54							Fractured TUFF: fracture zones with dark red, soft clay
-55				0	300		TUFF: gray, non-welded, (90% ash, 5% crystal, 5% clay), clay content increasing
-56							
-57							
-58							
-59							
-60							Fractured TUFF: fracture zones with dark red, soft clay
-61				0	300		TUFF: gray, non-welded, (90% ash, 5% crystal, 5% clay), soft
-62							
-63							
-64							
-65				0	300		
-66							CLAY: light olive-gray clay
-67							
-68							NO RECOVERY
-69							
-70							

Field Unit 4 Geological Log

Technical Area:	**35**	PRS No.:	**35-003(d,l,q)**	Page:	**3 of 3**
Location ID:	**35-2012**	Surface Elevation:	**7,190 ft**	Date:	**04-05-94**
Core Size:	**3.25 in.**	Total Depth:	**100 ft**		
Method:	**Hollow-stem auger**			Geologist:	**Stephen Stellavato**
				Field Team Leader:	**Stephen Stellavato**

Depth in feet	Sample Interval	Sample ID	Moisture (Dry / Wet)	OVA (ppm)	Beta-gamma (cpm)	Lithology	Description
-70							
-71				0	300		TUFF: gray, non-welded, (80% ash, 10% crystsal, 10% pumice)
-72							
-73							
-74							TUFF: same as above, increasing amounts of olive-gray clay
-75							
-76				0	300		
-77							
-78							TUFF: light gray, non-welded, (80% ash, 10% crystsal, 5% pumice, 5% olive-gray clay interlaced), soft
-79							
-80							
-81				0	300		
-82							
-83							
-84							
-85							
-86				0	300		
-87							
-88							
-89							
-90							
-91				0	300		
-92							
-93							TUFF: same as above, increasing hardness
-94							
-95							
-96				0	300		TUFF: gray, non-welded, (70% ash, 20% crystsal, 10% pumice), hard and moist
-97							
-98							
-99							
-100		AAB0973					

Field Unit 4 Geological Log

Technical Area:	35	PRS No.:	35-003(d,l,q)	Page:	1 of 3
Location ID:	35-2013	Surface Elevation:	7,171 ft	Date:	04/19/94
Core Size:	3.25 in.	Total Depth:	100 ft	Geologist:	Stephen Stellavato
Method:	Hollow-stem auger			Field Team Leader:	Stephen Stellavato

Depth in feet	Sample Interval	Sample ID	Moisture (Dry / Wet)	OVA (ppm)	Beta-gamma (cpm)	Lithology	Description
0							CLAY with TUFF cobbles: dark brown, sandy, hard
-1							
-2		AAB0981			200		
-3				0			
-4					200		
-5							
-6							
-7					200		
-8				0			
-9					200		
-10							
-11							
-12					200		
-13				0			
-14					200		
-15							
-16		AAB0982 AAB0983			200		TUFF: light gray, non-welded (70% ash, 20% crystals, 10% pumice), hard competent core
-17							
-18				0			
-19					200		
-20							TUFF: light gray, non-welded (70% ash, 20% crystals, 10% pumice), competent core, crumbles easily in hand
-21							
-22							
-23				0	200		
-24							
-25							
-26							
-27					200		
-28				0			
-29					200		
-30							TUFF: as above, decreasing consolidation with depth
-31							
-32					200		
-33				0			
-34					200		
-35		AAB0984					

Field Unit 4 Geological Log

Technical Area:	35	PRS No.:	35-003(d,l,q)	Page:	2 of 3
Location ID:	35-2013	Surface Elevation:	7,171 ft	Date:	04/19/94
Core Size:	3.25 in.	Total Depth:	100 ft		
Method:	Hollow-stem auger			Geologist:	Stephen Stellavato
				Field Team Leader:	Stephen Stellavato

Depth in feet	Sample Interval	Sample ID	Moisture (Dry / Wet)	OVA (ppm)	Beta-gamma (cpm)	Lithology	Description
-35							TUFF: light gray, non-welded (80% ash, 15% crystals, 5% pumice); soft incompetent core, with a few andesitic clasts, some light brown, soft clay
-36							
-37					200		
-38							
-39							
-40					200		
-41							
-42					200		
-43							
-44					200		
-45							Fractured TUFF: light gray, as above, with light brown soft clay in fractures
-46							TUFF: light gray, non-welded (80% ash, 15% crystals, 5% pumice); soft incompetent core, with a few andesitic clasts, some light brown, soft clay
-47					200		
-48							
-49					200		
-50							
-51							
-52					200		
-53							TUFF: light gray, non-welded (75% ash, 20% crystals, 5% pumice), soft incompetent core, some andesitic clasts
-54					200		
-55							
-56							
-57					200		
-58							
-59					200		
-60							TUFF: light pink, non-welded (70% ash, 20% crystals, 10% pumice), soft, increasing hardness with depth
-61							
-62					200		
-63				0			
-64					200		
-65		AAB0985					
-66							
-67					200		
-68				0			
-69					200		
-70							

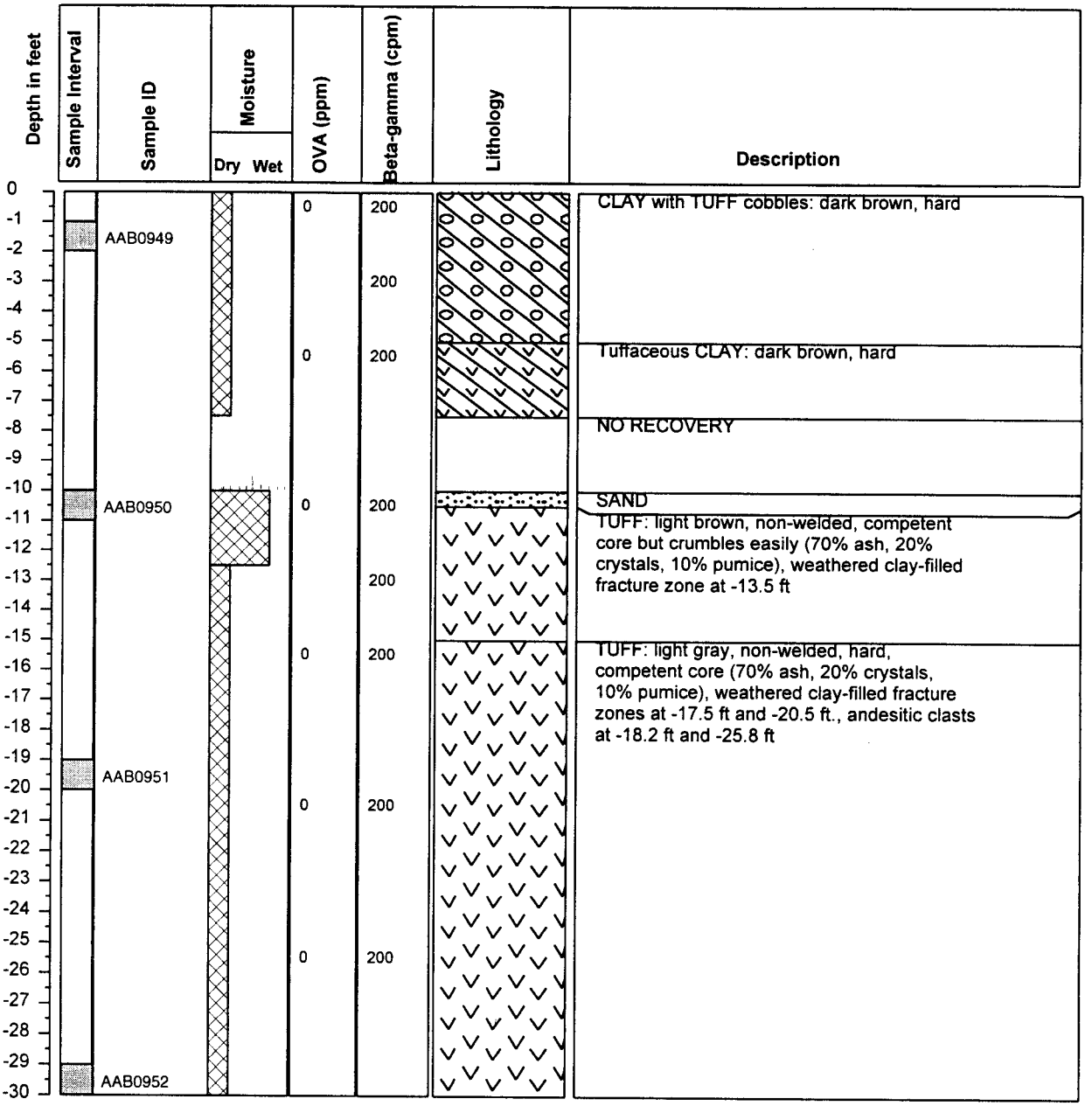
Field Unit 4 Geological Log

Technical Area:	35	PRS No.:	35-003(d,l,q)	Page:	3 of 3
Location ID:	35-2013	Surface Elevation:	7,171 ft	Date:	04/19/94
Core Size:	3.25 in.	Total Depth:	100 ft	Geologist:	Stephen Stellavato
Method:	Hollow-stem auger			Field Team Leader:	Stephen Stellavato

Depth in feet	Sample Interval	Sample ID	Moisture (Dry / Wet)	OVA (ppm)	Beta-gamma (cpm)	Lithology	Description
-70							TUFF: light pink, non-welded (70% ash, 20% crystals, 10% pumice), crumbles easily
-71							
-72					200		
-73				0			
-74					200		Fractured TUFF: large fracture zone filled with dark brown, hard clay
-75							TUFF: light pink, non-welded (70% ash, 20% crystals, 10% pumice), crumbles easily
-76							
-77							TUFF: light pink, non-welded (65% ash, 25% crystals, 10% pumice), hard, very competent core
-78				0	200		
-79							
-80							
-81							
-82							
-83				0	200		
-84							
-85							TUFF: dark pink, welded (40% ash, 45% crystals, 15% pumice), hard, dense; upper contact of Cooling Unit 2
-86							
-87					200		
-88				0			
-89					200		
-90							
-91							
-92					200		
-93				0			
-94					200		
-95							
-96							
-97					200		
-98				0			
-99					200		
-100		AAB0986					

Field Unit 4 Geological Log

Technical Area:	35	PRS No.:	35-003(d,l,q)	Page:	1 of 1
Location ID:	35-2015	Surface Elevation:	7,184 ft	Date:	04-25-94
Core Size:	3.25 in.	Total Depth:	30 ft	Geologist:	Stephen Stellavato
Method:	Hollow-stem auger			Field Team Leader:	Stephen Stellavato



Field Unit 4 Geological Log

Technical Area:	35	PRS No.:	35-003(o)	Page:	1 of 1
Location ID:	35-2016	Surface Elevation:	7,192 ft	Date:	03/16/94
Core Size:	3.25 in.	Total Depth:	30 ft	Geologist:	Stephen Stellavato
Method:	Hollow-stem auger			Field Team Leader:	Stephen Stellavato

Depth in feet	Sample Interval	Sample ID	Moisture (Dry Wet)	OVA (ppm)	Beta-gamma (cpm)	Lithology	Description
0							ASPHALT
-1							SAND and cobbles: light brown, medium grain
-2		AAA6589		0	190		CLAY with TUFF cobbles: light brown
-3							
-4					190		
-5							
-6							NO RECOVERY
-7							CLAY with TUFF cobbles: light brown
-8					190		TUFF: light pink, consolidated
-9		AAA6590		0			
-10							
-11					400		
-12							
-13							
-14		AAA6591		0	3000		Fractured TUFF: filled with dark red clay
-15					1700		TUFF: welded, light pink to light gray
-16							
-17							
-18							TUFF: non-welded, light gray
-19		AAA6592		0	2600		TUFF: welded, light gray
-20					4800 2500		NO RECOVERY
-21							
-22							
-23					1000		TUFF: non-welded, light gray
-24							
-25							NO RECOVERY
-26							
-27							
-28					190		TUFF: non-welded, light gray
-29							
-30		AAA6581		0			

Field Unit 4 Geological Log

Technical Area:	35	PRS No.:	35-003(f,g)	Page:	1 of 1
Location ID:	35-2017	Surface Elevation:	7,192 ft	Date:	03/15/94
Core Size:	3.25 in.	Total Depth:	30 ft		
Method:	Hollow-stem auger			Geologist:	Stephen Stellavato
				Field Team Leader:	Stephen Stellavato

Depth in feet	Sample Interval	Sample ID	Moisture (Dry / Wet)	OVA (ppm)	Beta-gamma (cpm)	Lithology	Description
0							ASPHALT
-1							SAND and GRAVEL: light brown, medium grain
-2		AAA6537		0	170		
-3							CLAY with TUFF cobbles: dark brown clay, dark pink tuff
-4				0	170		TUFF: dark pink
-5							CLAY: dark brown
-6		AAA6538		0	170		TUFF: light pink, consolidated
-7							
-8				0	170		Fractured TUFF: weathered fracure zones with light red, hard clay
-9							
-10							
-11							
-12							TUFF: light pink, consolidated
-13				0	170		
-14							
-15							
-16							
-17							
-18				0	170		
-19							
-20		AAA6539		0	170		
-21							
-22							
-23				0	170		
-24							
-25							Fractured TUFF: light pink, woth weathered fracture zones
-26							
-27							
-28				0	170		
-29		AAA6540					
-30		AAA6573			170		

Field Unit 4 Geological Log

Technical Area: **35**
Location ID: **35-2018**
Core Size: **3.25 in.**
Method: **Hollow-stem auger**

PRS No.: **35-003(m)**
Surface Elevation: **7,192 ft**
Total Depth: **30 ft**

Page: **1 of 1**
Date: **03/28 -29/94**

Geologist: **Stephen Stellavato**
Field Team Leader: **Stephen Stellavato**

Depth in feet	Sample Interval	Sample ID	Moisture (Dry Wet)	OVA (ppm)	Beta-gamma (cpm)	Lithology	Description
0							ASPHALT
-1							SAND: dark brown, medium grain
-2		AAA6633		1.5	207		CLAY with TUFF cobbles: dark brown, soft
-3							
-4				2.0	251		
-5							NO RECOVERY
-6							CLAY with TUFF cobbles: dark brown, soft
-7				1.0	203		
-8							
-9		AAA6634		1.0	1111		
-10							TUFF: dark gray, consolidated; fracture zone with hard red clay at 10.8 ft
-11							
-12				1.0	14000		
-13							
-14							
-15		AAA6635					
-16							Fractured TUFF: dark gray, with red to brown clay in fractures
-17							
-18				0	5000		
-19							
-20							
-21		AAA6636					
-22							
-23				0	700		
-24							TUFF: dark gray
-25							NO RECOVERY
-26							TUFF: dark gray
-27							
-28				0	350		
-29							
-30							

Field Unit 4 Geological Log

Technical Area:	35	PRS No.:	35-003(e)	Page:	1 of 1
Location ID:	35-2019	Surface Elevation:	7,190 ft	Date:	03/24/94
Core Size:	3.25 in.	Total Depth:	30 ft		
Method:	Hollow-stem auger			Geologist:	Stephen Stellavato
				Field Team Leader:	Stephen Stellavato

Depth in feet	Sample Interval	Sample ID	Moisture (Dry Wet)	OVA (ppm)	Beta-gamma (cpm)	Lithology	Description
0							SAND: light brown, with humus and roots
-1							
-2		AAA6521		0	190		SAND with CLAY and TUFF cobbles: light to dark brown
-3							
-4				0	190		
-5							
-6							
-7				0	190		
-8							TUFF: dark gray
-9				0	190		CLAY with TUFF cobbles: dark brown clay, gray tuff
-10							
-11							Tuffaceous CLAY: dark brown, hard clay, gray tuff
-12				0	190		
-13							TUFF: dark pink
-14				0	190		
-15							Tuffaceous CLAY: dark brown clay, gray tuff
-16							NO RECOVERY
-17							Tuffaceous CLAY: dark brown clay, gray tuff
-18				0	190		
-19							
-20		AAA6522		0	190		
-21							TUFF: light gray, consolidated
-22							
-23				0	190		
-24							
-25		AAA6523		0	190		
-26							
-27							
-28				0	190		
-29							
-30		AAA6524		0	190		

Field Unit 4 Geological Log

Technical Area:	35	PRS No.:	35-003(misc)	Page:	1 of 1
Location ID:	35-2020	Surface Elevation:	7,191 ft	Date:	03/30/94
Core Size:	3.25 in.	Total Depth:	30 ft	Geologist:	Stephen Stellavato
Method:	Hollow-stem auger			Field Team Leader:	Stephen Stellavato

Depth in feet	Sample Interval	Sample ID	Moisture (Dry Wet)	OVA (ppm)	Beta-gamma (cpm)	Lithology	Description
0							SAND: dark brown, medium grain, withh some cobbles
-1							CLAY with small cobbles: dark brown, soft
-2		AAA6625		0	380		Tuffaceous CLAY: dark brown, soft
-3							
-4				0	280		
-5							NO RECOVERY
-6							CLAY: dark brown, soft
-7				2.0	320		
-8		AAA6626					SAND: dark brown, medium grain, with plastic and paper
-9				0	525		CLAY: dark brown, soft
-10							TUFF: gray, consolidated, with clay-filled fractures at 10 ft and 18 ft
-11		AAA6627			600		
-12							
-13				0	350		
-14							
-15							
-16							
-17							
-18				0	400		
-19							
-20							TUFF: gray, soft
-21							
-22				0	400		
-23							NO RECOVERY
-24							
-25							TUFF: gray, soft
-26							
-27		AAA6628					
-28		AAA6629		0	260		NO RECOVERY
-29							
-30							

Field Unit 4 Geological Log

Technical Area: **35**
Location ID: **35-2021**
Core Size: **3.25 in.**
Method: **Hand auger**

PRS No.: **35-003(misc)**
Surface Elevation: **7,193 ft**
Total Depth: **10.8 ft**

Page: **1 of 1**
Date: **03/15/94**

Geologist: **Stephen Stellavato**
Field Team Leader: **Stephen Stellavato**

Depth in feet	Sample Interval	Sample ID	Moisture (Dry / Wet)	OVA (ppm)	Beta-gamma (cpm)	Lithology	Description
0							SAND and GRAVEL: dark brown, medium grain
-1							
-2				0	170		CLAY with TUFF cobbles: dark brown
-3				0	170		CLAY with TUFF cobbles: light brown
-4		AAA6574		0	170		SAND: brown, medium grain
-5				0	170		TUFF: light pink
-6				0	170		
-7				0	170		
-8				0	170		
-9				0	170		
-10		AAA6575		0	170		
					170		

Field Unit 4 Geological Log

Technical Area:	35	PRS No.:	35-003(d,l,q)	Page:	1 of 1
Location ID:	35-2022	Surface Elevation:	7,172 ft	Date:	04-07-94
Core Size:	3.25 in.	Total Depth:	30 ft	Geologist:	Stephen Stellavato
Method:	Hollow-stem auger			Field Team Leader:	Stephen Stellavato

Depth in feet	Sample Interval	Sample ID	Moisture (Dry / Wet)	OVA (ppm)	Beta-gamma (cpm)	Lithology	Description
0				0	150		SAND with CLAY and TUFF cobbles: light brown sand, soft clay, cobbles
-1							
-2		AAA6637			280		TUFF: light gray, (70% ash, 20% crystals, 10% pumice), consolidated and hard
-3				0	200		
-4							Fractured TUFF: weathered fracture zones with light red clay and roots
-5							TUFF: same as above
-6				0	170		Fractured TUFF: weathered fracture zones with light red clay and roots
-7							TUFF: light gray, (70% ash, 20% crystals, 10% pumice), consolidated and hard
-8							
-9							Fractured TUFF
-10				0	200		TUFF: light gray, (70% ash, 20% crystals, 10% pumice), consolidated and hard
-11							
-12							
-13							
-14							
-15				0	170		TUFF: light gray, (70% ash, 20% crystals, 10% pumice), consolidated, interlaced zones of light gray tuff (90% ash 10% crystals), soft
-16							
-17							
-18							
-19		AAA6638			200		
-20				0	250		
-21							
-22		AAA6639			250		Fractured TUFF: large weathered fracture zone with light red, soft clay and roots
-23							TUFF: light gray, (70% ash, 20% crystals, 10% pumice), consolidated, interlaced zones of light gray tuff (90% ash 10% crystals), soft
-24							
-25				0	200		
-26							
-27							
-28							
-29							
-30		AAA6640			170		

Field Unit 4 Geological Log

Technical Area:	35	PRS No.:	35-003(misc)	Page:	1 of 1
Location ID:	35-2024	Surface Elevation:	7,191 ft	Date:	03/21/94
Core Size:	3.25 in.	Total Depth:	30 ft		
Method:	Hollow-stem auger			Geologist:	Stephen Stellavato
				Field Team Leader:	Stephen Stellavato

Depth in feet	Sample Interval	Sample ID	Moisture (Dry / Wet)	OVA (ppm)	Beta-gamma (cpm)	Lithology	Description
0							ASPHALT
-1							SAND and cobbles: dark brown, medium grain
-2		AAA6601		0	190		
-3							Tuffaceous CLAY: dark gray, wet
-4					190		NO RECOVERY
-5							Tuffaceous SAND: dark gray, wet
-6							Tuffaceous CLAY: red to light gray, wet
-7					190		Tuffaceous SAND: with cobbles, light gray
-8					190		CLAY: dark red, hard
-9							Tuffaceous SAND: light brown
-10					250		
-11					300		
-12					400		
-13							Tuffaceous SAND: light gray
-14							
-15		AAA6602		0	450		
-16					1000		
-17							
-18					300		
-19							TUFF: light gray, consolidated
-20							
-21					190		NO RECOVERY
-22							
-23							
-24					190		Fractured TUFF: light gray, with dark red clay in fractures
-25		AAA6603		0			
-26							TUFF: light gray, consolidated
-27							
-28					190		Fractured TUFF: large fracture zone filled with dark red clay
-29							
-30		AAA6604		0			

Field Unit 4 Geological Log

Technical Area:	35	PRS No.:	35-003(misc)	Page:	1 of 1
Location ID:	35-2025	Surface Elevation:	7,186 ft	Date:	03/24/94
Core Size:	2.5 in. / 3.25 in.	Total Depth:	30 ft	Geologist:	Stephen Stellavato
Method:	Hollow-stem auger			Field Team Leader:	Stephen Stellavato

Depth in feet	Sample Interval	Sample ID	Moisture (Dry / Wet)	OVA (ppm)	Beta-gamma (cpm)	Lithology	Description
0							SAND with CLAY and angular cobbles: light brown, medium grain, soft clay
-1							
-2		AAA6613			240		Tuffaceous SAND: light gray, some cobbles
-3				0	190		Tuffaceous SAND: light gray, large root at 10.5 ft
-4				0	190		
-5							
-6				0	190		
-7					190		
-8				0			
-9							
-10		AAA6614		0	190		
-11							
-12		AAA6615		0	700		TUFF: light gray
-13							NO RECOVERY
-14				0	250		Tuffaceous SAND: light brown, with roots
-15							TUFF: light pink, consolidated
-16							
-17							
-18				0	190		
-19							
-20							
-21							NO RECOVERY
-22							
-23				0	190		TUFF: light pink, unconsolidated
-24							
-25							NO RECOVERY
-26							
-27					400		TUFF: light pink, unconsolidated
-28		AAA6616		0	450		
-29							NO RECOVERY
-30							

Field Unit 4 Geological Log

Technical Area:	35	PRS No.:	35-003(misc)	Page:	1 of 3
Location ID:	35-2026	Surface Elevation:	7,183 ft	Date:	04/19/94
Core Size:	3.25 in.	Total Depth:	30 ft		
Method:	Hollow-stem auger			Geologist:	Stephen Stellavato
				Field Team Leader:	Stephen Stellavato

Depth in feet	Sample Interval	Sample ID	Moisture (Dry / Wet)	OVA (ppm)	Beta-gamma (cpm)	Lithology	Description
0							SAND: light brown, medium grain, with roots
-1							CLAY with TUFF cobbles: dark brown, hard
-2					200		
-3		AAA6617		0	700		
-4					500		
-5					300		
-6							TUFF: light gray, non-welded (65% ash, 25% crystals, 10% pumice); hard, competent core; fracture zone filled with light brown, soft clay at 8.5 ft
-7					200		
-8				0			
-9					200		
-10		AAA6618					
-11							
-12							
-13				0	200		
-14							
-15							
-16							TUFF: light gray, non-welded, soft (80% ash, 20% crystals)
-17							TUFF: light gray, non-welded (70% ash, 20% crystals, 10% pumice), hard competent core
-18				0	200		
-19							NO RECOVERY
-20							
-21							TUFF: light gray, non-welded, soft (80% ash, 20% crystals)
-22					200		TUFF: light gray, non-welded (70% ash, 20% crystals, 10% pumice), hard competent core
-23				0			
-24					200		TUFF: light gray, non-welded, soft (80% ash, 20% crystals)
-25		AAA6619					
-26							
-27					200		
-28				0			TUFF: light gray, non-welded (70% ash, 20% crystals, 10% pumice), hard competent core
-29		AAA-6620			200		TUFF: light gray, non-welded, soft (80% ash, 20% crystals)
-30							NO RECOVERY

Field Unit 4 Geological Log

Technical Area:	35	PRS No.:	35-003(r)	Page:	1 of 9
Location ID:	35-2028	Surface Elevation:	7,103 ft	Date:	10-31-94
Core Size:	3.25 in.	Total Depth:	299 ft	Geologist:	Stephen Stellavato
Method:	Hollow-stem auger			Field Team Leader:	Stephen Stellavato

Depth in feet	Sample Interval	Sample ID	Moisture (Dry / Wet)	OVA (ppm)	Beta-gamma (cpm)	Lithology	Description
0							
-1		AAB4282		0	500		Tuffaceous SAND: Light brown, medium to fine tuffaceous sand, some tuff cobbles and roots
-2							NO RECOVERY
-3					1000		Tuffaceous SAND: Same as above
-4							
-5							Fractured TUFF: Dark red fracture zones with small roots
-6				0	1000		TUFF: Dark grey, consolidated with red staining
-7		AAB4283					Fractured TUFF
-8					600		TUFF: Dark grey, consolidated
-9							CLAY: Light brown,sandy
-10					250		TUFF: Light gray, non-welded, (40% crystals, 40% ash, 20% pumice) consolidated, competant core
-11				0	300		
-12							
-13					250		TUFF: Ash content increasing, core less competant
-14		0435-95-0208					
-15		AAB4284		0	250		
-16							
-17							
-18							
-19							
-20				0	250		TUFF: Light gray, (40% crystals, 40% ash, 20% pumice), consolidation increasing
-21							
-22							TUFF: Light pink, consolidated, (50% crystal, 30% ash, 20% pumice), very hard core
-23							
-24							
-25		AAB4285		0	200		TUFF: Dark pink,welded, (60% crystal, 30% ash, 10% pumice), very consolidated, competent core, upper contact of Cooling Unit 2
-26							
-27							
-28					270		
-29							
-30							
-31				0	200		
-32							
-33					250		
-34							
-35							

Field Unit 4 Geological Log

Technical Area:	35	PRS No.:	35-003(r)	Page:	2 of 9
Location ID:	35-2028	Surface Elevation:	7,103 ft	Date:	11-01-94
Core Size:	3.25 in.	Total Depth:	299 ft		
Method:	Hollow-stem auger			Geologist:	Stephen Stellavato
				Field Team Leader:	Stephen Stellavato

Depth in feet	Sample Interval	Sample ID	Moisture (Dry / Wet)	OVA (ppm)	Beta-gamma (cpm)	Lithology	Description
-35							
-36		AAB4286		0	230		TUFF: Dark pink, welded, (60% crystals, 20% ash, 20% pumice)
-37							NO RECOVERY: Believed to be very soft material
-38							TUFF: Dark pink, welded, (60% crystals, 20% ash, 20% pumice)
-39							
-40							
-41				0	250		
-42							
-43					300		
-44							
-45		AAB4287					
-46				0	250		
-47							
-48					250		
-49							
-50							
-51				0	250		
-52							
-53		0435-95-0209			250		
-54							
-55		XAAB4219					
-56				0	250		
-57							
-58					270		
-59							
-60							
-61				0	250		
-62							
-63							
-64							
-65							
-66				0	270		
-67							
-68							Fractured TUFF: Weathered fracture zones with dark red clay
-69		XAAB4220					
-70							NO RECOVERY

Field Unit 4 Geological Log

Technical Area:	35	PRS No.:	35-003(r)	Page:	3 of 9
Location ID:	35-2028	Surface Elevation:	7,103 ft	Date:	11-01-94
Core Size:	3.25 in.	Total Depth:	299 ft	Geologist:	Stephen Stellavato
Method:	Hollow-stem auger			Field Team Leader:	Stephen Stellavato

Depth in feet	Sample Interval	Sample ID	Moisture (Dry / Wet)	OVA (ppm)	Beta-gamma (cpm)	Lithology	Description
-70				0	280		Fractured TUFF: weathered fracture zone with dark red clay
-71							TUFF: Light pink, welded, (60% crystals, 20% ash, 20% pumice), very hard, competent core
-72							
-73							
-74							
-75				0	300		
-76							
-77							
-78							
-79							
-80		XAAB4221		0	280		
-81							
-82							
-83							
-84							
-85				0	300		
-86							
-87							
-88							
-89							
-90		XAAB4222		0	250		TUFF: Light pink, non-welded, (40% crystals, 40% ash, 20% pumice), soft, incompetent core
-91							
-92							
-93							NO RECOVERY
-94							
-95				0	250		TUFF: Light pink, non-welded, (40% crystals, 40% ash, 20% pumice), soft, incompetent core
-96							
-97							
-98							
-99							
-100		XAAB4223					

Field Unit 4 Geological Log

Technical Area: **35**
Location ID: **35-2028**
Core Size: **3.25 in.**
Method: **Hollow-stem auger**

PRS No.: **35-003(r)**
Surface Elevation: **7,103 ft**
Total Depth: **299 ft**

Page: **4 of 9**
Date: **11-02-94**

Geologist: **Stephen Stellavato**
Field Team Leader: **Stephen Stellavato**

Depth in feet	Sample Interval	Sample ID	Moisture (Dry / Wet)	OVA (ppm)	Beta-gamma (cpm)	Lithology	Description
-100							
-101				0	250		TUFF: Light pink, non-welded, (40% ash, 40% crystals, 20% pumice), soft, incompetent core.
-102							
-103					200		
-104							
-105							
-106				0	250		TUFF: Light pink, non-welded, (60% ash, 30% crystals, 10% pumice), very soft, incompetent core, crumbles easily
-107							
-108					250		
-109							
-110		AAB4226					
-111				0	250		TUFF: Same as above with friable sections
-112							
-113					250		NO RECOVERY
-114							TUFF: Light pink, non-welded, (40% ash, 40% crystals, 20% pumice), soft, incompetent core.
-115							
-116				0	250		
-117							
-118					250		
-119							
-120		AAB4227					
-121				0	250		
-122							
-123					250		
-124							
-125							
-126				0	250		
-127							
-128					250		
-129							
-130		XAAB4228					
-131				0	270		
-132							
-133		0435-95-0206			350		NO RECOVERY
-134		XAAB4229					TUFF: Same as above
-135							NO RECOVERY

Field Unit 4 Geological Log

Technical Area: **35**
Location ID: **35-2028**
Core Size: **3.25 in.**
Method: **Hollow-stem auger**

PRS No.: **35-003(r)**
Surface Elevation: **7,103 ft**
Total Depth: **299 ft**

Page: **5 of 9**
Date: **11-02-94**

Geologist: **Stephen Stellavato**
Field Team Leader: **Stephen Stellavato**

Depth in feet	Sample Interval	Sample ID	Moisture (Dry / Wet)	OVA (ppm)	Beta-gamma (cpm)	Lithology	Description
-135				0	300		TUFF: Light red, non-welded, (60% ash, 30% crystals, 10% pumice), interspersed xenoliths, crumbles easily
-136							
-137							
-138					300		
-139							
-140				0	280		TUFF: Light red-pink, non-welded, (60% ash, 30% crystals, 10% pumice), interspersed xenoliths, soft, incompetent core
-141							
-142							
-143					250		TUFF: Same as above, but light red in color
-144							
-145							NO RECOVERY
-146				0	210		TUFF: Reddish-brown, non-welded, (60% ash, 30% crystals, 10% pumice), interspersed xenoliths, soft
-147							NO RECOVERY
-148					225		TUFF: Same as above
-149							
-150		AAB4231					NO RECOVERY
-151				0	250		TUFF: Same as above
-152							
-153					250		
-154							
-155				0	250		TUFF: Reddish-brown, non-welded, (60% ash, 30% crystals, 10% pumice) , interspersed xenoliths, soft
-156							
-157							
-158					250		
-159							
-160		XAAB4235		0	250		TUFF: Reddish-brown, non-welded, (60% ash, 30% crystals, 10% pumice), soft
-161							
-162							
-163					250		
-164							
-165				0	250		
-166							
-167							
-168					300		
-169							
-170		XAAB4236					

Field Unit 4 Geological Log

Technical Area: **35**
Location ID: **35-2028**
Core Size: **3.25 in.**
Method: **Hollow-stem auger**

PRS No.: **35-003(r)**
Surface Elevation: **7,103 ft**
Total Depth: **299 ft**

Page: **6 of 9**
Date: **11-03-94**

Geologist: **Stephen Stellavato**
Field Team Leader: **Stephen Stellavato**

Depth in feet	Sample Interval	Sample ID	Moisture (Dry / Wet)	OVA (ppm)	Beta-gamma (cpm)	Lithology	Description
-170							
-171				0	250		TUFF: Reddish-brown, non-welded, (60% ash, 30% crystals, 10% pumice), soft
-172							
-173					250		
-174							
-175							
-176				0	250		TUFF: Light red-brown, non-welded, (25% crystals, 60 % ash, 10% pumice), soft, incompetent core, interspersed andesitic fragments
-177							
-178					250		
-179							
-180		XAAB4237					
-181				0	250		
-182							
-183					270		
-184							
-185							
-186				0	280		TUFF: Light red-gray, non-welded, (25% crystals, 60 % ash, 10% pumice), soft, incompetent core
-187							
-188					260		
-189							
-190		XAAB4238					
-191				0	250		TUFF: Gray, non-welded, (30% crystals, 60% ash, 10% pumice), soft, incompetent core
-192							
-193					280		
-194							
-195							
-196				0	280		
-197							
-198					250		
-199							
-200		XAAB4239					

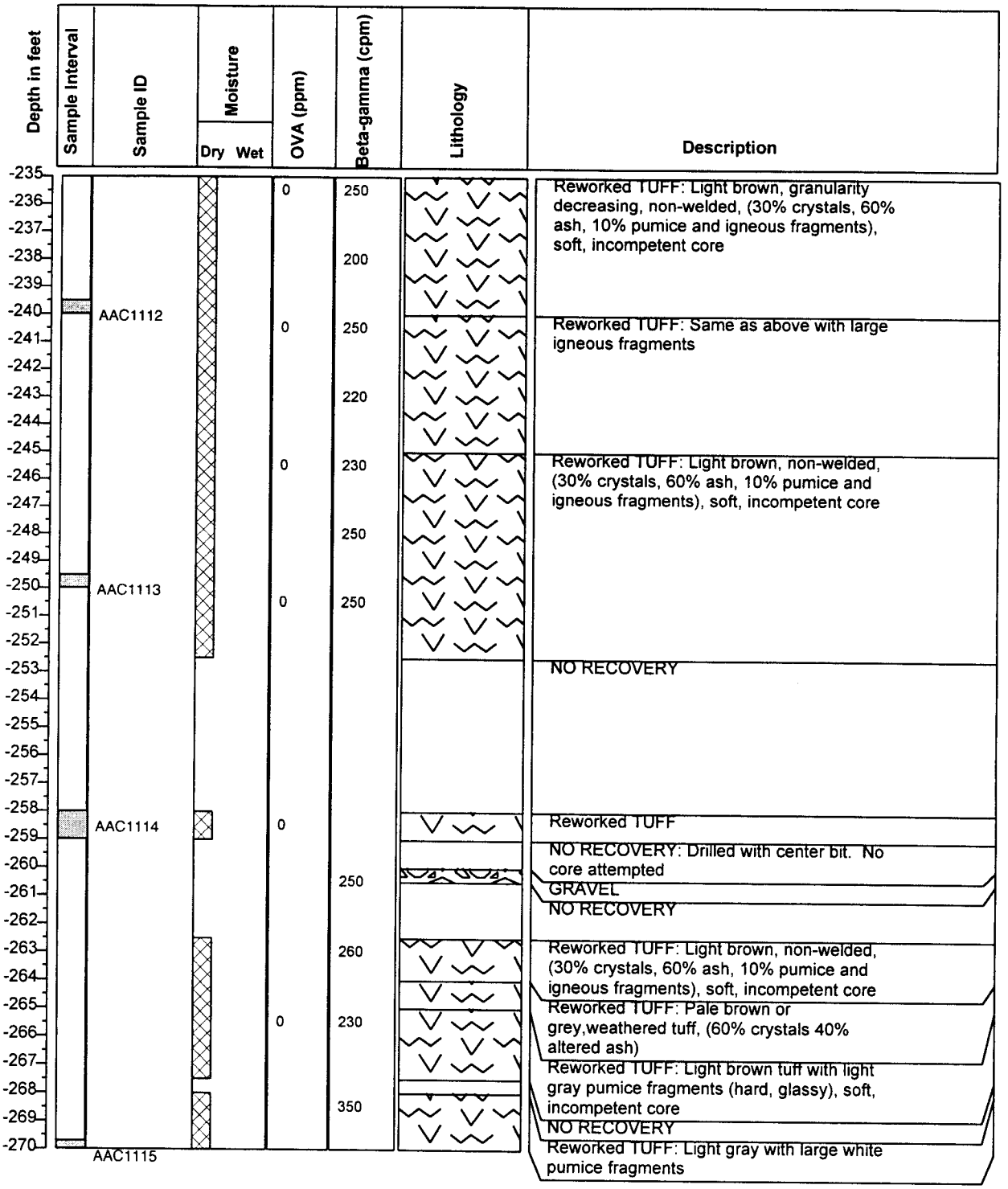
Field Unit 4 Geological Log

Technical Area:	35	PRS No.:	35-003(r)	Page:	7 of 9
Location ID:	35-2028	Surface Elevation:	7,103 ft	Date:	11-03-94
Core Size:	3.25 in.	Total Depth:	299 ft	Geologist:	Stephen Stellavato
Method:	Hollow-stem auger			Field Team Leader:	Stephen Stellavato

Depth in feet	Sample Interval	Sample ID	Moisture (Dry / Wet)	OVA (ppm)	Beta-gamma (cpm)	Lithology	Description
-200				0	230		TUFF: Gray, non-welded, (30% crystals, 60% ash, 10% pumice), soft, incompetent core
-201							
-202							
-203					200		
-204							
-205				0	250		
-206							
-207							
-208					250		
-209							
-210		AAC1109		0	280		TUFF: LIGHT Gray, non-welded, (20% crystals, 65% ash, 15% pumice), soft, incompetent core
-211							
-212							
-213					260		
-214							
-215				0	280		
-216							
-217							
-218					280		TUFF: Light gray, granular, non-welded (30% crystals, 60% ash, 10% igneous fragments) soft, incompetent core
-219							
-220		AAC1110		0	250		TUFF: Light red, granular, non-welded (30% crystals, 60% ash, 10% igneous fragments)
-221							
-222							
-223					250		
-224							
-225				0	200		TUFF: Red, non-welded, (30% crystals, 65% ash, 5% pumice and igneous fragments), soft, incompetent core
-226							
-227							
-228					250		
-229							
-230		AAC1111		0	190		Reworked TUFF: Red, non-welded, (30% crystals, 65% ash, 5% pumice and igneous fragments), soft, incompetent core
-231							
-232							
-233					190		Reworked TUFF: Light brown, granular, non-welded, (30% crystals, 60% ash, 10% pumice and igneous fragments), soft, incompetent core
-234							
-235							

Field Unit 4 Geological Log

Technical Area:	35	PRS No.:	35-003(r)	Page:	8 of 9
Location ID:	35-2028	Surface Elevation:	7,103 ft	Date:	11-04-94
Core Size:	3.25 in.	Total Depth:	299 ft	Geologist:	Stellavato / Koch
Method:	Hollow-stem auger			Field Team Leader:	Stellavato / Koch



Field Unit 4 Geological Log

Technical Area:	35	PRS No.:	35-003(r)	Page:	9 of 9
Location ID:	35-2028	Surface Elevation:	7,103 ft	Date:	11-07-94
Core Size:	3.25 in.	Total Depth:	299 ft	Geologist:	Richard Koch
Method:	Hollow-stem auger			Field Team Leader:	Richard Koch

Depth in feet	Sample Interval	Sample ID	Moisture (Dry / Wet)	OVA (ppm)	Beta-gamma (cpm)	Lithology	Description
-270				0	250		Reworked TUFF: Light gray with large white pumice fragments
-271							
-272							Reworked TUFF: Brown clay altered tuff,. layered weathering, crystal,ash, pumice fragments, and angular tuff fragments in graded and bedded layers. Color variations from light gray to moderately brown
-273					250		
-274							
-275				0	250		Reworked TUFF: Light gray-brown, altered tuff
-276							
-277							
-278					250		Reworked TUFF: Light brown
-279							
-280		AAC1116		0	250		Reworked TUFF: Light gray, alternating banding of red-brown weathered zones and altered pumice
-281							
-282							Reworked TUFF: Light brown to red-brown sticky, altered tuff
-283					200		
-284							
-285				0	250		Reworked TUFF: Light gray (salt and pepper), (70% crystals, 15% feldspar, 10 %pumice, ~5% Fe-Mg fragments)
-286							
-287							
-288					250		
-289							
-290		AAC1117		0	250		
-291							
-292							
-293					300		
-294							Reworked TUFF: Light gray, well sorted, (80-90% crystals, 10-15% ash, 5% dark volcanic lithics)
-295				0	380		
-296							Reworked TUFF: Light gray, well sorted
-297							PUMICE
-298					300		Reworked TUFF: Light brown, (80% feldspar, 10% crystals,10% pumice)
-299		XAAB4273					

Field Unit 4 Geological Log

Technical Area: **35**
Location ID: **35-2215**
Core Size: **3.25 in.**
Method: **Hollow-stem auger**

PRS No.: **35-003(misc)**
Surface Elevation: **7,193 ft**
Total Depth: **30 ft**

Page: **1 of 1**
Date: **03/30/94**

Geologist: **Stephen Stellavato**
Field Team Leader: **Stephen Stellavato**

Depth in feet	Sample Interval	Sample ID	Moisture (Dry / Wet)	OVA (ppm)	Beta-gamma (cpm)	Lithology	Description
0							ASPHALT
-1							SAND and cobbles: light brown, medium grain, angular cobbles
-2		AAB1009 AAB1010		0.2	300		Tuffaceous CLAY: dark brown, soft, gray tuff
-3							
-4				0.5	260		
-5							
-6		AAB1011					
-7							
-8				0.5	500		TUFF: gray, consolidated
-9							
-10							
-11							
-12							
-13				0.5	320		
-14							
-15							NO RECOVERY
-16							TUFF: gray, soft
-17							
-18				0.5	300		TUFF: gray, consolidated
-19							
-20							
-21							TUFF: gray, soft
-22		AAB1012					
-23				0.5	220		
-24							NO RECOVERY
-25							
-26							
-27							TUFF: gray, soft
-28				0.5	260		
-29		AAB1013					
-30							NO RECOVERY

Attachment III

Orthophotographic Maps for Sampling and Analysis Plans

additive effects is not identified for this class of chemical. Because only one chemical carcinogen, chromium, was identified as a COPC in Sections 5.4.5 and 5.4.6, an MCE calculation for chemical carcinogens was not performed. The screening assessment for chemical carcinogens is presented in Table 5.4.7-1. Sample results that exceeded SAL values are highlighted with black. The location of chromium above its hexavalent SAL value is shown in Figure 5.4.5-1.

All the COPCs identified in Section 5.4.5 have soil SALs for comparison except thorium. Thorium was measured above its XRF UTL value in only one of five samples, and at a concentration just 5% higher than the UTL. The distribution of thorium at this PRS does not differ significantly from the background level, as shown in Figure AI-14 in Attachment I of this RFI report. The only detected analyte for which neither a UTL nor a SAL value is available is titanium. Titanium is widely used as a food and cosmetics additive to whiten a product. It is generally considered to be physiologically inert in its common form as titanium dioxide (Amdur et al. 1991, 53961).

TABLE 5.4.7-1

PRS No. 35-016(g) CHEMICAL CARCINOGENS WITH CONCENTRATIONS* THAT EXCEED SALs

Location ID	Sample ID	Depth (ft)	Cr
SAL	N/A	N/A	30
35-2157	AAC1190	0-1	107
35-2157	AAC1191	1-2	99.5
35-2157	AAC1192	2-3	88.1

*mg/kg

5.4.7.2 Risk Assessment

A quantitative human health risk assessment was not performed for this PRS because additional data are required to define the nature and extent of contamination, as described in Section 5.4.7.2.1.

5.4.7.2.1 Review of Chemicals of Potential Concern and Extent of Contamination

Chromium, as hexavalent chromium, was the only COPC identified in the screening assessment. Chromium was identified as a COPC in three tuff samples in a 3-ft hand-auger hole on the mesa edge where NPDES outfall 04A-127 currently discharges. Saturated hydrocarbons and unknown organic compounds were reported in a soil sample collected adjacent to the discharge flow.

Additional data are required to determine the nature and extent of contamination at these PRSs. Because chromium was apparently released in a liquid form, contamination could conceivably have traveled a considerable distance from the point of discharge. Furthermore, the sample locations chosen for the Phase I sampling may have lower contaminant concentrations than areas of sediment accumulation farther down the discharge drainage. Field surveys have revealed the presence of natural sediment traps between the point of discharge and the main channel of Mortandad Canyon.

5.4.8 Preliminary Ecological Assessment

The general landscape condition around this PRS is moderately disturbed, and a high potential exists for receptors to come in contact with chemicals above background levels associated with the site (chromium, nickel, thorium, uranium, and zinc) (see Table 2.4-1 in Chapter 2.0 of this RFI report). Therefore, this PRS will be

included as a potential contaminant source in the ecological risk assessment. An ecological risk assessment will be conducted when that approach has been approved by the regulators. Threatened and endangered species and/or sensitive habitat listed in Chapter 2.0 of this RFI report will be evaluated in the ecological risk assessment.

5.4.9 Conclusions and Recommendations

The objective of the Phase I RFI for PRS No. 35-016(g) was to determine the presence or absence of contamination associated with outfall 04A-127. Chromium was identified as a COPC in the screening assessment.

One 3-ft hand-auger hole was drilled, and one surface soil sample was collected at the point of discharge for the outfall. Chromium was measured at concentrations exceeding the SAL for hexavalent chromium in all three samples in the hand-auger hole.

Further sampling is recommended to determine the nature and extent of chromium contamination identified in laboratory analyses associated with the Phase I RFI. The objectives of the further sampling, including specific sample locations and analytical suites, are identified in the SAP in Section 5.4.10.

5.4.10 Sampling and Analysis Plan for PRS Nos. 35-016(g and h)

Because areas of contaminant accumulation for PRS No. 35-016(g) overlap with PRS No. 35-016(h) and because of their geographical proximity, the sampling activities for these PRSs will be conducted as a combined event. Therefore, one SAP has been written for PRS Nos. 35-016(g and h).

5.4.10.1 Problem Definition

The Phase I data for PRS Nos. 35-016(g and h) are insufficient to determine the nature and extent of contamination associated with historical activities at these PRSs and, therefore, to guide the selection of interim or remedial actions or countermeasures that may be necessary. The description, history, and the results of previous investigations at these PRSs are presented in subsections 1 through 3 of Sections 5.4 and 5.5. Evaluations of Phase I data and conclusions based on these evaluations are presented in subsections 4 through 9 of Sections 5.4 and 5.5. Phase I sample locations for PRS No. 35-016(g) are shown in Figure 5.4.4-1 and for PRS No. 35-016(h) are shown in Figure 5.5.4-1.

Further investigations are intended to provide additional information regarding the nature and extent of environmental contamination to support decisions about future interim or remedial actions. At PRS Nos. 35-016(g and h), the potential interim or remedial actions include the following.

- Engineering controls to prevent the migration of surficial or buried contamination from the drainage of PRS No. 35-016(g) and/or the outwash deposit associated with PRS No. 35-016(h) into the accessible environment (Mortandad Canyon in particular). This alternative could be proposed if surface contamination is being mobilized by outfall discharge or storm events or if buried sources of contamination are being mobilized by infiltration or are in danger of being exposed by erosional processes.

- Removal of subsurface contamination if the inventory of long-lived radionuclides or hazardous chemicals is large and their migration to the accessible environment is possible.

- No further action if quantities of surficial or subsurface radionuclides and/or hazardous chemicals are sufficiently small that they would not present a serious risk to human health or the environment even if exposure were to occur under a reasonable worst-case scenario, or if the likely benefits of remedial activities are outweighed by economic or ecological costs.

Further investigations will focus on the outfall drainage associated with PRS No. 35-016(g) and an outwash deposit that may contain historical contamination associated with PRS No.35-016(h). These areas are shown in Figure AIII-3 in Attachment III of this RFI report. The investigation of PRS Nos. 35-016(g and h) will address the following questions.

- What is the spatial distribution and approximate inventory of radionuclides and hazardous chemicals present in surface and subsurface soils?

  Phase I data at PRS No. 35-016(g) revealed the presence of chromium and other metals at concentrations significantly elevated above background levels. In Section 5.4.7.1, chromium in particular was identified as a human health COPC. Sample locations for Phase I data are on the mesa edge at the point of discharge for the outfall. These chemicals were likely released in a liquid medium and may have been carried with discharge water down the drainage into Mortandad Canyon. Areas of sediment accumulation at the base of the mesa were observed to be moist during field surveys and support vegetation such as cattails that indicate saturated or near-saturated soils. Contaminant concentrations and inventories may be greater in these areas than was observed in Phase I data on the mesa edge. This area of Mortandad Canyon is accessible for recreational activities such as walking and bicycling by Laboratory employees and members of the general public. Therefore, contaminant data from these areas on the canyon floor may be used for screening-level risk calculations to determine if interim or remedial actions are necessary at this time. Additionally, these data will be incorporated into the broader canyons assessment (LANL 1995, 50290), which uses exposure scenarios and pathways beyond the scope of an assessment for these individual PRSs.

  Phase I data for PRS No. 35-016(h) were insufficient to determine the nature and extent of potential contamination associated with this PRS. As described in Section 5.5.7.2.1, the Phase I data provide information on levels of contamination associated with parking lot drainage sediments deposited by recent storm events. However, these data do not provide information associated with historical contamination from parking lot runoff nor do they provide information on soil contamination related to discharge from the water deionization unit outfall. Samples collected at the outwash deposit shown in Figure AIII-3 in Attachment III of this RFI report are intended to provide data associated with past storm water runoff from parking areas and hillsides in the area of TA-35-213. Additionally, if the location of the water deionization unit discharge cannot be conclusively determined by a review of archival information, residual contamination associated with the discharge should be identified by sampling both the PRS No. 35-016(g) drainage and the outwash deposit because these are the two primary areas of sediment accumulation below TA-35-213.

- What is the oxidation state of chromium in surface and subsurface soils at PRS No. 35-016(g)?

  The work plan indicates that the outfall associated with PRS No. 35-016(g) has discharged cooling tower blowdown water (LANL 1992, 7666). As discussed in Section 5.4.7.1, it is likely that this chromium was released as hexavelent chromium, which is a known human carcinogen via the inhalation route of exposure. Although hexavalent chromium is generally expected to be reduced to its trivalent oxidation state (which is noncarcinogenic) in the soil environment, the rate of this process depends on the specific chromium compound released as well as site-specific geochemical characteristics of the soil. Therefore, information regarding the oxidation state of chromium at this PRS is a necessary part of evaluating potential human health impacts.

5.4.10.2 Sampling and Analysis Plan Design

Sampling for PRS Nos. 35-016(g and h) will include sampling and analysis of surface and subsurface soils collected from areas of sediment accumulation on the mesa edge, hillside, and bench below TA-35-213. Five sampling locations have been identified for the investigation. These locations are shown in Figure AIII-3 in Attachment III of this RFI report.

5.4.10.2.1 Target Analytes

Fixed-site laboratory analyses for the following constituents will be performed on all samples: SVOCs, radionuclides (by gamma spectroscopy), tritium, and inorganic chemicals. In addition, gross-alpha, -beta, and -gamma radiation will be measured for each sample. At sampling locations 1 through 4, analysis for hexavalent chromium will be performed to measure the relative abundance of the hexavalent and trivalent oxidation states. Field screening measurements for gross radioactivity and organic vapors will also be performed for each sample. The target analytes and measurement methods are described in detail in Section 5.4.10.3.

SVOCs will be analyzed because of the presence of undifferentiated hydrocarbons and reported matrix effects in several Phase I samples. Areas of sediment accumulation targeted for sample collection in further sampling activities tend to act as sinks for higher molecular weight organic constituents. Organic chemicals are generally hydrophobic or have low solubility in water; therefore, they adsorb onto the particulate matter that is deposited in sediment traps. VOCs will not be evaluated in the investigation because no VOCs were identified during the Phase I RFI. VOCs are generally not persistent contaminants in surface water and surface soil and therefore are not expected to be present at these PRSs.

For reasons described in Section 4.3 of Chapter 4.0 of this RFI report, gamma spectroscopy data obtained for these PRSs are currently not available. Data for tritium, a suspected contaminant at these PRSs based on information provided in the work plan (LANL 1992, 7666), are also unavailable. Because the presence or absence of these radionuclides was not confirmed in the Phase I RFI, data for these radionuclides will be collected and evaluated during further investigation.

Several inorganic chemicals were measured above background levels at PRS Nos. 35-016(g and h), and chromium has been identified as a risk-based COPC. For reasons summarized in Sections 5.4.7.2.1 and 5.5.7.2.1, additional data for inorganic chemicals are required to determine if remedial actions are necessary. Because hexavalent chromium is associated solely with PRS No. 35-016(g), analysis for hexavalent chromium will not be performed at PRS No. 35-016(h).

Laboratory measurements of gross-alpha, -beta, and -gamma radiation will be performed rather than analysis of specific alpha- and beta-emitting radionuclides. Alpha- and beta-emitting radionuclides that are not included as gamma spectroscopy analytes are not suspected at these PRSs. The gross radioactivity measurements are less costly and time-consuming than isotope-specific analyses. As described in Section 5.4.10.3.2, if elevated levels of gross-alpha or -beta radiation are detected, isotopic analyses will be performed for these radionuclides. Similarly, laboratory VOC analyses will be performed if field screening indicates the presence of organic vapors in collected samples.

5.4.10.2.2 Sampling Strategy and Rationale

The number of samples to be collected and their specific locations and depths are described in this section. A summary of these samples is provided in Table 5.4.10-1; sample locations are shown in Figure AIII-3 in Attachment III of this RFI report.

Sampling Location 1: PRS No. 35-016(g) Active Drainage Channel at Discharge Point

One tuff sample will be collected in the active discharge channel immediately adjacent to the Phase I hand-auger hole for the primary purpose of determining the oxidation state of chromium. A shallow hole will be drilled

TABLE 5.4.10-1

SAMPLING SUMMARY FOR PRS Nos. 35-016(g and h)

Sampling Area	Location ID No.	Matrix	Planned Depth (ft)	Analytical Suites					
				Metals	Hexavalent Chromium	SVOC	Gross $-\alpha$, $-\beta$, $-\gamma$	Tritium	Gamma Spectroscopy
PRS No. 35-016(g) active drainage channel at discharge point	35-2386-A1	Tuff	0–1	1	1	1	1	1	1
	35-2387-A1	Sediment	0–0.5	1	1	1	1	1	1
	35-2387-A2	Sediment	0.5–1	1	1	1	1	1	1
	35-2387-A3	Sediment	1–1.5	1	1	1	1	1	1
PRS No. 35-016(g) active drainage channel above roadway	35-2388-S1	Sediment	0–0.5	1	1	1	1	1	1
	35-2389-S1	Sediment	0–0.5	1	1	1	1	1	1
PRS No. 35-016(g) former drainage channel; upper cattails area	35-2390-B1	Sediment	0–1	1	1	1	1	1	1
	35-2390-B2	Sediment	Biased	1	1	1	1	1	1
	35-2390-B3	Sediment	Biased	1	1	1	1	1	1
	35-2390-B4	Tuff	0–1*	1	1	1	1	1	1
PRS No. 35-016(g) former drainage channel; lower cattails area	35-2391-A1	Sediment	0–1	1	1	1	1	1	1
	35-2391-A2	Sediment	1–2	1	1	1	1	1	1
	35-2391-A3	Sediment	2–3	1	1	1	1	1	1
PRS No. 35-016(h) outwash deposit	35-2392-B1	Sediment	0–1	1	0	1	1	1	1
	35-2392-B2	Sediment	Biased	1	0	1	1	1	1
	35-2392-B3	Sediment	Biased	1	0	1	1	1	1
	35-2392-B4	Tuff	0–1*	1	0	1	1	1	1

* Tuff sample will be collected in the first 1-ft interval below the sediment/tuff interface.

in the tuff, and the sample will be collected from the 0 to 1-ft interval. This additional tuff sample is proposed because chromium was identified as a COPC in all three vertical intervals of the Phase I hand-auger hole placed in the active channel, but was not measured above background level in a surface sediment sample on the adjacent bank.

An area of sediment accumulation within the active channel will be sought on the edge of the mesa near the outfall discharge point. The field survey indicates that only shallow accumulations of sediment exist in the active discharge channel. Depending on the depth of sediment accumulation, sampling will be executed as follows. If the depth of the sediment is greater than 1 ft, three sediment samples will be collected in 0.5-ft vertical increments. However, if the depth of the sediment is between 0.5 and 1.0 ft, then two sediment samples will be collected in 0.5-ft vertical increments. If no area of sediment accumulation exceeds the 0.5 to 1-ft depth, two additional surface sediment samples will be collected from or directly adjacent to the active discharge channel. The purpose of these sediment samples is to verify Phase I data that suggest that inorganic chemicals have penetrated bedrock tuff at this location but are not accumulating in the sediments. Data from varoius vertical intervals at a single point are preferred because deeper sediment layers may harbor contaminants associated with the historical releases that are the primary focus of this investigation. Changes in the ratio of hexavalent and trivalent chromium with depth may also be useful to infer the environmental half-life of the more toxic hexavalent chromium ion at this site. Sediment data may be used to develop a source term for this mesa-edge area to support a screening-level risk assessment.

Sampling Location 2: PRS No. 35-016(g) Active Drainage Channel Above Roadway

Two surface sediment samples (0 to 0.5-ft vertical intervals) will be collected from the active discharge channel immediately above the intersection of this channel with the road. The purpose of these samples is to evaluate whether contaminated sediments are currently being mobilized from the hillside discharge channel. These data will be evaluated in conjunction with the sediment data from sampling location 1 to determine the nature and approximate concentrations of sediment contaminants within the discharge channel.

The road into Mortandad Canyon appears to have been regraded in early 1996. Currently, any surface water flow is diverted by the road and flows down a storm water channel on the north side of the road. During a field survey in the spring of 1996, the soil in the discharge channel at the intersection of the road was observed to be damp although no precipitation had occurred for several weeks. No surface water was evident. It is likely that during storm events the discharge channel collects runoff from the hillside and mobilizes sediments within the discharge channel, depositing them in sediment deposition areas associated with the roadside storm water channel. If high contaminant concentrations are identified in these samples, engineering controls may be warranted to prevent the redistribution of discharge channel sediments.

Sampling Location 3: PRS No. 35-016(g) Former Drainage Channel, Upper Cattails Area

A single borehole will be drilled in the area of sediment accumulation directly below the road within the lower portion of the discharge channel for PRS No. 35-016(g). Withered cattails were observed in this location during the 1996 field survey, but it is unknown if the regrading of the road will affect soil moisture in the lower portion of the discharge channel. Significant sediment accumulation is evident in this area, and it is possible that several feet or more of sediment currently overlay tuff here.

The borehole will be drilled through the sediment and approximately 3 ft into the underlying tuff. Three samples will be collected from 1-ft vertical intervals within the sediments. Borehole core material will be field screened for gross radioactivity and visually inspected for staining or other evidence of contamination. One sediment sample will be collected from the 0 to 1-ft interval. The remaining two sampling intervals will be biased by the gross radioactivity screening and visual inspection, if possible. If field biasing is not possible, the two additional intervals will be selected at random. One sample will be collected from the first 1-ft vertical interval of the underlying tuff. If contamination has infiltrated through overlying sediments, evidence of contamination should be observed in the tuff at the tuff/sediment interface.

Samples collected at depth are intended to identify the presence of historical contamination and provide information on the possible inventory of contaminants in this area of significant sediment accumulation.

Sampling Location 4: PRS No. 35-016(g) Former Drainage Channel, Lower Cattails Area

A single 3-ft hand-auger hole will be drilled in the lower area of the PRS No. 35-016(g) drainage where moist soil and cattails were observed in the 1996 field survey. Three samples will be collected at 1-ft vertical increments. It is anticipated that sufficient sediment accumulation has occurred at this location to obtain samples from a depth of 3 ft. However, if the sediments are shallower than anticipated, three sediment samples in 0.5-ft vertical increments will be collected instead.

The surface sediments at this location were observed to be fine grained and apparently rich in organic matter. Therefore, it is likely that if cationic contaminants such as chromium and uranium have been mobilized this far down the drainage, elevated concentrations will be observed at this location due to the tendency for cations to adsorb onto such sediments. This sampling location is the last significant area of sediment deposition before the main channel of Mortandad Canyon.

Sampling Location 5: PRS No. 35-016(h) Outwash Deposit

A single borehole will be drilled in the area of sediment accumulation directly below the road and east of the area described for sampling location 3. The sampling protocol for this sampling location will be identical to that for sampling location 3.

Sediment depth at this location is suspected to be significant based on the large area of the deposit. Because the culvert and backhoe trench sampled in the Phase I RFI (see Section 5.5.4) appear to be relatively recent, it is likely that this area has received sediment deposits associated with past parking lot runoff from the south and east sides of TA-35-213. Storm water runoff from the eastern portion of the hillside and road below TA-35-213 probably deposited sediments in this location as well.

Sampling locations 3 and 5 are located in the two primary areas of sediment accumulation below TA-35-213. If the pipe associated with the concrete stanchion and channel described in Section 5.5.7.2.1 had discharged at or below the road bed rather than directly into the Mortandad Canyon channel, the discharge flow should have impacted sampling location 3 because the local topography would have directed flow to that location. The location of the brine outfall will be ascertained through additional archival research and engineering surveys. If the brine waste line discharged further east along TA-35-213 and records of its location are lost, contamination should be identified at sampling location 5. Therefore, even if archival information cannot clarify the historic function of the pipe associated with the concrete stanchion or specify the location of the brine waste line, any residual contamination present from possible historic releases above the Mortandad Canyon channel will be characterized during this sampling event.

5.4.10.3 Sampling and Analysis Plan Implementation

The overall sample collection design for the investigation of PRS Nos. 35-016(g and h) is summarized in Table 5.4.10-1. The field and measurement methods proposed for sample collection and analysis are discussed in the following sections. Field QA/QC samples, such as field blanks and collocated samples, will be collected according to the most recent ER Project guidance (LANL 1996, 53450). QC samples are not included in the number of samples in Table 5.4.10-1.

5.4.10.3.1 Field Methods

Soil and sediment samples will be collected using the methods and ER Project SOPs listed in Table 5.4.10-2 (LANL 1991, 21556). The tools used will depend on the cohesion of the soil material, the collection depth, and the presence of flowing or standing surface water. A spade or hand auger may be used to collect samples at depths up to 1 ft. A hand auger will be used to collect samples at depths exceeding 1 ft. If undisturbed lithologic samples are required to examine sedimentary strata, an open tube (Trier) or thin-wall tube sampler will be employed. If surface water is present at the sampling location, a scoop, trowel, or hand corer will be used to

TABLE 5.4.10-2

SUMMARY OF SOIL SAMPLING METHODS REQUIREMENTS

Sampling Tools	Sample Types	Sampling Depth	LANL-ER-SOP No.
Spade and scoop	Surface grab	0–1 ft	06.09
Thin-wall tube	Surface grab; lithologic (undisturbed)	0–5 ft	06.10
Open tube (Trier)	Lithologic (undisturbed)	0–5 ft	06.17
Scoop and trowel	Grab (under surface water)	0–0.5 ft	06.14
Hand corer	Grab (under surface water)	0–0.5 ft	06.14
Hand auger	Surface or subsurface grab; vertical composite	0–5 ft	06.10
Hollow-stem auger	Subsurface	0–30 ft	04.01

collect grab sediment samples. Drilling methods (hollow-stem augering) are described in LANL-ER-SOP-04.01, "Drilling Methods and Drill Site Management."

All samples will be collected following the applicable ER Project SOPs (LANL 1991, 21556) for the collection, preservation, identification, storage, transport, and documentation of environmental samples, as described in the ER Project QAPP (LANL 1996, 53450). Decontamination of sampling equipment will be performed in accordance with LANL-ER-SOP-01.08,R0, "Field Decontamination of Drilling and Sampling Equipment." Wash water and other wastes generated during the sampling operation will be managed and disposed of in accordance with LANL-ER-AP-05.3, "Management of ER Program Wastes."

Each sample location will be marked or permanently monumented (where possible), photographed, and assigned a unique ER sample location identification number. All samples will be field-screened using hand-held instruments at the point of collection for gross radioactivity and organic vapors. When samples are submitted to the SMO, gross-alpha, -beta, and -gamma radiation measurements will be taken on each sample before they are transported to the analytical laboratory.

5.4.10.3.2 Measurement Methods

Soil samples collected in the initial sampling event described in Section 5.2 will undergo analysis for selected organic, inorganic, and radiological constituents. All analyses will be performed at an ER Project-approved fixed-site laboratory. The organic and inorganic analyte suites are listed in Table 5.4.10-3. Analysis for SVOCs will be performed according to EPA SW-846 protocols (EPA 1986, 31733). Samples will be analyzed for VOCs only if field screening indicates their presence. All analyses for inorganic constituents will be performed according to EPA SW-846 protocols (EPA 1986, 31732) using mineral acid sample extraction procedures for the ICPES, GFAA, and ICPMS techniques. The detailed analyte lists, EQLs or EDLs, required QC procedures, and the acceptance criteria for routine organic and inorganic analyses are found in the ER Project analytical services statement of work (LANL 1995, 49738).

Selected soil samples will be analyzed for hexavalent chromium using EPA SW-846 or standard methods. An extract will be prepared according to the toxicity characteristic leaching procedure (TCLP), SW-1311. The TCLP extract will then be analyzed for hexavalent chromium using either the chelation-extraction/flame atomic absorption method (SW-7197) or ion chromatography (standard method number 218.6). The amount of hexavalent chromium in the soil sample will be calculated from the amount in the TCLP extract using the following formula, which assumes that the density of the extraction fluid is 1 g/ml:

concentration Cr^{6+} in soil = 20 x concentration Cr^{6+} in extract (mg/L) x 1 (L/kg).

TABLE 5.4.10-3

ANALYTE SUITES AND ANALYTICAL METHODS FOR ANALYSIS OF ORGANIC AND INORGANIC CONSTITUENTS IN SOIL SAMPLES[a]

Analyte Suite	Analytical Method	Analytical Protocol
Organic constituents		
SVOCs	GC/MS	SW-8270
VOCs[b]	GC/MS	SW-8260
Inorganic constituents		
Trace metals	ICPES	SW-6010
As, Pb, Sb, Se, Tl	ICPMS or GFAA	SW-6020 or SW-7000
Hg	CVAA	SW-7471
Chromium (hexavalent)[c]	FAA or IC	SW-7197 or EPA Method No. 218.6

a. Detailed analyte lists and EQLs can be found in the ER Project analytical services statement of work (LANL 1995, 49738).
b. Samples will be analyzed for VOCs only if field screening indicates their presence.
c. Soil samples will first be extracted using the toxicity characteristic leaching procedure (SW-1311)

The radiological analyses listed in Table 5.4.10-4 include measurement of gross-alpha, -beta, and -gamma radiation; tritium by liquid scintillation counting; and gamma spectroscopy. All samples submitted for tritium analysis will also be analyzed for moisture content. The analyte list for the gamma spectroscopy analysis is given in the ER Project analytical services statement of work (LANL 1995, 49738) and includes long-lived activation and fission products such as ^{241}Am, ^{60}Co, ^{137}Cs, and ^{237}Np. Shorter-lived daughter products are usually included in the analyte list to verify the presence of the longer-lived parents. The shorter-lived radionuclides (half-life less than 180 days) are not considered to be primary COPCs. Soil samples will be prepared for gross radiation and gamma spectroscopy measurements by homogenization and drying; no sample extraction will be performed. The required QC procedures and acceptance criteria for the radiological analyses are found in the ER Project analytical services statement of work (LANL 1995, 49738).

If elevated levels of gross-alpha and/or beta radioactivity are measured in any sample, analyses for specific alpha- and beta-emitting radionuclides will be performed using methods described in the ER Project analytical services statement of work.

TABLE 5.4.10-4

ANALYTE LIST, ESTIMATED QUANTITATION LIMITS, AND ANALYTICAL METHODS FOR RADIONUCLIDE CONSTITUENTS IN SOIL SAMPLES

Analyte	Half-Life (years)	Detected Emission	EQL (pCi/g)	Analytical Method
Tritium	12.3	β	300 pCi/L	LSC
Gamma spectroscopy analytes		γ	1*	γ-Spectroscopy
Gross-alpha	—	α	10.0	GPC or LSC
Gross-beta	—	β	10.0	GPC or LSC
Gross-gamma	—	γ	2.0	NaI(Tl) or HPGe detection

* The minimum detectable activity for ^{241}Am and ^{137}Cs is 1 pCi/g; the value for other analytes will vary.

5.4.10.3.3 Field Decisions

The sampling design described in Section 5.4.10.2 requires that field decisions be made at two points during the sampling activities. At sampling locations 1 and 4, the number and depth of samples collected may be affected by the maximum depth of sediments at each sampling location. A brief decision protocol is described in Section 5.4.10.2 for guiding sample selection at these locations. The intent of these sampling protocols is to ensure that sample data provide information on the vertical profile of contamination at these locations, if possible.

At sampling locations 3 and 5, two sediment samples from the boreholes will be selected on the basis of field gross radioactivity measurements or sensory observations that indicate potential contamination. The decision level that defines when measurements are elevated above background radioactivity levels is usually set at the mean background value plus twice the standard deviation of the mean. Background count rate for a detector is usually determined by counting an area known to be uncontaminated and located as close to the sampling area as possible. If a known uncontaminated area close to the actual environmental measurement site is not available, the site can be surveyed and a background count rate determined by developing a statistical trend among the lowest measurements. Sensory observation of contamination is based on the professional judgment of the field team and may include obvious staining, odor, or other qualitative measures.

5.4.10.3.4 Sample Handling

All samples will be identified in accordance with LANL-ER-SOP-01.04, R3, "Sample Control and Field Documentation." Chain-of-custody requirements described in LANL-ER-SOP-01.04, R3 will be implemented. The SMO will be consulted regarding the appropriate sample containers and methods of preservation. Samples will be packaged and shipped according to LANL-ER-SOP-01.03, R1, "Handling, Packaging and Shipping of Samples." All samples will be shipped from the SMO to off-site laboratories for analysis except those samples that are submitted to a mobile radiological van for screening purposes.

5.4.10.3.5 Data Tracking

The data management scheme described in Sections A10 and B10 of the ER Project QAPP (LANL 1996, 53450) will be followed. Manually recorded data will be reviewed by the field team as required by LANL-ER-SOP-1.01, R0, "General Instructions for Field Investigations," LANL-ER-SOP-01.04, R3, and LANL-ER-SOP-03.12, R0, "Field and Laboratory Notebook Documentation for Environmental Restoration Earth Sciences Studies." Data generated by the analytical laboratories will be submitted to the SMO following the requirements of the ER Project analytical services statement of work (LANL 1995, 49738). The reporting requirements include electronic and hard copy deliverables for routine analyses. The SMO is responsible for data verification, validation, and upload to FIMAD. The results of radiological screening conducted in the mobile radiological van will be documented and sent to the SMO along with the samples.

5.4.10.4 Data Assessment

5.4.10.4.1 Verification and Routine Validation

Data generated by the analytical laboratories will undergo the verification and baseline validation procedures described in Sections D1 and D2 of the ER Project QAPP (LANL 1996, 53450). Field data will be reviewed for accuracy and completeness by the field team at the time of collection.

5.4.10.4.2 Data Quality Assessment

Reconciliation of the data with investigation objectives will be accomplished using the qualitative data quality assessment methods described in Section D3 of the ER Project QAPP (LANL 1996, 53450). The assessment team will evaluate the sufficiency of the data set for the decision-making purposes described in Section 5.4.10.1

using their best professional judgment. The assessment team shall consist of a geologist, geochemist, human health risk assessor, ecological risk assessor, statistician, and chemist (at a minimum). The data quality assessment process outlined in Figure D-3 of the ER Project QAPP will be followed.

5.4.10.5 Administration

5.4.10.5.1 Project Task Organization

The Field Unit 4 project task organization for implementing the field activities described in this SAP is shown in Table 5.4.10-5.

5.4.10.5.2 Training

All ER Project personnel involved with the execution of this SAP will have fulfilled the required training for applicable roles in accordance with the ER worker positions matrix in administrative procedure LANL-ER-AP-05.2, R1, "Determination, Completion, and Documentation of Environmental Restoration Worker Training." ER

TABLE 5.4.10-5

FIELD UNIT 4 KEY PERSONNEL

Functional Role	Name	Organization	Phone
Field Project Management			
Field Project Leader (FPL)	Allyn Pratt	EES-13	667-4308
Technical Team Leader	Dave Broxton	EES-1	667-2492
Field Team Manager (FTM)	Deba Daymon	ERM/Golder	662-1327
Management Support Leader	Curt Thomson	LATA	662-1812
Field Team			
Field Team Leader (FTL)	Leslie Sontag	SAIC	672-3666
Geologist	Leslie Sontag	SAIC	672-3666
Site Safety Officer (SSO)	Darril Stafford	SAIC	672-3666
Field Technician/Sampler	Carmella Romero	SAIC	672-3666
Field Technician/Sampler	Darril Stafford	SAIC	672-3666
Technical/Assessment Team			
Assessment Team Leader	Gabriela Gainer	LATA	662-1817
Human Health Risk Assessor	Ralph Perona	ERM/Golder	662-1305
Eco-risk Assessor	Orrin Meyers	EES-15	665-3742
Statistician	Kathy Campbell	EES-5	667-2799
Statistician	Mary Mullen	ESH-20	665-8963
Geochemist	Patrick Longmire	CST-7	665-1264
Geomorphologist	Steven Reneau	EES-1	665-3151
Watershed Hydrologist	Brad Wilcox	EES-15	665-6044
Chemist	Catherine Smith	LATA	662-1873
Alternate Personnel			
Alternate FTL/Geologist	Richard Koch	SAIC	672-3666
Alternate SSO/Sampler	John Hayes	ERM/Golder	662-1348
Coordinator			
Field Project Coordinator	Robert Simeone	DOE/LAAO	667-0587

Project personnel training records are located on-site during field activities and will be available for inspection. ER Project personnel will not perform tasks under site conditions that require special training beyond that documented in their training records.

5.4.10.5.3 Records

Field records will document sample collection and tracking, H&S briefings and checks of monitoring equipment performance, and nonsampling activities such as site inspections and walkovers, which are documented as engineering surveys in Daily Activity Logs. Table 5.4.10-6 is a summary of required field documents, the appropriate requirement reference, and document recipients. All original documents will be transferred to the ER Project RPF in accordance with administrative procedure LANL-ER-AP-02.1, R1, Procedure for LANL ER Records Management."

Photographs and videotapes may be used to document observations and sample collection activities. Site visit photographic documentation will be referenced in a Daily Activity Log in accordance with ER-SOP-01.04, R3.

TABLE 5.4.10-6

FIELD ACTIVITY DOCUMENTATION

Document	Requirement Reference	Document Recipients
	Sample Collection and Tracking	
Daily Activity Log	LANL-ER-SOP-01.04, R3* Attachment E	FU4 file, RPF
Sample Collection Log	LANL-ER-SOP-01.04, R3* Attachment B	FU4 file, RPF
Core Sample Log	LANL-ER-SOP-12.01, R1* Attachment E	FU4 file, RPF
Daily Drilling Summary	LANL-ER-SOP-12.01, R1*Section 8 (form attached)	FU4 file, RPF
Daily Report Form	FU4 Guidance (form attached)	FU4 file, RPF
Chain of Custody / Request for Analysis Forms	LANL-ER-SOP-01.04, R3* Attachment C	FU4 file, RPF
Electronic Follower (COC / Request for Analysis)	LANL-ER-SOP-01.04, R3* Section 6.1.5	SMO
	Health and Safety	
Tailgate Safety Meeting / Attendee Signoff Sheet	FU4 Guidance (form attached)	FU4 file, RPF
Flame/Photo Ionization Detector Field Data Form	FU4 Guidance (form attached)	FU4 file, RPF
Direct Survey Results	ESH-1 Guidance (form attached)	FU4 file, RPF
Smear Survey Results	ESH-1 Guidance (form attached)	FU4 file, RPF
LAS Survey Results	ESH-1 Guidance (form attached)	FU4 file, RPF
Radiation Grid Survey Results	FU4 Guidance (form attached)	FU4 file, RPF
Daily Safety Inspection Checklist	FU4 Guidance (form attached)	FU4 file, RPF
Daily Drill Rig Inspection Checklist	FU4 Guidance (form attached)	FU4 file, RPF
PPE Inspection Checklist	FU4 Guidance (form attached)	FU4 file, RPF
Equipment and Item Removal Log	FU4 Guidance (form attached)	FU4 file, RPF
Site Access Log	FU4 Guidance (form attached)	FU4 file, RPF
	Engineering Surveys	
Daily Activity Log	ER-SOP-01.04, R3* Attachment E	FU4 file, RPF

* LANL 1991, 21556

5.4.10.5.4 Oversight

Oversight, review, and approval of ER Project field activities are provided by the following Laboratory groups.

- ESH-1 for RCT support and oversight
- ESH-5 for review, approval, and oversight of the SSHASP
- ESH-3 and ESH-5 for review, approval, and oversight of the ES&H Questionnaire
- ESH-19 for oversight of the waste management plan and/or the Waste Characterization Strategy Form
- CST-5 and CST-17 for review and approval of the waste management plan and/or the Waste Characterization Strategy Form

The ER Project Office may schedule an audit of sampling activities to ensure the quality of field performance. Such audits will conform to the ER Project quality procedures LANL-ER-QP-01.1, R0, "Audits," and LANL-ER-QP-01.2Q, R0, "Surveys" (LANL 1992, 11686). Laboratory group ESH-5 will evaluate the ER Project field operations to determine compliance with H&S requirements.

5.4.10.5.5 Inspection and Acceptance Policies

All activities associated with this SAP will follow Laboratory policies on inspections and acceptance. All sampling equipment, including sample containers, rinsate water, and sample preservation reagents, are inspected by the field team leader upon receipt. The SMO provides the sample containers used for sample collection. The sample containers are certified by the manufacturer for prescribed cleanliness and quality. Sample preservation reagents are received from reputable chemical suppliers with reagent purity certification on the container label.

5.4.10.5.6 Reports to Management

The field team leader will submit daily activity reports to the field team manager during field activities.

5.4.10.5.7 Attachments

The following field forms (which are not included in the SOPs) used to execute the SAP are attached to this RFI report (see Attachment V).

- ESH-1 Direct Survey Form
- ESH-1 LAS Survey Form (LAS = large area swipe)
- ESH-1 Smear Survey Form
- ESH-1 Smear Continuation Form
- FU 04 Equipment and Item Removal Log
- FU 04 Survey Form
- FU 04 Site Access List
- FU 04 Tailgate Safety Meeting

5.5 PRS No. 35-016(h)

PRS No. 35-016(h) comprises two active storm-water drainage channels that were installed to handle runoff from the parking and storage areas around building TA-35-213 (LANL 1992, 7666).

No COPCs were identified during the screening assessment. However, antimony, calcium, copper, lead, thorium, uranium, and zinc were measured above background levels. Matrix effects that may indicate hydrocarbon contamination were reported in two samples that were analyzed for VOCs

Further investigations are proposed for PRS No. 35-016(h). The SAP for this PRSs is included in Section 5.4.10.

5.5.1 History

PRS No. 35-016(h) is described in Section 3.3.2 of the work plan and in Section 7.25 of the June 1994 addendum to the work plan (LANL 1992, 7666; Pratt 1994, 43475). The work plan states that the location of the outfalls for this PRS are unknown.

The storm-water drainage channels were installed around 1979 when TA-35-213 was constructed. These drainage channels may be contaminated with tritium because tritium was handled in TA-35-213 during the early 1980s. Waste brine may have also been discharged at the site from a water deionizer in the building. However, the location of the discharge point for the waste brine has not been determined.

The contaminants that were potentially present (and therefore investigated during this RFI) include gross-alpha, -beta, and -gamma radiation; VOCs; SVOCs; metals; and tritium.

5.5.2 Description

This PRS is located north of TA-35-213 on the northern edge of Ten Site Mesa. Two daylight drainage channels drain the surface area around the north and east sides of the building. The storm-water runoff flows into a roadside ditch (east of the security fence) that discharges to a 50-ft-long, 18-in.-diameter culvert, which extends beneath the Mortandad Canyon access road. The culvert flows into a flat-bottomed daylight drainage channel that is 2 ft wide, 3 ft deep, and extends about 75 ft to the edge of the mesa.

Rainwater from the asphalt-paved parking, driveway, and storage areas on the north side of TA-35-213 flows into a concrete-lined drainage channel at the northeast side of the security fence. This drainage channel is about 4 ft wide and extends for about 20 ft over the embankment at the edge of the parking area. This drainage channel discharges to a ditch on the south side of the Mortandad Canyon access road. Before recent regrading of the access road, runoff water flowed along the road for about 200 ft and then flowed across the road and into Mortandad Canyon, where water and sediment formed an outwash deposit in a flat area of the canyon bench (see Figure AIII-3 in Attachment III of this RFI report). Since the road was regraded, water flows along the access road to a point where the road reaches the canyon bench.

The topography includes a gently sloping mesa top near TA-35-213 to steep mesa-side topography beyond the mesa edge. The drainage channels flow intermittently during periods of precipitation. Surface water runoff and the discharge associated with the drainage channels flow northward into Mortandad Canyon.

5.5.3 Previous Investigations

No previous investigations have been performed at this site.

5.5.4 Field Investigation

The objective of the Phase I RFI was to characterize the nature of potential contamination associated with the storm-water drainage channels and discharge areas.

The conceptual model for the RFI predicted that if contaminants had been released into the environment, the material would infiltrate the surface soils at the point of discharge and be mobilized by surface runoff to the adjacent mesa edge. A judgmental sampling approach was used, and the sampling activities were biased toward areas below the discharge areas where residual contamination was expected.

Field activities included an H&S radiation survey, engineering surveys, and environmental surveys including radiation grid surveys.

Field screening during site surveys and sample collection activities were performed using a Hazco 1256 OVA, a Ludlum Model 39 alpha meter, and an Eberline ESP-1 beta/gamma meter. Using this instrumentation, background radiation measurements at TA-35 range from 200 to 500 cpm beta/gamma radiation depending on the location and substrate rock type. Field screening measurements greater than 500 cpm beta/gamma radiation were generally considered to be above background levels. No beta/gamma radiation measurements above background levels were obtained during field screening at this site, and no alpha radiation or organic vapors were detected.

5.5.4.1 Environmental and Engineering Surveys

The H&S radiation survey was performed on September 8, 1994. Beta/gamma radiation measurements ranged from 198 to 235 cpm and the average was 216 cpm, which is within background levels. On September 23, 1994, an additional survey was performed for alpha activity at the drainage channels, and no alpha radiation was detected.

The engineering surveys were performed on September 8, 1994, and September 12, 1994. The surveys consisted of a review of archival information, oblique photographs, aerial photographs, and engineering drawings of TA-35 as well as a field site inspection. The locations of the drainage channels were inaccurate in the work plan; therefore, the surveyors established the locations of the drainage channels and documented them in the Daily Activity Logs.

The engineering surveys also resulted in the identification of a 10-in.-diameter CMP that discharges into an arroyo northwest of TA-35-213. Several CMPs discharge into this arroyo, but one obviously originates from the area around TA-35-213. The discharge area below the outfall from this CMP was also investigated as part of this PRS.

The radiation grid survey was performed on September 12, 1994, and September 15, 1994. The radiation grid locations included Location ID Nos. 35-7676 through 35-7827, which were established in the drainage channels at approximately 10-ft intervals. Beta/gamma radiation measurements ranged from 139 to 316 cpm, and the average was 232 cpm, which is within background levels.

5.5.4.2 Deviations from the Sampling and Analysis Plan

The original SAP is described in Section 7.25 of the June 1994 addendum to the work plan (Pratt 1994, 43475). However, the SAP was modified based on information gathered during the engineering surveys. The changes to the SAP, which are summarized below, are documented in the January 3, 1995, memorandum to the Operable Unit 1129 file (Pratt 1995, 43528).

Two surface samples (Location ID Nos. 35-2158 and 35-2159) were relocated to the discharge area of the flat-bottomed channel below the CMP northeast of TA-35-213. Two surface samples (Location ID Nos. 35-2161 and 35-2162) were relocated to the ditch on the south side of the Mortandad Canyon access road below the concrete-lined drainage channel. One surface sample (Location ID No. 35-2160) was relocated to collect soil material from below the northwest-trending CMP in the arroyo northwest of TA-35-213 (see Figure 5.4.4-1).

These changes to the SAP impacted the success of the field activities because the appropriate samples were not collected to determine nature of contamination at this PRS.

5.5.4.3 Sampling Activities

Phase I sampling was performed on March 13, 1995. A total of seven locations were sampled, and seven surface samples were collected (not including duplicate QA/QC samples). The samples were collected at Location ID Nos. 35-2158 through 35-2164 from surface sediment material and bedrock tuff material in the drainage channels. Beta/Gamma radiation measurements obtained during field screening of the samples ranged from 194 to 237 cpm, which are within background levels.

Table 5.5.4-1 summarizes all sampling for PRS No. 35-016(h); Figure 5.5.4-1 shows the sample locations. The sample at Location ID No. 35-2160 is shown in Figure 5.4.4-1.

TABLE 5.5.4-1

SUMMARY OF SAMPLES TAKEN AT PRS No. 35-016(h)

Location ID	Sample ID	Depth (ft)	Matrix	VOC Mobile Lab	VOC Fixed Lab	PAH Mobile Lab	INORG Mobile Lab	INORG Fixed Lab	Rad Fixed Lab
35-2158	AAC1193	0-0.5	mixed soil	21556	NR	21556	21554	NR	21555
35-2159	AAC1194	0-0.5	mixed soil	21556	NR	21556	21556	NR	21555
35-2160	AAC1195	0-0.5	mixed soil	21556	NR	21556	21556	NR	21555
35-2161	AAC1196	0-0.5	mixed soil	21556	NR	21556	21556	NR	21555
35-2162	AAC1197	0-0.5	mixed soil	21556	NR	21556	21554	21554	21555
35-2163	AAC1198	0-0.5	mixed soil	21556	NR	21556	21556	NR	21555
35-2164	AAC1199	0-0.5	mixed soil	21556	21553	21556	21556	NR	21555

5.5.5 Background Comparisons

Background comparisons were performed for inorganic chemicals for which UTL values are available, as discussed in Section 3.2 in Chapter 3.0 of this RFI report. For inorganic chemicals analyzed by XRF in the mobile laboratory facility, the UTL values have been corrected for some analytes to account for method differences that generally result in higher measured background concentrations by XRF. Derivation of corrected UTL values for XRF data is discussed in Section 3.1.3 in Chapter 3.0 of this RFI report. If data are available by both methods, the data reported by the fixed-site laboratory will be given precedence because more confidence is placed in fixed-site laboratory data than in the XRF analyses.

Seven surface samples (0 to 0.5 ft) from seven locations were analyzed by XRF in the mobile laboratory facility for an analyte suite that included antimony, arsenic, barium, cadmium, calcium, chromium, copper, iron, lead, manganese, mercury, nickel, potassium, selenium, thorium, titanium, uranium, and zinc. As discussed in Section 4.1.3 in Chapter 4.0 of this RFI report, XRF data for antimony, cadmium, mercury, selenium, and uranium should be regarded as estimated, and nickel data may have a low bias. One surface sample was also analyzed in a fixed-site laboratory for an inorganic chemical analyte suite that included aluminum, antimony, arsenic, barium, beryllium, cadmium, calcium, chromium, cobalt, copper, iron, lead, lithium, magnesium, manganese, molybdenum, nickel, potassium, selenium, silver, sodium, strontium, thallium, vanadium, and zinc using the EPA methods described in Section 3.1.1 in Chapter 3.0 of this RFI report. No fixed-site laboratory radionuclide data were obtained at this PRS. Radionuclide data from samples submitted to the mobile laboratory facility are not available, as discussed in Section 4.3 in Chapter 4.0 of this RFI report.

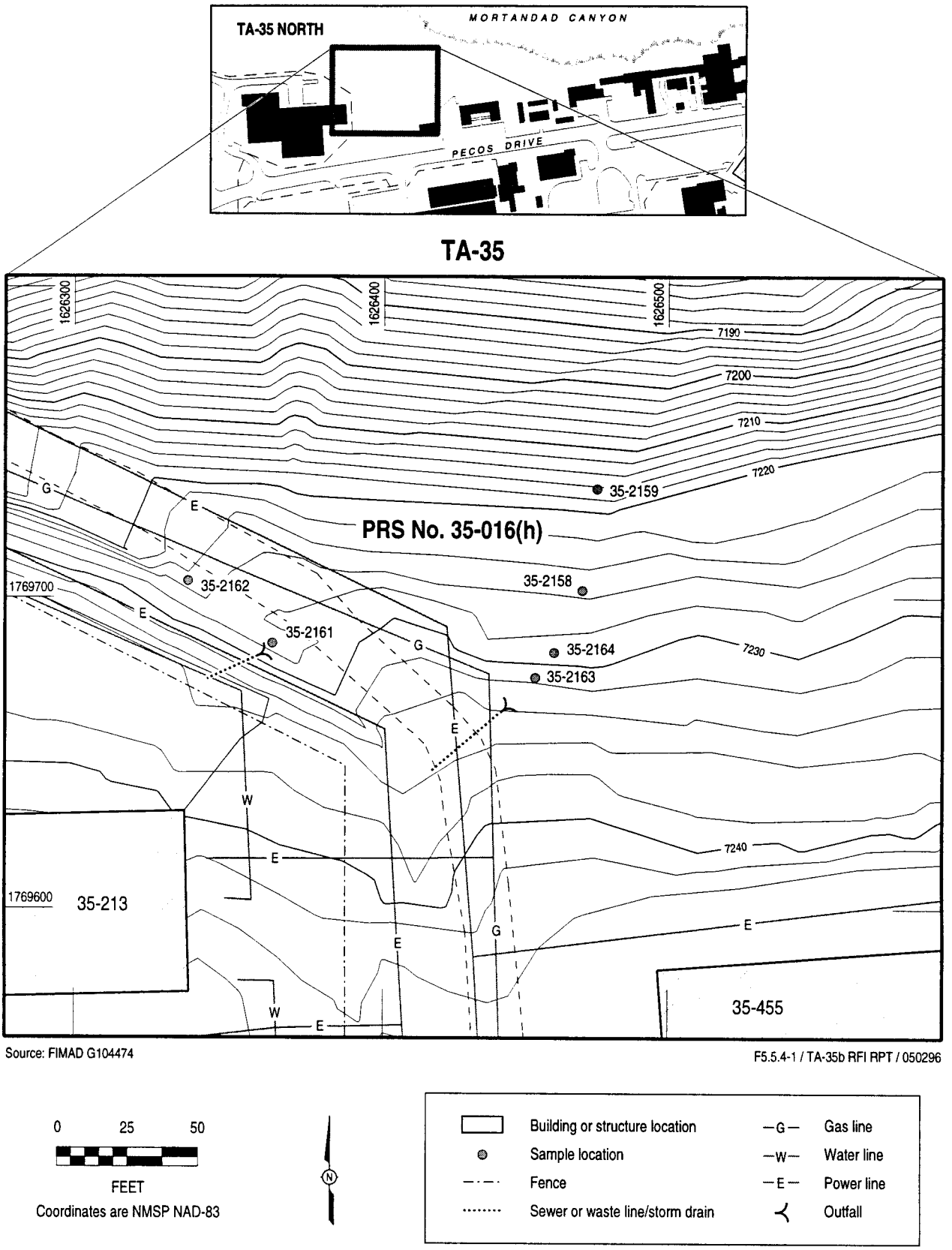


Figure 5.5.4-1. Locations of samples at PRS No. 35-016(h).

The sample matrices generally consisted of fragmented sand tuff with sand. In Table 5.5.5-1 the values in the boxes indicate inorganic chemicals that were detected in soil at concentrations greater than or equal to their respective UTL values, or for which UTL values are unavailable. Sample locations where inorganic chemicals exceeded UTL values are shown in Figure 5.5.5-1. The sample collected at Location ID No. 35-2160 is shown in Figure 5.4.5-1. The highest observed concentrations above a UTL value at each location are summarized below.

- Antimony was detected in one sample at a concentration of 4.17 mg/kg, which is above the XRF UTL of 1.45 mg/kg.
- Calcium was detected in one sample at a concentration of 14,900 mg/kg, which is above the XRF UTL of 10,900 mg/kg.
- Copper was detected in two samples at two locations at concentrations of 24.6 and 18.4 mg/kg, which are above the XRF UTL of 16.7 mg/kg.
- Lead was detected in one sample at a concentration of 57.9 mg/kg, which is above the XRF UTL of 28.4 mg/kg.
- Thorium was detected in one sample at a concentration of 23.6 mg/kg, which is slightly above the XRF UTL of 22.1 mg/kg.
- Uranium was detected in two samples at two locations at concentrations of 14.6 and 11.9 mg/kg, which are above the XRF UTL of 5.33 mg/kg.
- Zinc was detected in three samples at three locations at a maximum concentration of 164 mg/kg, which is above the XRF UTL of 76.6 mg/kg.

5.5.6 Evaluation of Organic Constituents

Seven surface soil samples from seven locations were analyzed for VOCs and SVOCs in the mobile laboratory facility. One soil sample was also analyzed for VOCs in a fixed-site laboratory. No organic chemical was measured above its EQL value in any soil sample. However, the mobile laboratory facility reported matrix effects for two VOC samples, which resulted in a potentially low bias for the VOC EQLs in these samples. The matrix effects may indicate the presence of undifferentiated hydrocarbon contamination in these samples.

As discussed in Section 4.2 in Chapter 4.0 of this RFI report, the sample results from the mobile laboratory facility are qualified with an "S" flag and may be biased low because of less effective extraction methods.

5.5.7 Human Health Assessment

5.5.7.1 Screening Assessment

Seven inorganic chemicals were carried forward from the background comparison. As described in Section 3.4.1 in Chapter 3.0 of this RFI report, analytes are divided into three classes for the screening assessment, depending on whether a reference dose (noncarcinogens), slope factor (chemical carcinogens), or dose conversion factor (radionuclides) is used to calculate their SAL, to evaluate possible additive effects within each class of chemical. Because radionuclide data are not available for this PRS, only two classes of chemicals are evaluated here.

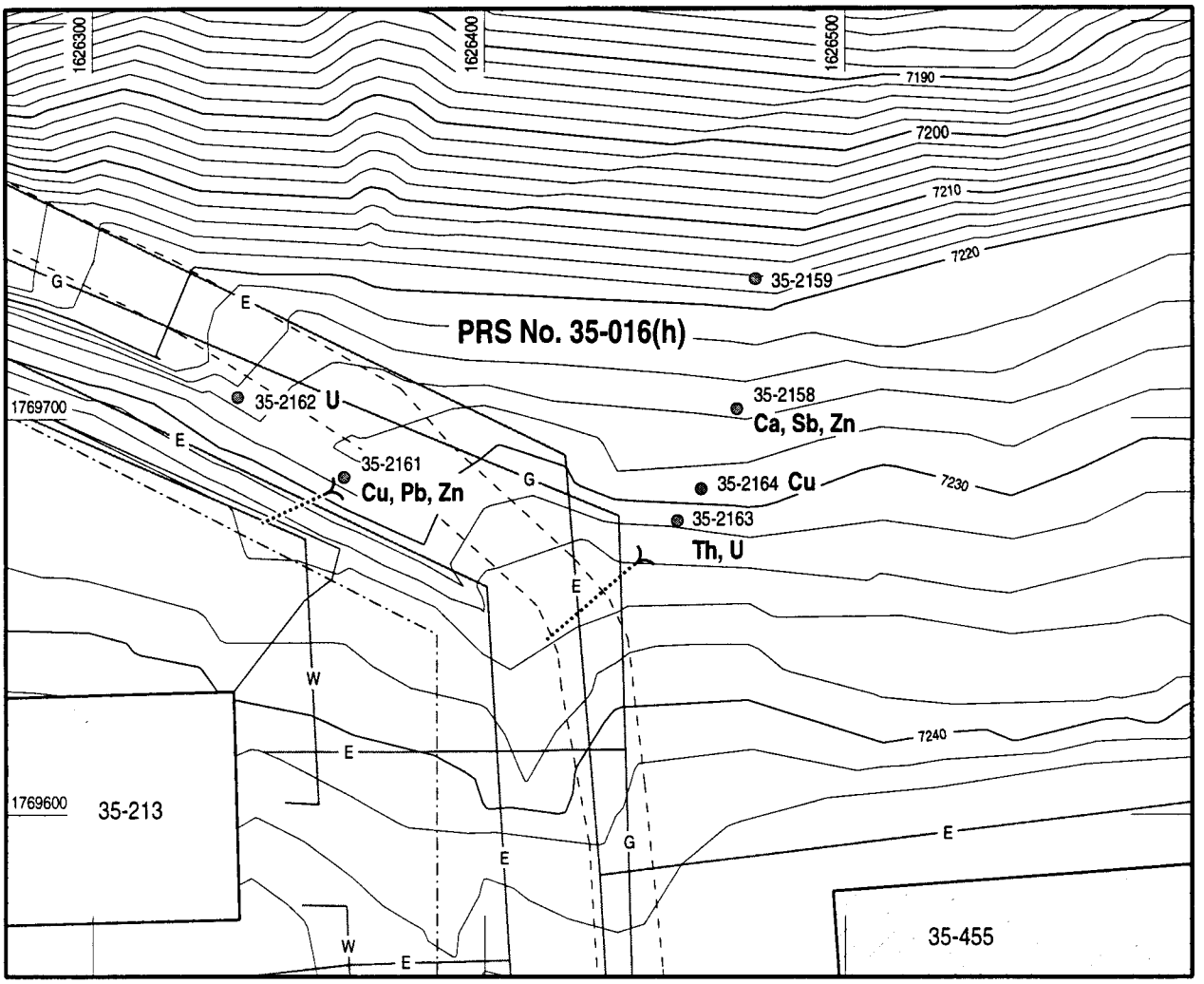
No sample results for any chemical exceeded SAL values. The MCE result for noncarcinogens was 0.80, which indicates that a potential human health risk based on additive effects is not identified for this class of chemical. Because the MCE calculation assumes simultaneous exposure to maximum concentrations of contaminants

TABLE 5.5.5-1

INORGANIC CHEMICALS WITH CONCENTRATIONS* GREATER THAN BACKGROUND UTL FOR PRS No. 35-016(h)

Location ID	Sample ID	Depth (ft)	Ag	Ca	Cd	Cu	Hg	Pb	Sb	Se	Th	Ti	Tl	U	Zn
SAL	N/A	N/A	383	N.A.	38	2800	23	400	31	380	N.A.	N.A.	N.A.	230	23000
Mixed soil UTL	N/A	N/A	N.A.	6120	2.7	15.5	0.1	23.3	1	1.7	14.6	N.A.	1	1.87	50.8
XRF UTL	N/A	N/A	N/A	10900	N.A.	16.7	N.A.	28.4	1.45	N.A.	22.1	N.A.	N.A.	5.33	76.6
35-2158	AAC1193	0-.5	NA	14900	<3	<8	<5	25.5	4.17	<4	14.5	2316	NA	<8	78.8
35-2159	AAC1194	0-.5	NA	7810	<3	13.2	<5	23.6	<4	<4	8.4	2237	NA	<8	62.8
35-2160	AAC1195	0-.5	NA	4600	<3	14.8	<5	25	<4	<4	14.9	1682	NA	<8	91.7
35-2161	AAC1196	0-.5	NA	9910	<3	24.6	<5	57.9	<4	<4	13.5	2721	NA	<8	164
35-2162	AAC1197	0-.5	<.33	5017	<.09	8	<.11	9.5	<.48	<1	20.1	2164	<1.1	14.6	43
35-2163	AAC1198	0-.5	NA	9970	<3	<8	<5	22.7	<4	<4	23.6	2177	NA	11.9	66.6
35-2164	AAC1199	0-.5	NA	7300	<3	18.4	<5	26.8	<4	<4	14.1	2640	NA	<8	70.6

*mg/kg



Source: FIMAD G104474

F5.5.5-1 / TA-35b RFI RPT / 050396

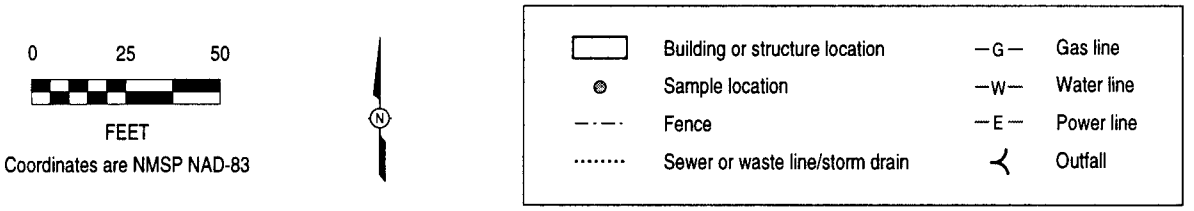


Figure 5.5.5-1. Locations of analytes that exceed UTLs at PRS No. 35-016(h).

among three geographically distinct outfalls (see Figure 5.5.5-1), the MCE value of 0.80 is biased high relative to an MCE for a single location. An MCE calculation for chemical carcinogens was not performed because no chemical carcinogens were identified as COPCs in Sections 5.5.5 and 5.5.6.

All the COPCs identified in Section 5.5.5 have soil SALs for comparison except thorium and calcium. Thorium was measured above its XRF UTL value in only one of seven samples, and at a concentration just several percent higher than the UTL. The distribution of thorium at this PRS does not differ significantly from the background level, as shown in Figure AI-14 of Attachment I of this RFI report. Calcium is among those essential elements that may be eliminated from further evaluation in a risk assessment based on professional judgment (EPA 1989, 8021). Calcium is an essential element and was detected above background in only one of seven samples. The only detected analyte for which neither a UTL or SAL value is available is titanium. Titanium is widely used as a food and cosmetics additive to whiten a product. It is generally considered to be physiologically inert in its common form as titanium dioxide (Amdur et al. 1991, 53961).

5.5.7.2 Risk Assessment

A quantitative human health risk assessment was not performed for this PRS because no COPCs were identified in the screening assessment. Furthermore, additional data are required to define the nature and extent of contamination, as described in Section 5.5.7.2.1.

5.5.7.2.1 Review of Chemicals of Potential Concern and Extent of Contamination

No COPCs were identified in the screening assessment.

Additional data are required to determine the nature and extent of contamination at this PRS. As described in Section 5.5.1, this PRS includes both surface-water drainage from parking areas adjacent to TA-35-213 and an outfall where brine from a water deionizer was discharged. The Phase I surface soil samples collected to characterize this PRS were obtained from channels where water flow associated with storm events will mobilize existing sediment and deposit new sediment on a frequent basis;therefore these samples were not adequate to determine nature of contamination at this PRS. These surface soil samples are unlikely to reflect historical contamination. The discharge area for the water deionizer brine was not identified in the Phase I field survey.

A subsequent field survey has identified a channel in the hillside below TA-35-213 that contains a concrete stanchion with an embedded segment of pipe. The historical process associated with this pipe, which apparently ran from TA-35-213, is unknown. It is possible that this pipe may have served the outfall designated as PRS No. 35-016(g) (NPDES Permit No. 04A-127), which has since been relocated to its current location. Section 3.3.2.1 of the work plan indicates that this outfall may originally have handled the water deionizer brine associated with PRS No. 35-016(h) (LANL 1992, 7666). The surface topography below the road cut in the area of this historical channel indicates that any discharge at this location would have flowed to the drainage for the current outfall, described in Section 5.4 of this RFI report.

An area of sediment accumulation (the outwash deposit) that has apparently received runoff from parking areas north and west of TA-35-213, as well as portions of the hillside below this building, was also identified in the subsequent field survey. This area is below the road cut and east of the current drainage for the outfall associated with PRS No. 35-016(g). Both this area and the lower drainage for the outfall for PRS No. 35-016(g) have considerable sediment deposits where historical contamination mobilized in surface water runoff and outfall discharge may have accumulated.

5.5.8 Preliminary Ecological Assessment

The general landscape condition around this PRS is moderately developed and disturbed, and a high potential exists for receptors to come in contact with chemicals above background levels associated with the site (antimony, calcium, copper, lead, thorium, uranium, and zinc) (see Table 5.5.5-1). Therefore, this PRS will be

included as a potential contaminant source in the ecological risk assessment. An ecological risk assessment will be conducted when that approach has been approved by the regulators. Threatened and endangered species and/or sensitive habitat listed in Chapter 2.0 of this RFI report will be evaluated in the ecological risk assessment.

5.5.9 Conclusions and Recommendations

The objective of the Phase I RFI for PRS No. 35-016(h) was to determine the presence or absence of contamination associated with surface-water drainage from parking areas adjacent to TA-35-213 and an associated outfall. This objective was not realized, and although no COPCs were identified in the screening assessment in surface samples from parking lot runoff drainage channels, further archival research and sampling is necessary to determine the location and to characterize this PRS.

Archival research and further sampling are recommended to determine the nature and extent of contamination.

5.5.10 Sampling and Analysis Plan for PRS No. 35-016(h)

Because likely areas of contaminant accumulation for PRS No. 35-016(h) overlap with PRS No. 35-016(g), the sampling activities for these two PRSs are combined. The objectives of the sampling, plan, including sample locations and analytical suites, are identified in the SAP in Section 5.4.10.

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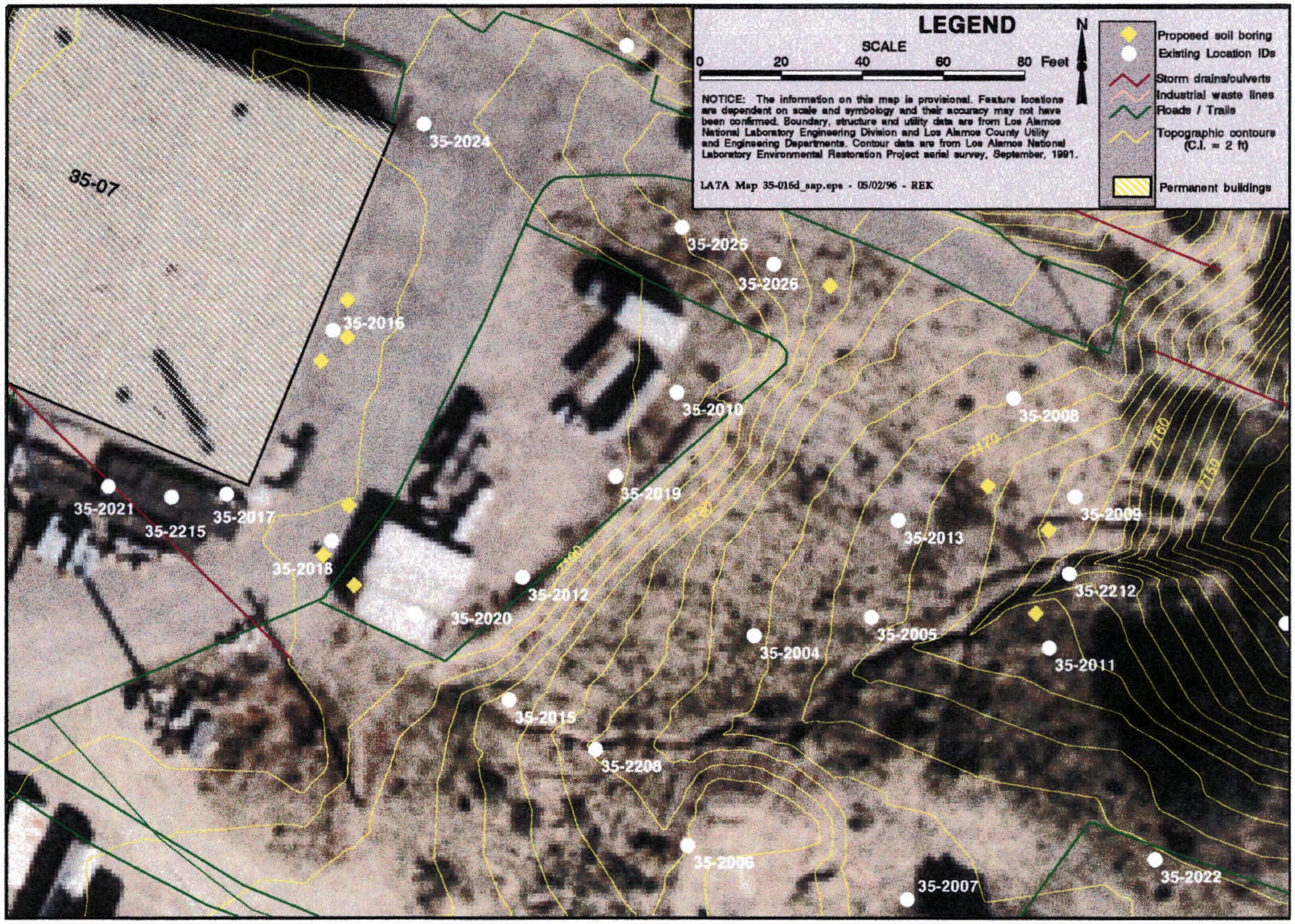

Figure AIII-1. View of PRS Nos. 35-003(d, e, f, g, l, m, o, and q) showing existing and proposed sample locations.

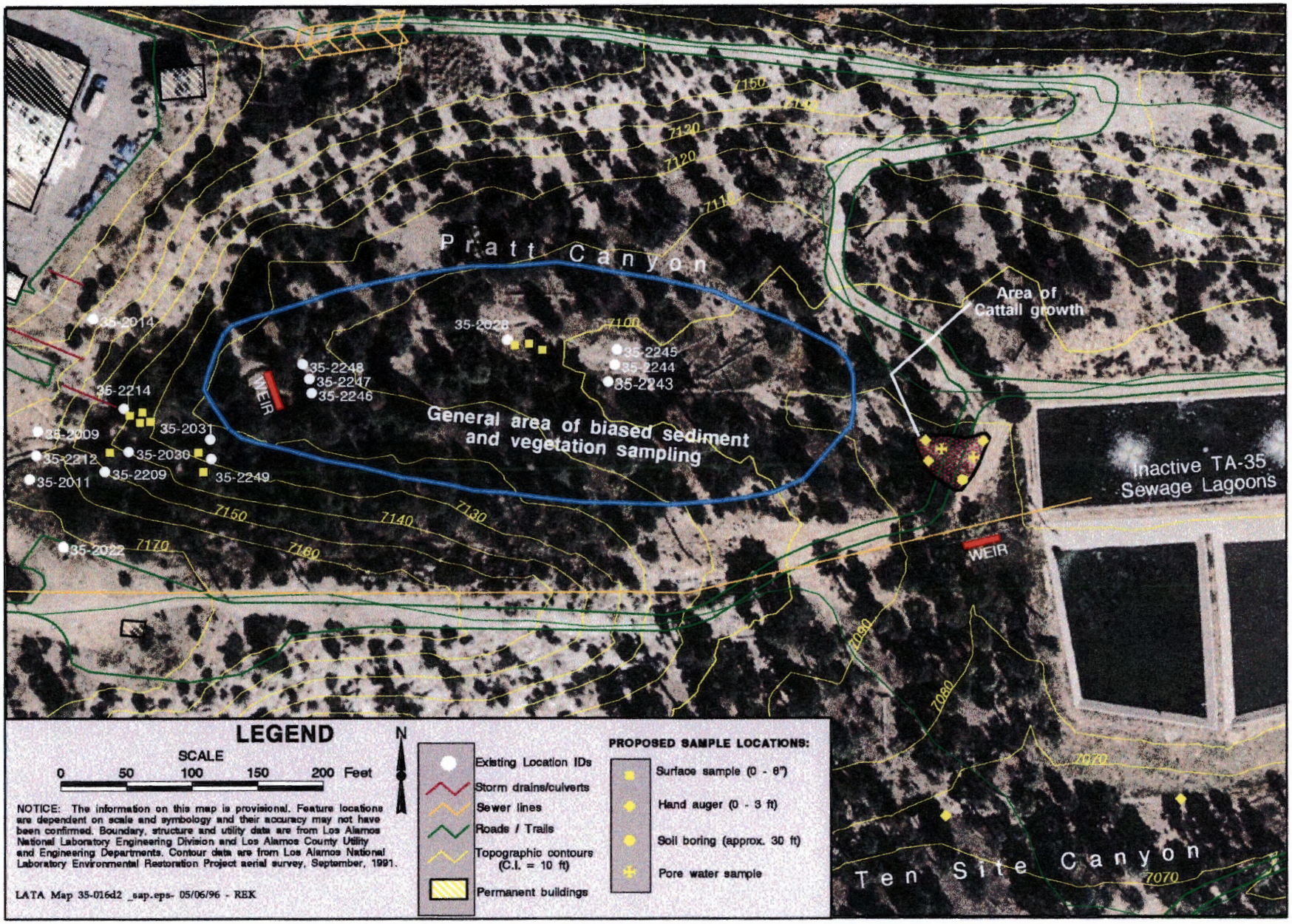

Figure AIII-2. View of PRS No. 35-003(r) (Pratt Canyon) showing existing and proposed sample locations.

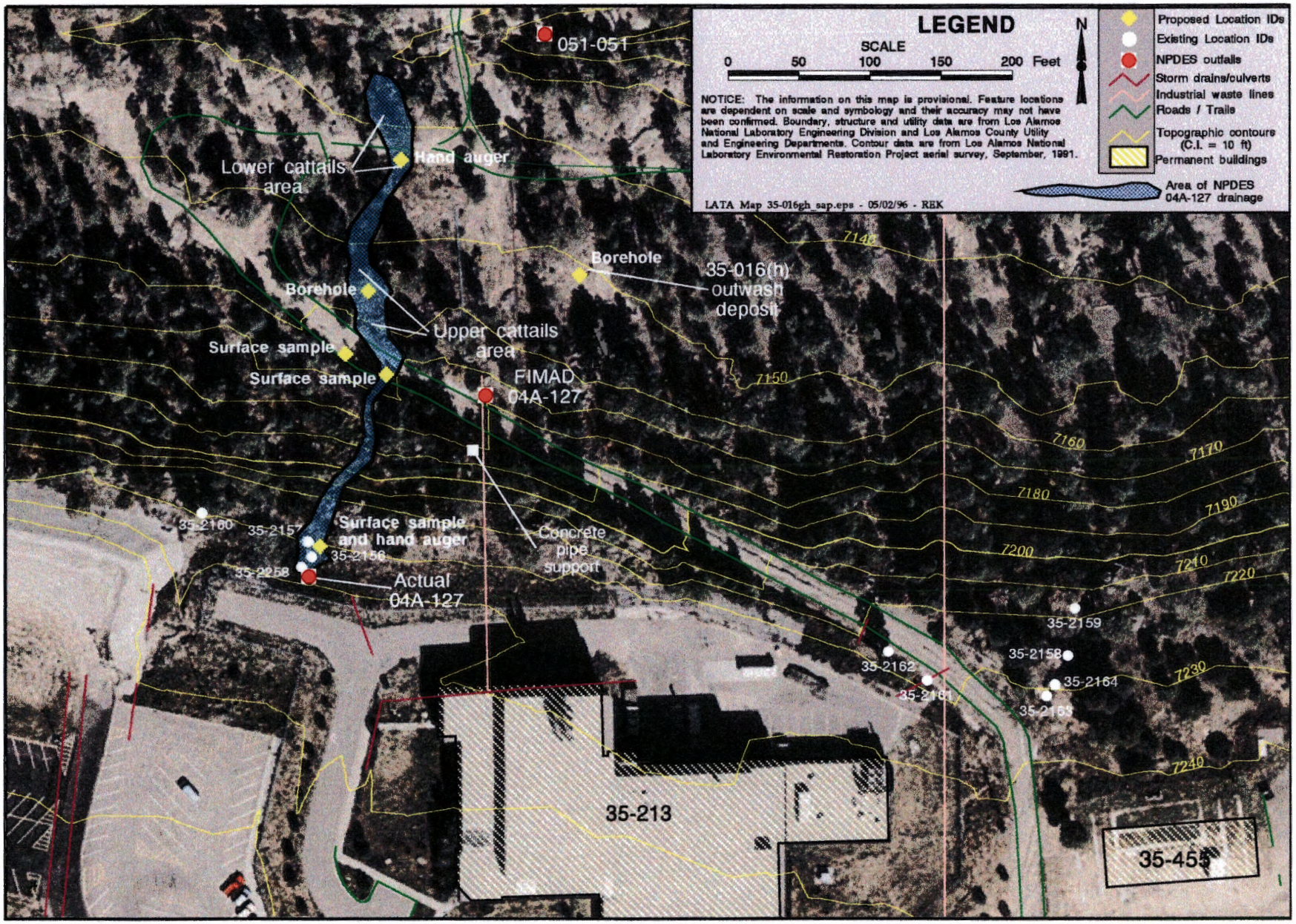

Figure AIII-3. View of PRS Nos. 35-016(g and h) showing existing and proposed sample locations.

Attachment IV

Requirements for Nonroutine Analysis

ATTACHMENT IV. REQUIREMENTS FOR NON-ROUTINE ANALYSES

IV.1 FIELD UNIT 4 REQUIREMENTS FOR PRETREATING SEDIMENT SAMPLES AND PARTICLE-SIZE DISTRIBUTION ANALYSIS

1.0 PURPOSE

This attachment addresses sediment sample pretreatment procedures and requirements for particle size distribution analysis (PSDA) of sediment samples. Sediment samples require a pretreatment procedure consisting of air-drying, sieving to remove the >2-mm size fraction, and representative sample splitting of the <2-mm size fraction into smaller aliquots for additional physical and chemical analyses. Selected sediment samples may require further sieving to obtain the <0.0625-mm size fraction. Requirements for PSDA employing dry-sieve and hydrometer methods are also described.

Sample prescreening for radioactivity consisting of gross-alpha, -beta, and -gamma radiation measurement will be conducted by Los Alamos National Laboratory (the Laboratory) within 24 hours of sample collection. Samples collected in areas that have a high potential for contamination by hazardous substances will be noted on service request agreements that will be included with the sample shipment.

2.0 THE SAMPLE PRETREATMENT PROCEDURE

2.1. Overview of the Procedure

The sample pretreatment procedure consists of air-drying and sieving to obtain specified size fractions. The sample may be submitted in more than one container. In this case, all the sample containers shall be combined before performing the pretreatment procedure. If tritium analysis has been requested, the sample aliquot for tritium analysis shall be removed before drying and sieving the sample. Sample aliquots for chemical, radiochemical and/or geotechnical analyses shall be removed following sample drying and sieving. For selected samples, additional radiochemical and chemical analyses of the silt plus clay size fraction (<0.0625 mm) may be requested. These samples will be clearly indicated on the service request agreement submitted by the Laboratory.

2.2. Shipping samples

Sediment samples may be shipped in more than one sample container (for example: two or three 2-liter plastic bottles per sample). If a sample is shipped in more than one container, the containers shall first be mixed together before any aliquots are removed or before the sample is dried and sieved. Samples shipped in more than one sample container will have identical sample identification numbers (barcode numbers) followed by the container number (for example: 0435-2345-01, 0435-2345-02).

2.3. Tritium Analysis

If requested, an aliquot of approximately 500 g (depending on gravimetric moisture content) shall be removed from the sample for tritium analysis. This sample split shall be removed after all sample containers are combined (if shipped in more than one container) and before drying and sieving. The sample shall then be analyzed for tritium according to procedures previously specified by the Laboratory. If the sample

is very dry, personnel shall determine the gravimetric moisture content and calculate the amount needed for tritium analysis. If there is insufficient sample, the Laboratory shall be contacted for further instructions.

2.4. Handling the Sediment Sample

The sediment sample shall be spread across a clean sheet of plastic or butcher paper, or across a clean plastic or metal tray. Sample should be spread to a depth of <2 cm. Allow the sample to air dry at room temperature (20°C or warmer) for 24 hours. The air-dried sample shall be weighed to the nearest 0.1 g.

2.5. Sieving Samples

Samples shall be sieved to remove the >2-mm size fraction (gravel and stones) and large pieces of non-mineral debris (roots, trash). A brass sieve with a mesh size of 2 mm (U.S. standard sieve mesh size No. 10) shall be employed. The <2-mm (gravel-free) fraction shall be weighed to the nearest 0.1 g and the weight recorded. If requested, the >2-mm (coarse) size fraction shall be stored in a labeled plastic bag for return to the Laboratory. Sieves should be thoroughly cleaned between each sample (using the best combination of brushing, compressed air, and/or washing with soap and deionized water) to remove trapped particles.

2.6. Mixing and Splitting Samples

The <2-mm size fraction shall be well mixed using appropriate methods (rubber policeman or mortar and pestle) to homogenize the sample. The technique used to homogenize the sample should minimize physical disintegration of samples. Implements used to homogenize sample should be thoroughly cleaned between each sample. Samples shall be split into representative aliquots using a standard soil splitter. The splitter should be thoroughly cleaned between each sample (using the best combination of brushing, compressed air, and/or washing with soap and deionized water) to remove trapped particles. Samples should be split into representative fractions for each suite of requested chemical and physical analyses. Weights required for each analysis are to be determined by the analytical laboratory.

3.0 REQUIREMENTS FOR PARTICLE SIZE DISTRIBUTION ANALYSIS

3.1. General Procedures

General procedures for particle size analysis as specified by American Society for Testing and Materials (ASTM) method ASTM D 422-63 (1990) shall be used for determining the particle size distribution of sediment samples submitted by the Laboratory. The Laboratory requires information about the distribution of sand-, silt-, and clay-sized particles.

3.2. Analysis for Sand-Sized Particles

Analysis for sand-sized particles shall be performed using dry-sieving procedures. Sands should be sieved using a set of sieves at one-phi increments corresponding to the size ranges listed below. The weight percent and sample weight for each sieved fraction, including the <0.0625-mm fraction caught in the bottom of the sieve pan, shall be reported to the nearest 0.1 g.

Phi value	Size Range (mm)
0	1.0
1	0.5
2	0.25
3	0.125
4	0.0625

3.3. Analysis for Silt- and Clay-Sized Particles

Silt-and clay-sized particle analysis shall be performed using the standard hydrometer procedures specified in the ASTM method. Distribution of the size fractions listed below shall be determined.

Particle Description	Phi Range	Size Range (mm)
Coarse and medium silt	4-6	0.0625-0.015
Fine and very fine silt	6-9	0.015-0.002
Clay	>9	<0.002

3.4. Data for PSDA

Laboratory-submitted data for PSDA shall include the following items.

- Weight percent of sample passing (or retained on) each sieve, or determined from hydrometer readings. Data shall be reported in both tabular and graphical form. The report shall include the following results: total weight of air-dried sample; the percent weight of the >2-mm and <2-mm size fractions; the percent weight of all sand-size fractions and remaining silt plus clay fraction; and the percent weight of the clay- and silt-sized fractions.

- Statistical and graphical interpretation of particle size distribution including graphic mean, standard deviation, skew, and kurtosis.

- Any notes regarding unusual properties or problems with the samples shall also be reported.

4.0 SILT PLUS CLAY SIZE FRACTION

4.1. Additional Sieving

Selected sediment samples may require additional sieving to obtain the silt plus clay (<0.0625 mm) size fraction. These samples will be selected at the discretion of the Laboratory and will be clearly specified in the service request agreement accompanying the samples. The sample aliquot requiring further sieving will be split from the sample that remains following removal of the >2 mm size fraction.

4.2. Procedure

Samples should be dry-sieved as described in Section 2.0 of this document. Both size fractions (>0.0625 mm and <0.0625 mm) shall be weighed to the nearest 0.1 g, and the weights recorded. Sieves should be thoroughly cleaned between each sample (using the best combination of brushing, compressed air, and/or washing with soap and deionized water) to remove trapped particles.

4.3. Contingency

Because of the coarse-sandy texture for many of sediment samples, there may be insufficient sample in the <0.0625-mm size fraction for additional chemical and radiochemical analyses. If this occurs, the analytical laboratory personnel shall contact the Laboratory for further instructions.

4.4. Splitting the Sample

The silt plus clay (<0.0625 mm) size fraction shall be split into representative portions using a standard soil splitter. The splitter should be thoroughly cleaned between each sample (using the best combination of brushing, compressed air, and/or washing with soap and deionized water) to remove trapped particles. Samples shall be split into representative fractions for each suite of chemical and radiochemical analyses. Weights required for each analysis are to be determined by the analytical laboratory.

5.0 LEFTOVER SAMPLE MATERIAL

All remaining sample material is to be shipped back to the Laboratory by the analytical laboratory unless otherwise instructed. Any sample remaining following sieving to remove the >2-mm size fraction, excluding sample aliquots taken for tritium analysis and PSDA, shall be returned to the original plastic bottle(s) used to ship the sample. The >2-mm size fraction shall be stored in a separate, labeled plastic bag and also returned to the Laboratory. For ease of shipping, the plastic bag containing >2-mm size fraction may be stored in the original sample container.

6.0 QUALITY ASSURANCE

A preparation blank sample consisting of high-purity, powdered aluminum oxide (or equivalent) shall be prepared with each batch of Laboratory samples. The blank sample will be air-dried, sieved through a 2-mm sieve, and split for analysis of radionuclides and trace metals. The preparation blank sample results will be reported with the data for each analytical suite.

IV.2 FIELD UNIT 4 REQUIREMENTS FOR PREPARING BOREHOLE CORE SAMPLES FOR ANALYSIS OF ANIONS BY ION CHROMATOGRAPHY

1. Core samples will be leached to extract water-soluble ionic species according to the procedure described in LANL-INC-DP-92, R1 (attached). The batch extraction method described in Section 6.5.1 of this document shall be used. Note: Although LANL-INC-DP-92 describes the extraction procedure for halide analysis, this procedure shall be used to prepare the leachate solution for all anion analyses, not just chloride and bromide.

2. Before preparing the leachate solution, the entire core sample will be ground using a ceramic grinder or ceramic ball mill (or equivalent) to a mesh size of 100 (<150 mm). The aliquot for analysis will be taken from the ground sample.

3. The minimum weight of sample to be extracted is 100 g. For deeper core samples, a larger sample mass may be required and analytical laboratory personnel will be advised when deep rock cores are submitted. A sample size of 500 ml will be provided to the analytical laboratory.

4. The mass of core sample extracted and the volume of water added to prepare the leachate shall be reported.

5. A preparation blank sample (high-purity, quartz sand or equivalent) shall be prepared with each batch of core samples.

6. The sample will be extracted for at least 16 hours. The extraction time for each sample shall be reported.

IV.3 FIELD UNIT 4 REQUIREMENTS FOR ANALYZING ANIONS BY ION CHROMATOGRAPHY

1. The procedure used for anion measurements shall be based on EPA SW-846 Method 9056 (September 1994 version).

2. The minimum required detection limits are 0.05 mg/L for F^- and 0.1 mg/L for Br^-, Cl^-, NO_3^- NO_2^-, PO_4^{3-}, and SO_4^{2-} (with a 100 µL sample loop and a 10 µmho full-range setting on the conductivity detector). However, all detected concentrations shall be reported. If an analyte is not detected, the value reported shall be the detection limit accompanied by a "U" flag.

3. The IC **[Cathy: Define? cf]** instrument must be calibrated using a minimum of three concentration levels and a blank. One of the standards should be at a concentration near, but above, the method detection limit. The other standards should define the working range of the instrument. The calibration curve must have a correlation coefficient $r^2 \geq 0.99$.

4. The working calibration curve must be verified on each working day as described in SW-9056. The response and retention time for any analyte may not vary by more than ±10% from the initial calibration values. If the results exceed ±10%, a new calibration curve must be prepared. The results of the daily calibration check shall be reported in the hard copy deliverable.

5. A quality control (QC) reference sample must be analyzed with each sample batch. The QC reference sample must be a sample of known composition prepared independently of the calibration standards. The percent recovery from the QC reference sample shall be reported in the hard copy deliverable.

6. After every 10 injections, a midrange calibration standard must be analyzed. If the instrument response has changed by more than 5%, a new calibration curve must be prepared.

7. Duplicate samples shall be analyzed at a frequency of 10%, or one duplicate per batch, whichever is greater. The results of the duplicate sample analysis shall be reported in the hard copy deliverable.

8. A matrix spike sample shall be analyzed at a frequency of 5%, or one per batch, whichever is greater. The percent recovery from the matrix spike sample shall be reported in the hard copy deliverable.

IV.4 FIELD UNIT 4 REQUIREMENTS FOR ANALYZING HEXAVALENT CHROMIUM IN SOIL EXTRACTS

1. An **[Cathy: A? cf]** soil extract shall be prepared according to the Toxicity Characteristic Leaching Procedure (TCLP), SW-1311. The TCLP extract will then be analyzed for hexavalent chromium using either the chelation-extraction/flame atomic absorption method (SW-7197) or ion chromatography (EPA standard method number 218.6). The amount of hexavalent chromium in the soil sample will be calculated from the amount in the TCLP extract using the following formula, which assumes that the density of the extraction fluid is 1 g/ml:

$$\text{concentration } Cr^{6+} \text{ in soil} = 20 \times \text{concentration } Cr^{6+} \text{ in extract (mg/L)} \times 1 \text{ (L/kg)}$$

2. The minimum required detection limit for hexavalent chromium is 5 µg/L. However, all detected concentrations shall be reported. If an analyte is not detected, the value reported shall be the detection limit accompanied by a "U" flag.

3. The instrument must be calibrated using a minimum of three concentration levels and a blank. One of the standards should be at a concentration near, but above, the method detection limit. The other standards should define the working range of the instrument. The calibration curve must have a correlation coefficient $r^2 \geq 0.99$.

4. The calibration curve must be verified on each working day. The response and retention time for hexavalent chromium may not vary by more than ±10% from the initial calibration values. If the results exceed ±10%, a new calibration curve must be prepared. The results of the daily calibration check shall be reported in the hard copy deliverable.

5. A QC reference sample must be analyzed with each sample batch. The QC reference sample must be a sample of known composition prepared independently of the calibration standards. The percent recovery from the QC reference sample shall be reported in the hard copy deliverable.

6. After every 10 injections, a midrange calibration standard must be analyzed. If the instrument response has changed by more than 5%, a new calibration curve must be prepared.

7. Duplicate samples shall be analyzed at a frequency of 10% or one duplicate per batch, whichever is greater. The results of the duplicate sample analysis shall be reported in the hard copy deliverable.

8. A matrix spike sample shall be analyzed at a frequency of 5%, or one per batch, whichever is greater. The percent recovery from the matrix spike sample shall be reported in the hard copy deliverable.

SAMPLE LEACHING TO EXTRACT SOLUBLE CHLORIDE AND BROMIDE

1.0 PURPOSE

This detailed technical procedure (DP) describes three sample leaching procedures used for extracting soluble chloride and bromide from soil and rock samples for the Yucca Mountain Site Characterization Project (YMP).

2.0 SCOPE

This DP applies to all YMP personnel who conduct soil and rock sample leaching as part of the YMP's Water Movement Test task for Los Alamos National Laboratory (LANL).

3.0 REFERENCES

TWS-QAS-QP-02.7	Personnel Training
LANL-YMP-QP-03.5	Procedure for Documenting Scientific Investigations
TWS-QAS-QP-12.1	Procedure for Control of Measuring and Test Equipment
LANL-INC-DP-87	Identification, Storage, and Handling of Samples at Hydro Geo Chem
LANL-INC-DP-88	Collection of Soil Samples for Analysis of Moisture Content, Bulk Density, Halides and Chlorine Isotopes
LANL-INC-DP-89	Procedure for Sieving Soil and Rock Samples
LANL-INC-DP-93	Step-Leaching Procedure for Extracting Soluble Chloride and Bromide
LANL-INC-DP-94	Procedure for Using Ion Chromatography to Determine Chloride and Bromide Concentrations
LANL-INC-DP-95	Preparation of Samples for Chlorine-36 Analysis
LANL-INC-DP-97	Preparation of Carrier Solution for Chlorine-36 Samples

4.0 DEFINITIONS

4.1 Samples

Samples are geologic materials intended for laboratory studies or analyses as part of YMP site characterization investigations. Soil samples include any unconsolidated material above bedrock, i.e., the regolith, collected by the methods described in DP-88. Rock samples

include, but are not limited to, surface samples, drill cores, drill cuttings, and muck from mining operations.

4.2 Leachate

Leachate refers to the aqueous solution obtained by combining reagent water with a sample of soil or rock and allowing time for soluble constituents to dissolve into the water.

4.3 Reagent Water

Reagent water is water that has been analytically purified to remove impurities so that the resistivity is greater than 17.5 megohms.

4.4 Process Blank

The purpose of a process blank is to test for the presence of chloride contamination in the materials used for processing samples for chloride and chlorine isotopic analyses. The process blank consists of taking a volume of reagent water through the same processes, and using the same materials, as are used for actual samples, following this DP. Because the materials used in the leaching process should be chloride-free, the presence of chloride in the process blank (detected following DP-94) may indicate a problem with chloride contamination.

4.5 Carrier

Carrier is a chloride salt, prepared in solution pursuant to DP-97, that contains a negligible concentration of chlorine-36 relative to stable chlorine; ideally, the carrier should have a $^{36}Cl/Cl$ ratio $\leq 8 \times 10^{-15}$. Carrier may be added to a filtered leachate in order to increase the chloride mass to levels sufficient for isotopic analysis.

5.0 RESPONSIBILITIES

5.1 Principal Investigator (PI)

The PI has overall responsibility for work performed under this DP, ensures that each user is trained, recommends and directs variations when appropriate, and determines the acceptability of data. He/She may assign portions of these tasks to appropriate personnel trained to the DP.

5.2 Users

YMP personnel who use this DP are responsible for adhering to the procedures described in it and for documenting deviations from this procedure in accordance with QP-03.5.

6.0 PROCEDURE

6.1 Principle

Soil and rock samples included as part of the YMP Water Movement Test investigation need to be leached in order to extract soluble halides for subsequent analyses of chloride, bromide, chlorine-36, and stable chlorine isotopes. Details of the leaching procedure described in this DP vary slightly depending upon whether subsequent analyses are only for total halides or for chlorine isotopes as well. Standardized leaching procedures ensure the consistency and integrity of analytical results.

6.2 Equipment and Hardware/Software

6.2.1 Equipment Malfunctions

Any equipment malfunction occurring during implementation of this procedure is likely to be readily detectable in the course of conducting work and hence is not expected to have a detrimental effect on the final results. If a problem with any equipment arises which can be considered a potential source of error or uncertainty for the results, then it is addressed following section 6.7.

The water purification system has a meter that indicates the resistivity of the purified water. This meter is checked periodically to verify that the resistivity is within the range of acceptable values, i.e., greater than 17.5 megohms.

6.2.2 Safety Considerations

Good laboratory and scientific practices are used in the laboratory to protect against injury. Applicable LANL and/or LANL-contractor safety practices for conducting laboratory work are followed, as appropriate.

6.2.3 Equipment, Materials and Chemicals

Equipment, materials, and chemicals needed to conduct soil and rock leaching are listed below. Required entries related to these items are listed in Attachment 2. Items equivalent to those listed below may be used provided they perform the same function with an acceptable level of performance as judged by the user or the PI. Not all of the following items may be needed for processing any given sample by this DP.

6.2.3.1 Equipment

- water purification system capable of producing reagent water (e.g., Barnstead/Thermolyne NANOpure Analytical Grade Deionizing Water Purification System, Model D4742, with 0.2 μm final filter and Culligan pre-treatment Reverse Osmosis unit)
- analytical balance (e.g., AND Model FX-2000)
- hot plate with temperature control up to 100°C or greater (e.g., Lindberg Hot Plate, Model 53015)
- centrifuge
- vacuum pump for filtration apparatus
- convection oven

All of the leaching procedures described in section 6.5 require the use of the analytical balance and water purification system, with use of the centrifuge being optional. When soil or rock samples are leached for chlorine isotope analyses (section 6.5.2 and 6.5.3), then the vacuum pump is also required.

6.2.3.2 Materials and Supplies

New labware is initially washed with detergent such as Alconox, rinsed with tap water, then rinsed three times with reagent water. Subsequent use requires rinsing three times with reagent water, unless excessive sample material or non-soluble compounds have contaminated a piece of labware, in which case the item is washed using the procedure for new labware. Just prior to use, each piece of labware is rinsed with a small volume of the solution it will contain. Filters used for filtering leachate are 0.45 μm cellulose nitrate filter membranes, which are flushed with reagent water prior to use and which are tested periodically for leachable chloride by preparing a process blank. A detailed list of materials and supplies is given in Attachment 1.

6.2.3.3 Reagent chemicals

- reagent water
- high purity nitric acid (HNO_3)
- high purity ammonium hydroxide (NH_4OH)
- carrier solution, prepared pursuant to DP-97

6.3 Preparatory Verification

6.3.1 Hold Points

The user contacts the PI to determine whether the sample needs to be sieved in accordance with DP-89 before being leached.

6.3.2 Calibration

The analytical balance, which is used to weigh soil samples prior to leaching and carrier solution prior to its addition to a leachate, is controlled pursuant to QP-12.1.

6.3.3 Environmental Conditions

Measures to minimize the potential for cross-contamination by particles or by sources of chloride and bromide other than that in the sample being analyzed are discussed in section 6.5. To monitor the adequacy of these measures, at least one process blank is required to be processed as part of each sample suite.

6.4 Control of Samples

It is imperative that sample identification and control be sufficient to trace a sample and its derivatives from its original field location to the point of analysis and that the integrity of the sample be safeguarded during the entire analytical process. Consequently, users must be trained to DP-87 before they can work with samples analytically and they must also follow guidelines set forth in that document for sample management.

Laboratory containers are labeled with the identifier of the sample that they are to hold, prior to that sample being transferred into them. This precaution will reduce the possibility of incorrect or ambiguous sample identification and cross-contamination.

6.5 Implementing Procedure

This section describes three procedures for leaching halides from soil and rock samples. The choice of method is determined by the user based both on the type of analysis to be performed and on the convenience of a particular method.

Section 6.5.1 describes a batch extraction method to be used when the leachate is only to be analyzed for chloride and bromide concentrations, i.e., when sample size is relatively small (generally less than 1 kg).

Section 6.5.2 describes a batch extraction method to be used when the leachate is also to be analyzed for chlorine isotopic ratios, i.e., when sample size is relatively large (several kg).

Section 6.5.3 describes a column leaching method which can also be used when the leachate is to be analyzed for chlorine isotopic ratios. It is an alternative to the batch extraction method for large samples.

6.5.1 Batch Extraction Method for Halide Analyses

6.5.1.1 Sample Size Requirements

Leachable halides are extracted from soil or rock samples by mixing a weighed quantity of this material with a measured volume of reagent water, in an appropriately-sized container. For shallow soil samples which are likely to contain a high chloride content, 100 grams of soil, sieved as directed by the PI per section 6.3.1, is usually sufficient for determination of chloride and bromide content. For deep rock samples expected to be lower in chloride, 1-3 kg of rock material is probably sufficient for chloride and bromide determination. Again, this material may need to be processed according to section 6.3.1 prior to being leached. Sample masses are obtained using an analytical balance and recorded with a precision of 1% or better.

6.5.1.2 Leaching Procedure

The weighed air-dry sample is combined with a minimum volume of reagent water so as to maximize the sample:water ratio and hence the chloride concentration of the leachate (see note). The volume of water added is determined with a precision of 1% or better. After the sediment and water are combined, the mixture is stirred or swirled intermittently over a

period of 48 hours, after which suspended solids in the sample are allowed to settle.

NOTE: The minimum volume of water which can be used must be sufficient to completely saturate the sample, with enough excess water to ensure that sufficient volume can be extracted for analysis and archiving (step 6.5.2.3.a). An approximate proportion of 1:1 (on a mass basis) for sample:water generally is satisfactory in these regards.

6.5.1.3 Extraction of Leachate for Analysis

A small volume of leachate is drawn into a clean sample syringe. This aliquot is analyzed for chloride and bromide following DP-94.

6.5.1.4 Disposition of Leached Sample

If the solid sample or remaining leachate is to be saved, then the leachate is extracted from the soil or rock sample by decanting or by centrifugation. Generally, the only time that one would want to archive the leached solid material would be if step-leaching (DP-93) or particle-size analysis (DP-89) were to be conducted on it. If the leached solid is to be archived, then the residual solid sample material is dried, e.g. in a convection oven, and stored in a sealed, labeled container for possible future use. The extracted leachate is stored in the refrigerator in a capped and labeled sample bottle for additional analyses. When the PI determines that there is no longer a need for the leached sample or the leachate, they can be discarded. Disposition of the leached sample is documented in the notebook or logbook.

6.5.2 Batch Extraction Method for Chlorine Isotope Analyses

6.5.2.1 Sample Size Requirements

Larger sample volumes are needed for determination of chlorine-36 than for chloride and bromide alone because isotopic analysis by the tandem accelerator mass spectrometer requires a minimum of 1.5 mg chloride, with 20 mg chloride the preferred target amount. Analytical requirements for determination of the stable chlorine isotope ratio dictate a minimum of 10 mg chloride. For shallow soil samples, approximately 1 kg of soil is needed; deep rock samples can

require as much as 10 to 15 kg of material. These numbers are guidelines rather than absolutes. If the actual chloride content of a particular sample is known, e.g., by processing a small quantity following step 6.5.1, then the size requirements for leaching can be tailored to that sample. Sample masses can be obtained using either an analytical or mechanical beam balance and are recorded with a precision of 1% or better.

6.5.2.2 Leaching Procedure

The weighed air-dry sample is combined with a minimum volume of reagent water so as to maximize the sample:water ratio and hence the chloride concentration of the leachate (see note). The volume of water added is determined with a precision of 1% or better. After the sediment and water are combined, the mixture is stirred or swirled intermittently over a period of 48 hours, after which suspended solids in the sample are allowed to settle.

NOTE: The minimum volume of water which can be used must be sufficient to completely saturate the sample, with enough excess water to ensure that sufficient volume can be extracted for analysis and archiving (step 6.5.1.4). An approximate proportion of 1:1 (on a mass basis) for sample:water generally is satisfactory in these regards.

It is possible that the sample may need to be partitioned into more than one container for leaching. After the sample and water are combined, the mixture is stirred or swirled intermittently over a period of 48 hours, after which the suspended solids in the sample are allowed to settle. After 48 or more hours, the leachate is extracted from the solid sample by suctioning, decanting or by centrifugation. If more than one container was used for the leaching of a single sample, then all leachates are combined into a single container at this point.

6.5.2.3 Determination of Chloride, Bromide, and Adequacy of Sample Size

a. Determination of the quantity of chloride in the sample. A small volume of leachate is drawn into a clean syringe and analyzed for chloride and bromide following DP-94. The total amount of chloride in the aqueous sample is roughly estimated using the measured chloride concentration and the leachate volume. If the total chloride is at least 5 mg, then an additional

50 ml or more of leachate is removed and stored in the refrigerator in a capped and labeled sample bottle as an archival sample for re-analysis if judged necessary. The user proceeds to step 6.5.2.4.

b. Methods for augmenting the quantity of chloride in the sample. If the total chloride is significantly less than 5 mg, then the PI is consulted. The PI may instruct the user to augment the recovered Cl by processing additional sample material; additional leachate is prepared following step 6.5.2.2, combined with the first leachate at the end of 6.5.2.2, and processed as a single sample starting with step 6.5.2.3.a. Alternatively, the PI may decide that a known amount of carrier solution, prepared and used in accordance with DP-97, should be added to the leachate to increase the quantity of chloride. The archival sample described in step 6.5.2.3.a is removed before the addition of the carrier. The desired quantity of carrier solution is weighed and added to the leachate. As a double-check, the Cl concentration of the leachate after this addition is determined in accordance with DP-94. If the concentration differs from that expected by more than 5%, work on this sample shall stop until the discrepancy can be explained or else the PI is consulted for sample disposition.

6.5.2.4 Addition of Nitric Acid

If the leachate still contains significant suspended material that makes filtration highly inefficient, the leachate is acidified with high purity HNO_3 acid (about 1 ml acid per liter of leachate) and the suspended material allowed to settle overnight.

6.5.2.5 Volume Determination

The leachate is filtered through a pre-rinsed 0.45 μm cellulose nitrate filter membrane. The volume or mass of the filtered leachate is measured to a precison of 10% or better. The volume is used in conjunction with the chloride analysis obtained previously in order to determine the total quantity of chloride in the leachate.

6.5.2.6 Evaporation

Leachate volumes much greater than 1 liter are evaporated down to about 1 liter or less in volume. If nitric acid was added to the leachate in step 6.5.2.4, then an equivalent volume of concentrated NH_4OH is added to the leachate before the

sample is heated in order to minimize the possible loss of chloride from the solution by volatilization of hydrogen chloride. The final volume of the evaporated leachate need not be determined.

6.5.2.7 Preparation for Isotopic Analysis

The leachate is then processed into AgCl precipitate for chlorine-36 analysis following DP-95, or submitted as a solution to an outside laboratory for analysis of the stable chlorine isotope ratio.

6.5.2.8 Disposition of Leached Sample

If the residual solid sample material is to be archived, then it is dried (e.g., in a convection oven) and stored in a sealed, labeled container for possible future use. If or when the PI determines that there is no longer a need for the leached sample or for the archived leachate, they can be discarded.

6.5.3 Column Leaching Method for Chlorine Isotope Analyses

6.5.3.1 Sample Size Requirements

Column leaching is an alternative method for leaching kilogram quantities of soil or rock material. Volume requirements are the same as described in section 6.5.2.1.

6.5.3.2 Initial Setup of Column

The column leaching method uses a simple device which allows water to flow slowly through the sample material, and theoretically should produce a smaller volume of leachate that is less turbid than that for the batch extraction method. A layer of glass wool is placed in the bottom of a wide-diameter glass tube, followed by a layer of reagent-grade quartz sand. Several kilograms of sample material, sieved if necessary according to section 6.3.1, are placed in the glass tube. The sample is then covered by an additional layer of quartz sand.

6.5.3.3 Initial Saturation of Sample

The user may choose one of two ways to initially saturate the sample. First, a gravity-fed system, connected to the bottom of the sample cylinder, may be used to saturate the sample from below with reagent water. The inflow is stopped once

outflow begins to occur above the upper layer of sand, i.e., flow is upward through the column. The pore volume is estimated at this point by noting the volume of water that was required to initially saturate the sample.

Alternatively, the user may choose to saturate the sample by adding reagent water to the sample in a large beaker and then transferring the slurry into the sample cylinder. This method minimizes the problem of air entrapment as the advancing wetting front saturates the column. The pore volume (needed for the next step) then must be estimated by the user. However, the accuracy of the porosity is not critical to the success of the procedure.

In either case, once the sample is saturated, it sits undisturbed for 48 or more hours.

6.5.3.4 Leaching of Sample

After 48 or more hours, an additional 1-2 pore volumes of reagent water is slowly flushed through the system, and the entire volume of leachate is collected in a pre-cleaned container. The quartz sand placed on top of the sample in the column coarsely filters the leachate as it drains to the outlet.

6.5.3.5 Determination of Chloride, Bromide, and Adequacy of Sample Size

a. Determination of the quantity of chloride in the sample. A small volume of leachate is drawn into a clean syringe and analyzed for chloride and bromide following DP-94. The total amount of chloride in the aqueous sample is roughly estimated using the measured chloride concentration and the leachate volume. If the total chloride is at least 5 mg, then an additional 50 ml or more of leachate is removed and stored in the refrigerator in a capped and labeled sample bottle as an archival sample for re-analysis if judged necessary. The user proceeds to step 6.5.3.6.

b. Methods for augmenting the quantity of chloride in the sample. If the total chloride is significantly less than 5 mg, then the PI is consulted. The PI may instruct the user to augment the recovered Cl by processing additional sample material; the second leachate is prepared following steps 6.5.3.2 through 6.5.3.4, combined with the first leachate at the end of 6.5.3.4, and processed as a single sample starting with step 6.5.3.5.a.

Alternatively, the PI may decide that a known amount of carrier solution, prepared and used in accordance with DP-97, should be added to the leachate to increase the quantity of chloride. The archival sample described in step 6.5.3.5.a is removed before the addition of the carrier. The desired quantity of carrier solution is weighed and added to the leachate. As a double-check, the Cl concentration of the leachate after this addition is determined in accordance with DP-94. If the concentration differs from that expected by more than 5%, work on this sample shall stop until the discrepancy can be explained or else the PI is consulted for sample disposition.

6.5.3.6 Processing of the Leachate

Subsequent treatment of the leachate and disposition of the leached sample follow the procedures described in sections 6.5.2.4 through 6.5.2.8.

6.6 Data Acquisition and Reduction

Initial soil and water masses and volumes are generally determined with precisions of 1% or better, and volumes of recovered leachates with a precision of 10% or better. Masses and volumes determined for estimation purposes may have greater uncertainties. Attachment 2 lists the required data entries, and Attachment 3 provides an example of the logsheet for recording these entries. Calculations using the data generated following this DP are verified by the PI before submission of the results to the Records Processing Center (RPC). The acceptability and precision of the data are also evaluated by the PI prior to submission of the results to the RPC, taking into account the precision of the instruments used as documented pursuant to QP-12.1.

6.7 Deviations from the DP and Potential Sources of Error and Uncertainty

Careful labeling of containers reduces errors due to mislabeling. The possibility of sample contamination is reduced by working in a clean environment. The user is responsible for documenting deviations from this procedure in accordance with QP-03.5. If a problem arises which can be considered a potential source of error or uncertainty for the results, then it is also documented in the laboratory notebook or logbook in accordance with QP-03.5.

7.0 RECORDS

Records to be generated as a result of the proper execution of this DP are entries in laboratory notebooks or logbooks and in the Sample Inventory Logbook. These records are controlled by procedures QP-03.5 and DP-87. A checklist for laboratory notebook entries relevant to this DP is provided in Attachment 2, and an example logsheet for recording these entries is provided in Attachment 3.

8.0 ACCEPTANCE CRITERIA

The criteria that show that this procedure has been correctly implemented are the records identified in Section 7.0.

9.0 TRAINING

A prerequisite for this DP is to train to DP-87. This DP requires read-only training. In accordance with the training procedure QP-02.7, the authors are considered trained to this DP. Training of personnel to this DP is documented pursuant to QP-02.7.

10.0 ATTACHMENTS

Attachment 1:	Detailed List of Materials and Supplies (1 page)
Attachment 2:	Checklist of Laboratory Notebook Entries (1 page)
Attachment 3:	Example Logsheet for Leaching Procedure (1 page)

DETAILED LIST OF MATERIALS AND SUPPLIES

Materials and supplies for batch leaching (sections 6.5.1 and 6.5.2)

- glass beakers with covers (e.g., watch glasses, parafilm)
- large-volume (10 liters or more) stainless steel vessels
- volumetric pipets and pipet bulb
- volumetric flasks
- filtration apparatus
- pre-rinsed 0.45 μm cellulose nitrate membrane filters with forceps for picking up
- vacuum flask
- tubing to connect vacuum flask to pump
- hot mitt or pot holder
- glass bottles (for archived leachates)

Materials and supplies for column leaching (section 6.5.3)

- large-diameter (e.g., 7-10 cm) glass tube, about 30 cm long, with a hose fitting on one end
- flexible tubing, with outer diameter to fit hose fitting on glass tube
- hose clamps
- glass funnel to serve as feed reservoir
- glass wool
- large ringstand with clamps, 1 for each setup
- pipet bulb and volumetric pipets
- volumetric flasks
- filtration apparatus
- pre-rinsed 0.45 μm cellulose nitrate membrane filters with forceps for picking up
- vacuum flask for filtering
- tubing to connect vacuum flask to pump
- hot mitt or pot holder
- glass beakers
- glass bottles (for archived leachates)

CHECKLIST OF LABORATORY NOTEBOOK ENTRIES

Initial descriptive information is entered in the laboratory notebook of logbook as appropriate prior to starting a technical procedure and on a continuing basis as experimental and procedural changes dictate. These entries are:

- reference to this and any other relevant DPs, including revision number
- unique identifiers for any calibrated equipment used to conduct this DP
- manufacturer and lot number of any chemical reagents used in this DP

Additional information is entered into the laboratory notebook or logbook as relevant. These entries are:

- deviations from specified technical procedure (if any)
- acceptance or rejection of any data produced by a deviation from this DP
- problems (if any) which may pose a potential source of error or uncertainty for the results

In addition to general entries, several parameters need to be recorded in order to evaluate the resulting data. These entries are:

- sample processed, listed by its unique identifier
- air-dried mass of sample (1% precision or better)
- volume of reagent water added (1% precision or better)
- leaching method used (column or batch)
- leaching start date
- volume of extracted leachate (10% precision or better)
- volume of HNO_3 acid added (if any, 20% precision or better)
- mass and solution identifier for any carrier added (precision as stated in DP-97)
- disposition of leached sample (e.g., archived or discarded)

EXAMPLE LOGSHEET FOR LEACHING PROCEDURE

LEACHING PROCEDURE - SAMPLE PREPARATION (a) Reference: LANL-INC-DP-92, R1

Sample Aliquot Acquisition Documented in (Check Appropriate Logbook):

_____ Rock Samples: TWS-INC:_____

_____ Soil Samples: TWS-INC:_____

1	2	3	4	5	6	7	8	9	10	11	12
									Chlorine-36 Entries		
Sample	36-Chlorine or Cl/Br	Sieved or Hand-picked	Leaching Start Date	Air-Dry Leached Mass, g	Water Added, ml	Dilution Factor (b)	Leaching End Date	Disposition of Leached Sample	Volume of Filtered Leachate, ml	Volume of HNO3 Added, ml	Mass and ID of Carrier Solution Added, if any

Comment:

Leaching Begun By (columns 1 through 7):

Date:

Comment:

Leaching Finished By (columns 8 through 12):

Date:

(a) Comments and any deviations are documented in Lab Notebook, TWS-INC:_____

(b) Dilution Factor = Water Added, ml / Air-Dry Leached Mass of Sample, g

Attachment V

Field Unit 4 Field Activity Forms

ESH-1 DIRECT SURVEY FORM

SAMPLE DESCRIPTION

Sample Date/Time: _____ No. Of Samples: _____

TA: _____ Bldg: _____

RCT: _____ Z Number: _____

Phone/Fax: _____

SAMPLE TRACKING NUMBER

PURPOSE OF SURVEY

☐ ROUTINE ☐ PRE-JOB ☐ POST-JOB ☐ HOT-JOB

☐ ITEM RELEASE ☐ OFFSITE SHIPMENT ☐ ONSITE SHIPMENT

☐ NON-ROUTINE/OTHER: _____

INSTRUMENTATION

TYPE	SE No.	CAL DUE	% EFF	

ADDITIONAL INFORMATION

☐ Occurrence No.: _____

☐ Incident No.: _____

☐ RWP No.: _____

Item/Area	Alpha		Beta/Gamma		Remarks
	cpm	dpm	cpm	dpm	

ESH-1 LAS SURVEY FORM

SAMPLE DESCRIPTION

Sample Date/Time: _____ No. Of Samples: _____

TA: _____ Bldg: _____

RCT: _____ Z Number: _____

Phone/Fax: _____

SAMPLE TRACKING NUMBER

PURPOSE OF SURVEY

☐ ROUTINE ☐ PRE-JOB ☐ POST-JOB ☐ HOT-JOB

☐ ITEM RELEASE ☐ OFFSITE SHIPMENT ☐ ONSITE SHIPMENT

☐ NON-ROUTINE/OTHER: _____

INSTRUMENTATION

TYPE	HSE No.	CAL DUE	% EFF	BKG

ADDITIONAL INFORMATION

☐ Occurrence No.: _____

☐ Incident No.: _____

☐ RWP No.: _____

Item/Area	Alpha		Beta/Gamma		Remarks
	cpm	dpm	cpm	dpm	

ESH-1 SMEAR SURVEY FORM

SAMPLE DESCRIPTION

Sample Date/Time: _____ No. Of Samples: _____

TA: _____ Bldg: _____

RCT: _____ Z Number: _____

Phone/Fax: _____

SAMPLE TRACKING NUMBER

PURPOSE OF SURVEY

☐ ROUTINE ☐ PRE-JOB ☐ POST-JOB ☐ HOT-JOB

☐ ITEM RELEASE ☐ OFFSITE SHIPMENT ☐ ONSITE SHIPMENT

☐ NON-ROUTINE/OTHER: _____

INSTRUMENTATION

TYPE	HSE No.	CAL DUE	% EFF	BKG

ADDITIONAL INFORMATION

☐ Occurrence No.: _____

☐ Incident No.: _____

☐ RWP No.: _____

Smear No.	Location	Alpha*	Beta*	Gamma*

Smear No.	Location	Alpha*	Beta*	Gamma*

*dpm/100 cm2

ESH-1 SMEAR CONTINUATION FORM

Smear No	Location	Alpha*	Beta*	Gamma*

Smear No.	Location	Alpha*	Beta*	Gamm

FU 04 EQUIPMENT AND ITEM REMOVAL LOG[a]

Survey Instrument	Smear Counter	Facility
HS Property Number	HS Property Number	
Calibration Due Date	Calibration Due Date	

			Exterior Survey		Interior Monitoring[b]				
Date	RCT: Enter name (print), signature, and Z #	Item Part Number and Description	Direct Survey (dpm/100cm^2)	Smear Survey (dpm/100cm^2)	Required? Yes/No	Direct Survey (dpm/100cm^2)	Smear Survey (dpm/100cm^2)	Responsible Person: Enter name (print), signature, Z #, and organization phone	Comments Write additional comments on back

a Item cannot be released unless survey results are below *LANL Radiological Control Manual* Table 2-2 limits for conditional release and below detectable activity for unconditional release (release to the general public).

b Disassembly and interior monitoring is required unless responsible person verifies by his/her signature that internal contamination is not possible, based upon knowledge of process and previous use.

FU 04 Survey Form

Item Surveyed: _____ **Page** _____ **of** _____ **Date:** _____/ _____/ _____

Site: _____	α Direct	β/γ Direct	α Removable:	β/γ Removable
RCT/RSP: _____	Ratemeter: _____	Ratemeter: _____	Ratemeter: _____	Ratemeter: _____
Name: _____	Probe: _____	Probe: _____	Probe: _____	Probe: _____
Signature: _____	Cal. Due Date: _____	Cal. Due Date: _____	Cal. Due Date: _____	Cal. Due Date: _____
Comments:	HSE #: _____	HSE #: _____	HSE #: _____	HSE #: _____
	Bkgd: _____cpm Eff: ____%	Bkgd: _____cpm Eff: ____%	Bkgd: _____cpm Eff: ____%	Bkgd: _____cpm Eff: ____%
	MDA: _____	MDA: _____	MDA: _____	MDA: _____

Item Survey	Direct Alpha		Direct Beta/Gamma		Removable Alpha		Removable Beta/Gamma		Dose Rate	Comments
	cpm	dpm/100cm^2	cpm	dpm/100cm^2	cpm	dpm/100cm^2	cpm	dpm/100cm^2	micro-R/hr	

MDC (Ratemeter) = 3σ (units cpm)
MDC (Ratemeter) = MDC/Efficiency × probe correction
MDA (Scaler) = $[2.71 + (4.65 \cdot (b^{\circ} \cdot t_S)^{0.5})]/(Eff \cdot t_S)$
t_S = Sample Count Rate
b° Background Count Rate

$$\sigma = [0.25 \times (\Sigma(B_i - B)^2)]^{1/2} \text{(units cpm)}$$
$i = 1$ to n

B_i = individual background count reading
B = the mean or average of 5 different background count readings from different areas

Probe type	Correction Factor:
β/γ Ludlum GM Pancake probe	100/15 5(cm^2/cm^2)
α Ludlum GM Pancake probe	100/75 cm^2/cm^2)
α Eberline AC-3 (Zns) probe	100/59 cm^2/cm^2)

FU 04 SURVEY FORM (Continued)

Item Surveyed: _____ **Page** _____ of _____ **Date:** _____/ _____/ _____

RCT: _____

Signature: _____

Item Survey	Direct Alpha		Direct Beta/Gamma		Removable Alpha		Removable Beta/Gamma		Dose Rate	Comments
	cpm	dpm/100cm^2	cpm	dpm/100cm^2	cpm	dpm/100cm^2	cpm	dpm/100cm^2	micro-R/hr	

MDC (Ratemeter) = 3σ (units cpm)
MDC (Ratemeter) = MDC/Efficiency × probe correction
MDA (Scaler) = $[2.71 + (4.65 \cdot (b^{\circ} \cdot t_S)^{0.5})]/(Eff \cdot t_S)$
t_S = Sample Count Rate
b° Background Count Rate

$$\sigma = [0.25 \times (\sum_{i=1}^{n}(B_i - B)^2)]^{1/2} \text{(units cpm)}$$

B_i = individual background count reading
B = the mean or average of 5 different background count readings from different areas

Probe type	Correction Factor:
β/γ Ludlum GM Pancake probe	100/15 5(cm^2/cm^2)
α Ludlum GM Pancake probe	100/75 cm^2/cm^2)
α Eberline AC-3 (Zns) probe	100/59 cm^2/cm^2)

FU 04 TAILGATE SAFETY MEETING

OU _____ TA _____ SSHASP No. _____ Date _____ / _____ / _____

Site Work Plan _____

SAFETY TOPICS PRESENTED

SUBJECTS DISCUSSED (Including Change Orders)

_____

_____

_____

HAZARDS: _____

_____

Biological (Site/Operational) _____

_____

Chemical _____

_____

Physical _____

_____

Radiological _____

_____

HAZARD CONTROL MEASURES:

Personal Protective Equipment _____

_____

Engineering/Administrative Control _____

_____

Monitoring(IH/HP) _____

_____

Special Equipment _____

_____

EMERGENCY ACTIONS:

_____

_____

_____

_____

_____

_____

MEETING ATTENDEES

PRINT NAME/ORGANIZATION	Z #	SIGNATURE

Meeting Conducted By: _____ _____
(Print Name) (Title) (Signature)

FU 04 Site Access List

TA _____ Site Work Plan _____ Date _____/_____/_____

Page _____ of _____

Badge Z No.	Name	Group	Training	Task	Time Arrived onsite	Time Enter:Exit Zone (Exclusion)				Time Depart Site	Total time Onsite	PPE Level	Time in Exclusion Zone	Signature
111270	Butler, Nancy	ESH-5	24 hr HW	H&S Rep.										
117207	Daymon, Deba	ERM	40 hr HW	Field Team Mgr										
083071	Hutton, Rick	SAIC	40 hr HW	Field Support										
115401	Harris, Jenny	ERM	40 hr HW	Field Tech										
117228	Hayes, John	ERM	40 hr HW	H&S, SSO										
114816	Koch, Richard	SAIC	40 hr HW	Geologist										
099718	Pratt, Allyn	EES-13	40 hr HW: 8 hr Sup	Manager										
108821	Peifer, Marty	ESH-1	40 hr HW	H&S-RCT Supp										
099070	Romero, Carmella	SAIC	40 hr HW: 8 hr Sup	Site Smpl Coord										
117380	Sontag, Leslie	SAIC	40 hr HW: 8 hr Sup	FTL										
013418	Stafford, David	SAIC	40 hr HW: 8 hr Sup	Sample Tech										

03: 2/1/96